CONFERENCE AND WORKSHOP

CRITICAL ZONE SCIENCE, SUSTAINABILITY AND SERVICES IN A CHANGING WORLD

ORGANIC MATTER FLUX AND STABILIZATION IN THE CRITICAL ZONE

THURSDAY – SATURDAY, OCTOBER 22-24, 2015
Dear conference attendees,

Welcome to the conference and workshop on Critical Zone Science, Sustainability, and Services in a Changing World. It is clear to Earth scientists and natural resource managers that intensification of natural resource extraction from terrestrial systems is occurring at a breakneck pace and in many cases without adequate knowledge—or with complete disregard—of the limits and capacity of the supporting ecosystems, water resources, air and soil quality, and surface geology. The complex interactions across these environmental domains that function to support human activity occur in what has been recently conceptualized as the Earth’s “Critical Zone” (CZ), the thin surface layer from the top of vegetation to the bottom of aquifers. Rapid growth in human population, changing consumption patterns, and climate change are intensifying pressures on the CZ, especially in emerging economies such as China.

This 2015 Joint Annual Conferences of the US-China EcoPartnership for Environmental Sustainability (USCEES) and the China-US Joint Research Center for Ecosystem and Environmental Change (JRCEEC) will focus on critical zone science, sustainability, and services in collaboration with the Cross CZO Working Group on Organic Matter Dynamics. It will bring together and leverage the scientific communities from the USCEES, the JRCEEC, and members of the US Critical Zone Observatory Network (US-CZO) to address key aspects of CZ function and services and the threats to its sustainable use in a changing climate, increasing urbanization and population, and increasing resource extraction pressure.

This conference is organized with a common plenary session each morning followed by afternoon thematic symposia and workshops. The cross-CZO Working Group on Organic Matter (XCZO-WG-OM) has organized afternoon workshops focused on flux, stabilization, and reactivity of organic matter in the CZ with the goal of making recommendations to NSF for common measurements, common methods, common laboratories, and common experiments to support cross-U.S. CZO and international CZ science.

Three workshops have been planned and include 1) multivariate and chemometric methods for large and complex data set analysis in CZ science, 2) organic matter dynamics as controlled by erosion and deposition, 3) mineralogical and microbial controls on soil and sediment OM reactivity and persistence. The findings and recommendations from these workshops will be presented to the CZO National Office and will support the XCZO-WG-OM overarching mission to define what controls 1) the organic matter storage in biomass above the critical zone, 2) organic matter storage and flux in the mineral and soil matrix, 3) gaseous exports of organic matter from the critical zone, and 4) dissolved and colloidal organic matter flux from and within the critical zone. Specifically, the workshop outcomes will include publication of the recommendations for common measures and supporting methods so to better address cross CZO questions related to organic matter dynamics.

We have included a field trip on Thursday, Oct 23 to the Purdue Water Quality Field Station, a large field drainage tile lysimeter system, to highlight the extensive hydrologic modification in the upper Midwest. On the last day of the conference a field trip will explore the field sites for the Intensively Managed Landscapes Critical Zone Observatory. On the way to University of Illinois an in-bus presentation will be given by Diane E Stott, PhD, National Soil Health Specialist USDA/NRCS Soil Health Division on the concept and opportunities associated with the USDA Programs on Soil Health.

We look forward to your participation.

Sincerely, Your Co-Chairs,

Timothy Filley
Professor Purdue University and
U.S. Director of the USCEES

Dali Guo
Professor Institute of Geographic Sciences and
Natural Resources, Chinese Academy of Sciences
HISTORY OF THE USCEES AND JRCEEC COLLABORATION

The USCEES, one of 30 current US-China EcoPartnerships, was established within the U.S.-China Strategic Economic Dialogue framework in May 2011. The six organizations that form the core group of the USCEES combine the capabilities of three U.S. institutions (Purdue University’s Global Sustainability Initiative, University of Tennessee’s (UT) Institute for a Secure and Sustainable Environment and Institute of Agriculture, and the UT-Oak Ridge National Laboratory Joint Institute for Biological Sciences) with three complementary center and institute partners of the Chinese Academy of Sciences (the Institute of Geographic Sciences and Natural Resources Research, the Research Center for Eco-Environmental Sciences, and the Institute of Applied Ecology). The USCEES was developed from the China-U.S. Joint Research Center for Ecosystem and Environmental Change, which was established in July 2006 between the Chinese Academy of Sciences, the University of Tennessee, and Oak Ridge National Laboratory and later Purdue University.

US-China Ecopartnership for Environmental Sustainability

English Language – http://www.purdue.edu/discoverypark/ecopartnership/

本网站中文版 – http://www.purdue.edu/discoverypark/ecopartnership-cn/

China-US Joint Research Center for Ecosystem and Environmental Change

http://jrceec.utk.edu

The Ecopartnership Network:

https://ecopartnerships.lbl.gov

BACKGROUND INFORMATION

BACKGROUND ON THE U.S. NSF CRITICAL ZONE OBSERVATORY NETWORK

The critical zone is defined as the portion of the Earth’s land surface that extends from the top of the vegetation canopy to the lowest limit of circulating groundwater. Critical zone science views the ecological, geological, and hydrological processes taking place in this zone as an integrated and interconnected system that acts over broad spatial and temporal scales and determines the availability of life-sustaining natural resources. The U.S. National Science Foundation (NSF) has created and supports a network of Critical Zone Observatories (CZOs) in the United States. Each CZO has attributes in climate, lithology, land use, biology, and topography that makes its character unique for studying a range of Critical Zone processes. The CZO network, which began in 2007, currently consists of 10 sites. Collaborative research within each CZO, as well as across the CZO network, leverages a diverse and growing scientific community that now has the platform for novel and fundamental advances in knowledge of our Earth system and the study of how Critical Zone processes, like soil formation, stream flow generation, landscape evolution, and the biogeochemical cycling of essential elements, benefit society.

NSF Critical Zone Observatory Network

http://criticalzone.org/national/
OUR PUBLIC AND NOT FOR PROFIT SPONSORS

The U.S. National Science Foundation

The Confucius Institute – Purdue University

Purdue’s Discovery Park Global Sustainability Institute
Global Engineering Program
College of Science
College of Agriculture

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Attending: Yonghao Hou, Patent Attorney
www.faegrebd.com

TEDA U.S. Office
Attending: Jianning Li, Chief Representative; Tingyu Liu, Representative
en.teda.gov.cn
CHAIRPERSONS
Dr. Timothy Filley (Purdue University- Intensively Managed Landscapes(IML)-CZO)
Dr. DaLi Guo (Institute of Geographic Sciences and Natural Resources Research)

ORGANIZING COMMITTEE
Asmeret Berhe (University of California-Merced- Sierra CZO)
Neal Blair (Northwestern University-IML CZO)
Sharon Billings (University of Kansas-Calhoun CZO)
Marie-Anne deGraaff (Boise State University-Reynolds Creek CZO)
Terry Hazen (University of Tennessee)
Chi-Hua Huang (USDA - National Soil Erosion Research Lab)
Chad Jafvert (Purdue University)
Cliff Johnston (Purdue University)
Praveen Kumar (University of Illinois- IML CZO)

Meiling Li (Institute of Geographic Sciences and Natural Resources Research-CAS)
Henry Lin (The Pennsylvania State University -IML CZO and Shale Hills CZO)
Thanos Papanicolaou (University of Tennessee, Knoxville -IML CZO)
Alain Plante (University of Pennsylvania -Luquillo CZO)
Dan Richter (Duke University Calhoun CZO)
Gary Sayler (University of Tennessee)
Ron Turco (Purdue University)
Jie Zhuang (University of Tennessee, Knoxville)

CONTACT INFORMATION
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EMAIL: ericaw@purdue.edu; Phone: 7654947221

Dr. Timothy Filley, Department of Earth, Atmospheric, and Planetary Sciences
Purdue University, West Lafayette, IN. 47907.
EMAIL: filley@purdue.edu; Phone 7654794329

ORGANIZATION WEB SITES
US-China Ecopartnership for Environmental Sustainability
   English Language – http://www.purdue.edu/discoverypark/ecopartnership/
       本網站中文版 – http://www.purdue.edu/discoverypark/ecopartnership-cn/
China-US Joint Research Center for Ecosystem and Environmental Change– http://jrceec.utk.edu
U.S. Critical Zone Observatory Network – http://www.czen.org
HOTEL INFORMATION

ADDRESS
Holiday Inn City Center
515 South St
Lafayette, IN 47901

PHONE
Local: (765) 423-1000

PARKING
Holiday Inn City Center offers complimentary parking to hotel guests. Purdue University will shuttle conferees to and from conference activities.

PRESENTATION SPEAKERS

Power points or PDF versions of talks should can be uploaded in the intersession prior to the talk block. Posted talk times represent the opportunity for your presentation plus questions.

POSTERS

Posters can hung starting from lunch time October 22 and will remain up until the close of the conference in the morning of October 24. The display areas are 4’ wide by 6’ long.

RIVERBOAT DINNER AND CULTURAL CRUISE IN CHICAGO

We are very pleased to invite you to join us for an exciting closing conference event! We have arranged a riverboat dinner and cultural cruise in Chicago highlighting the rich architectural history of that great city. Chicago’s Fair Lady offers a spectacular cruising experience wonderful for stargazing or admiring Chicago’s world renowned skyline! Learn more at www.cruisechicago.com. Boarding will begin upon arrival at 5:30pm and will leave the dock promptly at 6:00pm. Tickets are complimentary for the first 100 registrants. You will be asked in the registration whether you plan on attending the dinner cruise. This includes a 3 hour cruise, a tapas buffet by Café Ba Ba Reeba and beer and wine for the evening. We arrive back to the dock at 9:00pm.

At the close of the final conference dinner we have arranged two options for bus transportation. You can take the bus back to Purdue, arriving approximately 12:30 am local time, or take the bus to the Hilton Garden Inn at O’hare International Airport where we will provide hotel rooms free of charge for our international guests for Saturday night. This hotel offers a free shuttle to the O’Hare International Airport, which you will take to catch your departure flight if you are leaving on October 25 from ORD.
THURSDAY AT A GLANCE

**DAY 1 MORNING**
8:00 – 11:15 am
Grand Ballroom, 2nd Floor, Holiday Inn City Center

Breakfast, talks, signing ceremony for collaborative U.S.-China partnerships, and group photo

At the conclusion of morning activities – bus ride to Beck Agricultural Center.
*Select buses will have a demonstration of ISEE Spatial Integration Software during the ride.*
*Sign up required at registration desk (http://isee.purdue.edu/extra.php?about=isee)*

**DAY 1 LUNCH AND KEY NOTES**
Until 2 pm
Beck Agricultural Center

**DAY 1 TALKS**
2:00 – 5:10 pm
Beck Agricultural Center, Room 117

Anthropogenic Contaminants, Session 1;
Surficial and deep spatial patterns, Session 1

**DAY 1 TALKS**
2:00 – 5:10 pm
Beck Agricultural Center, Room 111AB

Organic Matter Stabilization
Mechanisms in the CZ, Sessions 1,2

**DAY 1 TALKS**
2:00 – 5:10 pm
Beck Agricultural Center, Room 141

Near surface flux of C and N in the CZ, Session 1,2

**DAY 1 TOUR**
5:30 – 6:30 pm
Tour of Purdue Water Quality Field Station – Introduction to modified drainage in the US upper Midwest

**DAY 1 DINNER AND OPEN POSTER SESSION**
6:30 – 8:30 pm
Beck Agricultural Center
## FRIDAY AT A GLANCE

### DAY 2 MORNING
8:00 – 11:15 am  
Grand Ballroom, 2nd Floor, Holiday Inn City Center
  
Breakfast and talks

At the conclusion of morning activities — bus ride to Beck Agricultural Center.  
*Select buses will have a demonstration of ISEE Spatial Integration Software during the ride.*  
*Sign up required at registration desk (http://isee.purdue.edu/extra.php?about=isee)*

### DAY 2 LUNCH AND KEY NOTES
Until 2 pm  
Beck Agricultural Center

### DAY 2 WORKSHOP BREAKOUT A
2:00 – 5:10 pm  
Beck Agricultural Center, Room 111A

### DAY 2 WORKSHOP BREAKOUT B
2:00 – 5:10 pm  
Beck Agricultural Center, Room 111B

### DAY 2 WORKSHOP BREAKOUT C
2:00 – 5:10 pm  
Beck Agricultural Center, Room 141

### DAY 2 TALKS
2:00 – 5:10 pm  
Beck Agricultural Center 117
  
*Anthropogenic Contaminants, Session 1; Surficial and deep spatial patterns, Session 1*

### COLLABORATIVE DISCUSSION TIME

### DAY 2 DINNER AND OPEN POSTER SESSION
6:30 – 8:30 pm  
Beck Agricultural Center
DAY 3 CLOSING REMARKS
Grand Ballroom, 2nd Floor, Holiday Inn City Center

8:30 – 10:15 am
Main group leave for University of Illinois IML and Chicago Final Conference Dinner

In-Bus Presentation by Diane E Stott, PhD, National Soil Health Specialist USDA/NRCS Soil Health Division about USDA Programs on Soil Health.

CROSS CZO OM CORE GROUP
10:30 am – 2:00 pm
Stewart Center 218 A
Day 2 Workshop Breakout A

CROSS CZO OM CORE GROUP
10:30 am – 2:00 pm
Stewart Center 218 B
Day 2 Workshop Breakout A

CROSS CZO OM CORE GROUP
10:30 am – 2:00 pm
Stewart Center 218 C
Day 2 Workshop Breakout A

COMBINED CLOSING SESSION FOR CROSS CZO OM CORE GROUP
2:00 – 3:20 pm

LEAVE FOR CHICAGO
3:30 EDT
Cross CZO OM Core Group

CONFERENCE FINAL DINNER
6:00 – 9:00 CDT
Aboard The Fair Lady (www.cruisechicago.com)

LEAVE FOR AIRPORT HOTEL OR PURDUE UNIVERSITY
9:00 CDT
WEDNESDAY, OCTOBER 21, 2015

All Day Conference Check in
6:00-9:00pm Mixer (cash bar)

THURSDAY, OCTOBER 22, 2015

7:00-8:00 Breakfast: Grand Ballroom, 2nd Floor, Holiday Inn City Center and Conference

8:00-11:00 ORAL SESSION #1 – GRAND BALLROOM, 2ND FLOOR, HOLIDAY INN CITY CENTER

8:00-8:15 TIMOTHY FILLEY, (Purdue University); DALI GUO, (Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Science) Conference Organizers Welcome – History of Bi-National Cooperation of the USCEES and Joint Centers.

8:15-8:45 ENRIQUETA BARRERA, (NSF Program Director, Geobiology and Low Temperature Geochemistry; CZO International Programs) CZ Science— the history, the network, the future

8:45-8:55 MITCHELL E. DANIELS, JR., (President of Purdue University) Welcome Greeting to Purdue

8:55-9:30 PRAVEEN KUMAR, (University of Illinois) Critical Zone Science: An Interdisciplinary Collaborative Landscape

9:30-10:05 DALI GUO, (IGSNRR-Chinese Academy of Sciences) China’s Critical Zone Science based on the China Ecological Research Network

10:05-10:15 Coffee Break

10:15-10:35 SIGNING CEREMONIES
1) Inducting Nanjing University into the USCEES and Joint Centers — Passing the Baton for the 2016 US-China Annual Conference
2) Creation of a joint degree program between Purdue University and Nanjing University

10:35-11:15 CONFERENCE PHOTO
After the conference photo we will take a very short bus ride to the Beck Agricultural Center where we will have lunch, the afternoon thematic sessions, and NSF Cross CZO workshops

11:45-2:00 LUNCH AND KEY NOTE ADDRESSES – BECK AGRICULTURAL CENTER

12:20-1:05 TERRY HAZEN, (University of Tennessee, Knoxville) Microbial Community Structure Predicts Groundwater Geochemistry

1:05-1:50 DAN RICHTER, (Duke University) Linking terrestrial ecosystem metabolism and deep mineral formation
### 2:00-5:10  **AFTERNOON SESSIONS – BECK AGRICULTURAL CENTER**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location 1</th>
<th>Location 2</th>
<th>Location 3</th>
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<tbody>
<tr>
<td>2:00-2:20</td>
<td><strong>Anthropogenic Contaminants in the Critical Zone:</strong></td>
<td>Room 117</td>
<td>Room 111AB</td>
<td>Room 141</td>
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<td>2:00-2:20</td>
<td><strong>OM stabilization mechanisms:</strong></td>
<td>Room 117</td>
<td>Room 111AB</td>
<td>Room 141</td>
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<tr>
<td>2:00-2:20</td>
<td><strong>Near surface flux of C and N from catchments:</strong></td>
<td>Room 117</td>
<td>Room 111AB</td>
<td>Room 141</td>
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</tbody>
</table>
| 2:00-2:20 | **Hongyan Guo**  
Nanjing University  
Mesocosm Study on Fate and Ecologic Effect of Pollutants in Critical Zone | | | |
| 2:00-2:20 | **Jeff Dukes**  
Purdue University  
Moisture dependence of above- and below-ground responses to warming in an old-field ecosystem | | | |
| 2:00-2:20 | **Asmeret Asefa Berhe**  
University of California, Merced  
Landscape Biogeochemistry: how soil erosion controls storage, stabilization and destabilization of soil organic matter in dynamic landscapes | | | |
| 2:20-2:40 | **Ji Rong**  
Nanjing University  
Fate of the Brominated Flame Retardant Tetrabromobisphenol-A (TPPBA) in Soil | | | |
| 2:20-2:40 | **Chao Liang**  
Institute of Applied Ecology-CAS  
Dual Control of Soil Carbon Storage by Microbial Catabolism and Anabolism. | | | |
| 2:20-2:40 | **Thanos Paniconolaou**  
University of Tennessee, Knoxville  
A Landscape-oriented Approach to Simulate Soil Organic Carbon Dynamics in Intensively Managed Landscapes | | | |
| 2:40-3:00 | **Jiang Liu**  
University of Tennessee, Knoxville  
Microbial Community Changes and Crude Oil Biodegradation in Different Deep Oceans | | | |
| 2:40-3:00 | **Michael Weintraub**  
University of Toledo  
Challenges Predicting Decomposition Temperature Responses in the Critical Zone. | | | |
| 2:40-3:00 | **Huang Chi-Hua**  
USDA National Soil Erosion Research Laboratory  
Challenges in current process-based soil erosion prediction models | | | |
| 3:00-3:20 | **Chen Gu**  
Nanjing University  
Enhanced Photoreduction of Nitro-aromatic Compounds by Hydrated Electrons Derived from Indole on Natural Montmorillonite | | | |
| 3:00-3:20 | **Javier Gonzalez**  
USDA - National Soil Erosion Research Laboratory  
Land use influences soil lignin in hill-land environments. | | | |
| 3:00-3:20 | **Rebecca Lever**  
University of California, Merced  
Lateral mobilization of soil and soil organic matter after the Rim Fire, Yosemite National Park | | | |
<p>| 3:20-3:30 | Coffee Break | | | |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker Name</th>
<th>Affiliation</th>
<th>Topic</th>
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<tbody>
<tr>
<td>3:30-3:50</td>
<td>Surficial and Deep Spatial Patterns in the CZ: 1</td>
<td>DARRELL SCHULZE</td>
<td>Purdue University</td>
<td>Visualizing Soil Landscapes - Seeing the CZOs in the Larger Context.</td>
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<td>MARIE-ANNE DEGRAAFF</td>
<td>Boise State University</td>
<td>Plant root impacts on soil organic carbon dynamics.</td>
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<td>CHENGYI ZHAO</td>
<td>Xinjiang Institute of Ecology and Geography, Chinese Academy of Science</td>
<td>Soil CO2 efflux and concentration under drip irrigation in dry-land agriculture, China</td>
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<td>3:50-4:10</td>
<td>OM stabilization mechanisms: 2</td>
<td>JIE ZHUANG</td>
<td>University of Tennessee, Knoxville</td>
<td>Impact of Land Use on Soil Organic Matter Preservation: Pore-Scale Mechanisms</td>
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<td>TANJA WILLIAMSON</td>
<td>United States Geological Survey</td>
<td>How do simulations of soil-water movement differ depending on how hydrologic properties are characterized?</td>
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<tr>
<td>4:10-4:30</td>
<td>Near surface flux of C and N from catchments: 2</td>
<td>SHAOQIANG WANG</td>
<td>Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences</td>
<td>Spatial-temporal patterns of GPP simulation based on BEPS and LUE models in China from 1982 to 2011.</td>
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<td>4:30-4:50</td>
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<td>YUNTING FANG</td>
<td>Institute of Applied Ecology-CAS</td>
<td>Minor contribution of anammox to nitrogen removal in two temperate forest soils.</td>
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<td>PAN GENXING</td>
<td>Nanjing Agricultural University</td>
<td>Carbon stability versus microbial activity in aggregate size fractions across a rice soil chronosequence from Eastern Chin</td>
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<tr>
<td>4:50-5:10</td>
<td></td>
<td>CHUNJIANG LI</td>
<td>Shanghai Jiao Tong University</td>
<td>Multiple-element stoichiometric traits at different trophic levels in a food chain across temperate and subtropical biomes: Patterns of variation and the influential factors.</td>
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5:30-5:50     | Tour of Purdue Water Quality Field Station — Introduction to modified drainage in the US upper Midwest — Group A |
|              | 5:30-8:30                                                                                         | Dinner at Beck Center                |
|              | 6:30-8:30                                                                                         | Open Poster Session                 |
7:00-8:00  Breakfast: Grand Ballroom, 2nd Floor, Holiday Inn City Center and Conference

8:00-11:00  GRAND BALLROOM, 2ND FLOOR, HOLIDAY INN CITY CENTER

8:00-8:45  SONNY RAMASWAMY,  (Director, National Institute of Food and Agriculture United States Department of Agriculture)
Critical Zones: Food and Agriculture Perspectives

SCALES OF INTERACTION ACROSS THE CZ

8:45-9:05  PETER NICO,  (Berkeley National Laboratory)
Linking metal biogeochemical cycles to carbon chemistry

9:05-9:25  STEVE BANWART,  (The University of Sheffield)
Rock Weathering by Mycorrhizal Fungi – Capturing Solar Energy for Soil Formation

9:25-9:45  KYUNGSOO YOO,  (The University of Minnesota)
Organic matter meets minerals: earthworms and erosion

9:45-9:55  Coffee Break

The priming effect of different carbon inputs on soil organic carbon mineralization

10:15-10:35  SHARON BILLINGS,  (University of Kansas)
Can we explain CZ-scale patterns of C dynamics using small-scale experiments?

10:35-10:55  JANE WILLENBRING,  (University of Pennsylvania)
Landscape influence on soils, nutrient pools, and canopy biomass in a tropical forest

10:55-11:15  GREG MICHALSKI,  (Purdue University)
Multiple Stable Isotope Approach for Assessing N Sources and Processing in Runoff

After 11:15 we will take a very short bus ride to the Beck Agricultural Center where we will have lunch, Key note, and the afternoon thematic sessions, and NSF Cross CZO workshops.

11:45-2:00  LUNCH AND KEY NOTE ADDRESSES – BECK AGRICULTURAL CENTER

12:20-1:05  MINGAN SHAO,  (Institute of Geographic Sciences & Natural Resources Research, Chinese Academy of Sciences)
Using Critical Zone (CZ) Science to Understand Soil and Water Processes in the Loess Plateau: Opportunities and Challenges

1:05-1:50  NEAL BLAIR,  (Northwestern University)
Tracking Organic C from Uplands to the Deep-sea
FRIDAY, OCTOBER 23

2:00-5:10  DAY 2 WORKSHOP BREAKOUT SESSIONS

Session A – Beck Agricultural Center, Room 111A
Session B – Beck Agricultural Center, Room 111B
Session C – Beck Agricultural Center, Room 141

2:00-5:10  AFTERNOON SESSIONS – BECK AGRICULTURAL CENTER, ROOM 117

ANTHROPOGENIC CONTAMINANTS IN THE CRITICAL ZONE: 2

2:00-2:20  CHAD JAVERT, (Purdue University)
How Critical Zone functions and chemical specific properties interact to regulate contaminant reactivity, mobility, and mean residence time

2:20-2:40  TIM BERRY, (Purdue University)
Microbial Response to Carbon Nanomaterials in Agricultural Soils with Contrasting Properties

2:40-3:00  XUILI DANG, (Shenyang Agricultural University)
Phosphate removal from aqueous solution by switchgrass-derived biochar produced by fast pyrolysis

3:00-3:20  WENDELL WALTERS, (Purdue University)
Nitrogen stable isotope composition of various fossil-fuel combustion nitrogen oxide sources

3:20-3:30  Coffee Break

SURFICIAL AND DEEP SPATIAL PATTERNS IN THE CZ: 2

3:30-3:50  NAN SHAN, (Nanjing University)
Research on the placement of the ecological shelter buffer in the Three Gorges Reservoir Area, China

3:50-4:10  YANGJIAN ZHANG, (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)
Separating effects of anthropogenic activities and climate change on vegetation dynamics on the Tibetan Plateau

4:10-4:30  ZEQING MA, (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)
Functional biogeography of root traits from deserts to tropical forests

4:30-4:50  HUIMIN WANG, (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)
Thinning effect on the carbon balance of a coniferous plantation in subtropical China

5:30-6:30  Tour of Purdue Water Quality Field Station – Introduction to modified drainage in the US upper Midwest – Group B

6:30-8:30  Dinner at Beck Center

6:30-8:30  Open Poster Session
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<td>7:00-8:00</td>
<td>Breakfast: Grand Ballroom, 2nd Floor, Holiday Inn City Center and Conference</td>
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</table>
| 8:30-10:15| Main group leaves for University of Illinois IML and Chicago Final Conference Dinner  
In-Bus Presentation by Diane E Stott, PhD, National Soil Health Specialist USDA/NRCS Soil Health Division about USDA Programs on Soil Health |
| 10:30-2:00| Cross CZO OM Core Group Day 2 Workshop Breakouts, Stewart Center     |
| 2:00-3:20 | Combined closing session for Cross CZO OM core groups               |
| 3:30 (EDT)| Cross CZO OM core group leave for Chicago Final Conference Dinner   |
| 6:00-9:00 (CDT)| Conference Final Dinner aboard The Fair Lady (www.cruisechicago.com) |
| 9:00 CDT  | Groups leave for either Airport Hotel or back to Purdue and depart October 25 |
The priming effect of different carbon inputs on soil organic carbon

mineralization

Edith Bai, Hui Wang, Thomas W. Boutton, Guoqing Hu, Wenhua Xu

aState Key Laboratory of Forest and Soil Ecology, Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang, 110016, China
bCollege of Resources and Environment, Shandong Agricultural University, Taian, 271018, China
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dNational Field Observation and Research Station of Shenyang Agroecosystems, Shenyang 110016, China

Changes in biogeochemical cycles and the climate system due to human activities are expected to change the quantity and quality of plant litter inputs to soils. How these changes might influence the priming effect (PE) on soil organic matter (SOM) mineralization is still under debate. Here we used $^{13}$C labeling technique to investigate the effects of substrate quantity and quality on PE in forest soils. We found with an increasing WSC addition rate, cumulative PE increased for both layers, but tended to level off when the addition rate was higher than 400 mg C kg$^{-1}$ soil. This saturation effect indicates that stimulation of soil C loss by exogenous substrate would not be as drastic as the increase of C input. In fact, we found that the mineral layer with an WSC addition rate of 160 – 800 mg C kg$^{-1}$ soil had net C storage although positive PE was observed. Different effects of substrate quality on priming effect were mainly due to different patterns of microbial utilization of substrate. Soils amended with stalks had a higher cumulative PE than those amended with leaf. Our study suggested that under global change with higher C input and lower C quality, SOM mineralization would be stimulated. Soil microbial demand of C and nutrients is the most important control of priming effect and should be further explored. The organic layer of temperate forest soils is very important for carbon cycling and should be simulated separately from the mineral layer in ecosystem models.
Rock Weathering by Mycorrhizal Fungi – Capturing Solar Energy for Soil Formation

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Mycorrhizal symbiosis between soil fungi and the roots of host plants provides a pathway for some of the largest and most ubiquitous fluxes of organic carbon between the above- and below-ground environments of Earth’s Critical Zone. More than 90% of all land plants are mycorrhizal and can actively direct up to 25-30% of fixed photosynthate carbon from the host plant into the soil weathering environment. This occurs via the direct flow of carbon from plant roots into the attached hyphal network (Taylor et al., 2009). New evidence of biological weathering mechanisms demonstrates that hypha direct the photosynthate flux into specific weathering zones that contain nutrient resources that can support plant growth (Smits et al., 2012). Results from weathering experiments in axenic microcosms with ectomycorrhizal fungi grown in symbiosis with pine seedlings demonstrate that active weathering zones exhibit a correlation between the flux of photosynthate and the mass transfer of Ca from mineral phases as a proxy measure for the rate of rock and mineral weathering (Schmalenberger et al., 2015). Field studies also quantify the extent of physical and chemical alternation of mineral phases emplaced in the rooting zone of a range of tree species with well-know, distinct mycorrhizal associations (Quick et al., 2012). The results demonstrate that rates of weathering depend on the carbon flux to the weathering zones rather than the amount of hyphal biomass present, and that rates of biological weathering by mycorrhizal fungi can be up to 100 times greater than those observed for abiotic dissolution of minerals in laboratory studies using pure minerals immersed in bulk aqueous solution. Results from the laboratory and field studies are used to conceptualise and parameterise biological weathering rate functions for a wide range of climate and lithology, thus enabling some of the first estimates of the impact of this biological weathering mechanisms on global weathering fluxes for modern Earth and through the geological past since the rise of land plants and their mycorrhizal symbionts (Taylor et al., 2012).

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Landscape Biogeochemistry: how soil erosion controls storage, stabilization and destabilization of soil organic matter in dynamic landscapes

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ABSTRACT: Theme Category A, D, F
The Earth's land surface is dominated by sloping landscapes, and soil erosion is a ubiquitous process on the earth's surface. Biogeochemical cycling of essential elements in the terrestrial biosphere, at least partly, takes place in a dynamic reservoir of mineral and organic materials (i.e. the soil) that is continually moved and mixed around in the landscape by soil erosion and other mass movement events. Among other things, soil erosion plays important role in regulating fluxes of carbon, nitrogen, and phosphorous within and out of the soil system; and their storage, distribution within the soil matrix, and residence times in soil. In this talk, I will present insights gained from work in the Southern Sierra Critical Zone Observatory (CZO) and beyond to highlight the importance of lateral mass movement on organic matter dynamics in the terrestrial biosphere and its flux to the hydrosphere. After a brief discussion on how our understanding of the role of erosion on terrestrial carbon sequestration has evolved over the last two decades, I will present some of the latest findings of mechanistic and modeling works related to erosion and deposition from different CZOs and other sites. I will also discuss some interesting research questions that can be tackled at the level of CZOs.
Microbial Response to Carbon Nanomaterials in Agricultural Soils with Contrasting Properties

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Abstract: Theme Category B

Carbon nanomaterials (CNM) such as nanotubes and buckminsterfullerene (C₆₀) are highly-condensed structures with applications in microelectronics, drug-delivery, and manufacturing. Unfortunately, the same resilience that makes these next-generation materials so promising also limits their degradation in the environment, raising concerns about CNM accumulation following accidental release or the disposal of CNM containing products. Furthermore, recent studies have found that CNM contamination of soils can have detrimental effects on microorganisms and invertebrates known to be important in soil nutrient cycling. However, since soils can differ radically in chemical composition and physical structure across a landscape it is important to understand how soil properties mediate the impacts of CNMs on soil microorganisms.

To explore the role of soil properties in controlling microbial responses to CNM we conducted laboratory microcosm incubations using two agricultural soils with similar land-use history but contrasting properties, the organic and clay rich Drummer soil and the less organic, sandier Clermont soil. Microcosms were treated with C₆₀-fullerenes or the more oxidized fullerols, each with ¹³C-enrichment to allow for accurate quantification of CNM mineralization. While neither soil was able to mineralize pristine fullerenes, both soils were able degrade the more oxidized analog; Drummer soil mineralized 59.1% of added fullerols while Clermont mineralized 25.9%.

As a potential measure of soil health, bacterial community structure was assessed by PCR-DGGE. Fullerenes significantly altered the community structure of both soils, with the community in the less organic soil undergoing larger shifts in composition. Interestingly, this trend was reversed in soils containing the more oxidized fullerols; the community in the clay and organic rich soil was significantly impacted while the sandier soil was not. The differing responses of the soils to CNM exposure in this study highlight the importance of considering edaphic properties when assessing the impacts of anthropogenic contaminants.
Can we explain CZ-scale patterns of C dynamics using small-scale experiments?

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Abstract: Theme Categories C, D, F

Illumination of the mechanisms governing ecosystem-scale processes (equivalent to the scale of the critical zone, CZ) often requires controlled, mechanistic laboratory studies. However, scaling phenomena observed in small, reductionist systems up to the scale of the CZ in both space and time is challenging. For example, historically agricultural plots at the Calhoun CZ observatory likely experienced reduced inputs of organic matter (OM) deep within the profile for >150 y. Many of those same plots also experienced erosional loss of the original surface horizon. As a result, forests re-growing on former agricultural land are supported by previously deeper horizons whose OM stocks are small compared to soil profiles in intact, old-growth hardwood stands. Given the importance of soil OM mineralization for ecosystem productivity, these large-scale features of the landscape likely influence contemporary ecosystem function. However, the fundamental microbial mechanisms linking depth-related variation in soil OM characteristics to modern forest C balances remain unclear. We are working across scales to address these issues by conducting microcosm studies of isolated soil bacteria, mesocosm studies of soil organic matter (SOM) decay and mineralization, and ecosystem studies of altered soil profiles in both upland and lower landscape positions. Using stoichiometric characteristics of eroded and intact soil profiles as guides, we are varying the ratios of resources available to bacteria growing at a known rate and quantifying C flow into their biomass vs. CO₂. We compare these rate responses to resource ratios with those observed during decay and mineralization of incubating SOM from multiple depths which exhibit similar, natural variation in resource ratios. Preliminary results from this on-going project suggest that by working across scales and incrementally increasing the complexity of our experimental systems, we can elucidate some of the fundamental, small-scale mechanisms driving ecosystem processes observed across far greater temporal and spatial scales.
Tracking Organic C from Uplands to the Deep-sea

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Our classic view of soil organic matter is that it is a penecontemporaneous mixture in which an aged, diagenetically altered component (humic material) is derived from previous inputs of photosynthetically-derived material. In reality, particulate organic carbon (POC) in surficial environments (both soils and sediments) is a mixture that can be fundamentally resolved into three general categories: contemporary (recently fixed C), aged (century to millennial time scale) and ancient (millions of years old). The relative abundances of these three C-pools are highly dependent on the environment and they evolve as particulates move across the landscape and bathyscape. In this talk, a global-scale conceptual model will be presented that describes the behavior of these POC mixtures in coupled watershed-marine systems. The implications of this research within the context of global environment change will be considered.
Phosphate removal from aqueous solution by switchgrass-derived biochar produced by fast pyrolysis

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**ABSTRACT: Theme Category G**

The removal of phosphate from aqueous solution by biochar derived from switchgrass was investigated. Switchgrass-derived biochar was produced through fast pyrolysis at 450°C and 800°C and their physicochemical properties were determined. Batch adsorption experiments were performed to investigate the effect of contact time, initial pH, and ionic strength on the removal of phosphate by biochar. The results showed that the adsorption process was time dependant. The phosphate adsorption decreases as pH and electrolyte concentration increase. The removal of phosphate increased by increasing the biochar production temperature. The pseudo second-order model fitted the data better than other mathematical models used to describe the adsorption kinetics of phosphate onto biochar. The adsorption equilibrium fitted well to both the Langmuir and Freundlich models. The characteristics of post-adsorption biochar were measured using XRD and FTIR. Based on the experimental results phosphate seem to be efficiently removed from solution by adsorbing onto MgO particles on the biochar surface. The results suggest that switchgrass-derived biochar pyrolyzed at higher temperature is an effective alternative inexpensive adsorbent, which can be used to reclaim phosphate from water or reduce phosphate leaching from fertilized soils.
Plant root impacts on soil organic carbon dynamics

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Plant roots are an important conduit of soil carbon (C) input and stabilization through the processes of root exudation and root decomposition. However, enhanced root-derived C inputs can also stimulate destabilization of soil organic C (SOC) by priming microbial activity, leading to a smaller than expected increase in soil C content. Environmental perturbations, such as climate change can alter root morphology, and this may impact the quantity of root-derived soil C inputs and SOC decomposition rates. Using field studies in concert with controlled laboratory incubations, we explored how specific root length (SRL) and changes therein may affect root-derived C inputs, root decomposition and SOC dynamics. Using Panicum virgatum as a model plant, we found that subtle differences in SRL among cultivars influenced the rate of soil C input through exudation, with a positive correlation between SRL and plant-derived C recovered in soil four years following establishment. In addition, a relative increase in the abundance of roots in the smallest diameter size class enhanced root decomposition rates, but reduced SOC decomposition rates. These data suggest that small changes in SRL following an environmental perturbation may significantly alter root C inputs, which may be explained by a change in the root surface area from which exudation occurs. Furthermore, changes in SRL can impact root decomposition rates by changing the relative abundance of roots of different diameter size classes. These changes can further impact SOC dynamics across the profile and should be taken into account when modeling impacts of environmental perturbations on SOC cycling.
Moisture dependence of above- and belowground responses to warming in an old-field ecosystem

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ABSTRACT: Theme Category F

Future rates of climate change will depend in part on biosphere-atmosphere feedbacks, including those mediated by the carbon cycle. Warming surface temperatures will affect carbon uptake and losses from ecosystems, and the magnitude and even sign of these carbon cycle feedbacks will depend strongly on both the degree of warming and the availability of moisture. To examine the degree to which species and ecosystem responses to warming are nonlinear and moisture-dependent, we exposed plots of an old field with tree seedlings to factorial combinations of warming (four levels, from ambient to +4°C) and precipitation (-50%, ambient, and +50%). We measured responses of plant growth and soil processes to the treatments over six years. In general, responses of plant and soil processes to warming depended strongly on precipitation treatments. Warming typically decreased plant growth under dry conditions, but had no effect or increased growth under ambient or wet conditions. Warming affected growth of seedlings of some tree species (Acer rubrum, Betula lenta) more strongly than others (Pinus strobus, Quercus rubra). Heterotrophic respiration and nitrogen transformations accelerated under warming, but only in treatments and/or seasons with sufficient soil moisture. These processes also became less sensitive to temperature in warmed plots. Responses of carbon uptake (plant growth) to warming were generally offset by responses of carbon loss (heterotrophic respiration), to yield little overall response of net ecosystem exchange to warming. Understanding the character of land and soil process responses to warming, and their dependence on soil moisture, improves our ability to represent these processes in models and correspondingly improves our ability to realistically model carbon feedbacks to climate from the land surface.
Minor contribution of anammox to nitrogen removal in two temperate forest soils

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ABSTRACT: Theme Category A, F
Anaerobic ammonium oxidation with nitrite reduction to dinitrogen (termed as anammox) has been reported to be an important process removing the fixed nitrogen (N) in marine ecosystems, some agricultural or wetland soils. However, its importance in upland forest soils has been never quantified. In this study, we evaluated the occurrence of anammox activity in two temperate forest soils from northeastern China. With $^{15}$N-NO$_3^-$ labelling, we found that anammox and co-denitrification mainly presented in the surface 10 cm mineral soil layer with potential rates, with their combined N$_2$ production rates ranging from 0.02 ± 0.01 to 1.29 ± 0.19 nmol N g$^{-1}$ dry soil h$^{-1}$ when the incubation headspace filled with ultrahigh purity N$_2$ gas and from 0 to 0.56 ± 0.03 nmol N g$^{-1}$ dry soil h$^{-1}$ when the incubation headspace filled with room air, respectively. Anammox and co-denitrification accounted for 2.6 - 13.5% of total N$_2$ production over the whole 40 cm soil profile. However, the labelling experiments with $^{15}$N-NH$_4^+$ and $^{15}$N-NO$_2^-$ indicated that co-denitrification might be a more important process than anammox in N$_2$ production. Phylogenetic analyses showed that anammox genera were present in the examined soils, including Candidatus Brocadia fulgida and Candidatus Jettenia asiatica. Abundance of anammox bacteria hzsB gene was below the detection limit. Our results demonstrate that anammox process existed but its contribution to N$_2$ loss might be minor in the study forest soils. However, we suggest that biogeography of anammox bacteria and their activities should be further studied in other forest soils, e.g., in tropical regions, for the understanding of the N cycle at the global scale.
Understanding macroscale invasion patterns and processes

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ABSTRACT: Theme Category G

Invasion of exotic species poses a major threat to many ecosystems, resulting significant ecosystem degradation and economic loss. Research on the invasion of exotic species has been a major topic in the last two decades and much knowledge has been accumulated on invasion ecology from small plot research. However, our understanding of the long-term invasion process at regional to continental scale is limited, partially due to the lack of long-term, largescale empirical data. In this presentation, we demonstrate the use of FIA data to explore the following two research questions: (1) Are some regions more vulnerable to invasion than others, and what cross- and within-taxonomic generalizations can be made about these patterns? (2) What are the underlying processes that lead to the emergence of the spatiotemporal invasion patterns and how can the key within- and cross-scale interactions and thresholds/tipping points in invasion processes be identified?
Transport and Fate of Nutrients in the Cornbelt Region of the United States

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Abstract

Excess nutrients in streams have ecological, human health, and economic consequences. The Cornbelt Region in the Midwest United States is one of the most intensively farmed and agriculturally productive regions in the world. The flat landscapes, fertile soils, and humid temperate climate make it well suited for agricultural production. One requirement of intensive agriculture is the application of large amounts of fertilizer and manure to fields, some of which ends up in streams and groundwater. This has led the Cornbelt Region to have some of the highest concentrations of nutrients in streams and groundwater in the country. Examples of nutrient hotspots from the Cornbelt Region will be shown.

Two of the main factors that control the movement and removal of nutrients from the ecosystem are: (1) hydrology and (2) geochemistry of nutrients, or environmental conditions that either augment or inhibit the movement of nutrients. Tile drains are widely used to improve crop yields by removing water from fields but they also transport dissolved nutrients, especially nitrate and orthophosphate, from fields to rivers. Overland flow typically transport more suspended sediment and compounds bound to soil, such as phosphorus and pesticides, from fields to rivers. Examples of nutrient concentrations and loads from several studies from the various environmental compartments will highlight the differences in transport pathways. New continuous monitoring of nitrate and orthophosphate provide insight into nutrient transport pathways and nutrient processing. On a landscape level, regional studies provide insight into what are the most important variables in determining stream nitrate concentrations.

Processing of nutrients such as denitrification or biological uptake can greatly effect stream concentrations and biologically community composition. A method of using nutrients, algal biomass, and biological community data will show how to determine nutrient reference conditions in the Midwest.
Abstract

The effect of Pyrogenic Organic Matter on native soil carbon is dependent upon its wood source and charring temperature

Authors: Christy Gibson, Timothy Filley, Pierre_Joseph Hatton, Knute Nadelhoffer, Ruth Stark, and Jeffrey Bird

Fire is a major mediator of carbon (C) cycling in forests and can result in the formation of pyrogenic organic matter (PyOM). The biological reactivity of PyOM is largely dependent upon the physiochemical characteristics of source material and production temperature. As a result, PyOM can persist up to centennial time scales after deposition while simultaneously enhancing or suppressing the mineralization of native soil C (NSC).

To investigate the interactive effects of PyOM source and production temperature on NSC, we added \textsuperscript{13}C-enriched red maple (RM) or jack pine (JP) pyrolyzed at 200, 300, 450 or 600°C to a low C (0.5%;), near-surface soil (0–20 cm-depth) at 60% water holding capacity and 11% of native soil C and then incubated the samples in the dark at 25°C for 6 months.

We found that PyOM mineralization rates decreased with increasing pyrolysis temperature for either species while NSC mineralization was suppressed across all treatments with the largest decrease observed in JP 300°C. This decrease in mineralization corresponded to an increase in the mean residence time (MRT) of the labile (~12- 18 days) and resistant (~2-5 years) pools compared to un-amended controls (9 days and 1.5 years respectively). MRT of PyOM-C was significantly higher in PyOM >300°C resulting in MRT of ~150 – 400 y compared to ~1–10 y in lower temperature PyOM (0-300 °C). The modelled active and slow pools of PyOM-C mineralized decreased with increasing combustion temperature. JP 300°C had a 20% smaller active pool when compared to RM suggesting that for both species, 300°C - 450°C represented a thermal transition point.

These results highlight how differences in PyOM physiochemical characteristics linked to a species thermal transformation threshold may be a predictor in determining its biological reactivity in soil.
Potential and diversity of CO2-assimilating microbes in typical agricultural soils
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Like higher plants, microbial autotrophs possess photosynthetic systems that enable them to fix CO₂. Whilst present in large numbers in soils, the importance of microbial CO₂ fixation and the relative contributions of microbial autotrophic growth in the sequestration of soil carbon are less well understood. In this paper, the diversity and abundance of CO₂-fixing bacteria were investigated using terminal restriction fragment length polymorphism (T-RFLP) and quantitative PCR of the \textit{cbbL} gene (encodes for RubisCO) in soils incubated for 80 days in a closed, continuously labeled \textit{¹⁴C-CO₂} atmosphere, and the \textit{¹⁴C}-labelled organic C synthesized was determined. The results indicate that the synthesis rates of \textit{¹⁴C}-labelled organic C ranged from 0.0134 to 0.103 g C m\(^{-2}\) d\(^{-1}\), which represent an annual, global rate of about 0.6–4.9 Gt C, and were closely related to RubisCO activities and the abundance of \textit{cbbL}-genes in the soils, indicating that the synthesis could be attributed to soil microbial autotrophs. The \textit{cbbL} abundances for bacteria and non-green algae, as detected using real-time qPCR, varied between \(10^6\) to \(10^8\) copies g\(^{-1}\) soil, and between \(10^3\) to \(10^5\) copies g\(^{-1}\) soil, respectively. Bacterial \textit{cbbL} abundance was shown to be positively correlated with RubisCO activity (\(r = 0.839, P < 0.05\)). Phylogenetic analysis showed that the dominant \textit{cbbL}-containing bacteria were \textit{Azospirillum lipoferum}, \textit{Rhodopseudomonas palustris}, \textit{Bradyrhizobium japonicum}, \textit{Ralstonia eutropha}, and \textit{cbbL}-containing, non-green algae of the genera \textit{Xanthophyta} and \textit{Bacillariophyta}. Multivariate statistics analyses of community profiles obtained using T-RFLP revealed significant variations in \textit{cbbL}-containing microbial communities among different soil types and SOC was the most dominant factor regulating the diversity of \textit{cbbL}-containing microbe. This finding suggests that microbial assimilation of atmospheric CO₂ is an important process in the sequestration and cycling of terrestrial C that, until now, has been ignored.

Key words: Microbial autotrophy, soil carbon sequestration, CO₂ fixation, \textit{¹⁴C} continuous labeling, \textit{cbbL}, RubisCO
Land use influences soil lignin in hill-land environments

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**ABSTRACT: Theme Category D, F**

Lignin, the third most abundant plant constituent after cellulose and hemicellulose, is thought to be one the building blocks for soil organic matter formation. Assessment of soil lignin composition may be useful as a predictor for long-term soil organic matter stabilization and for storing carbon. Soil lignin changes during a succession of a forest to silvopasture/pasture systems in a hill-land environment were evaluated by alkaline CuO oxidation with a microwave digestion system. The results of this study showed soil lignin differences with land use, as determined by the sum the vanillyl, syringyl, and cinnamyl groups. The recently established (7-years old) silvopastoral system contained higher lignin content than the older established (>15 years old) forest and pasture systems. However, the soil humic acids from the forest sites contained more C-lignin, followed by the pasture and silvopasture systems. Furthermore, land use influenced lignin degradation, as indicated by the acid/aldehyde ratios of the vanillyl and the syringyl groups; highest acid/aldehyde ratios were observed in the soils from the pasture systems, followed by soils from forest and silvopastoral systems. Contribution of woody and non-woody material to the soil lignin was similar for both silvopastoral and forest soils, as indicated by the low cinnamyl/vanillyl ratios. The above results indicate that conversion or change of land use influences lignin quantity and quality; the highest yet youngest lignin content, derived from both woody and non-woody tissues were observed in the newer established silvopasture system, suggesting that tree residues in silvopastoral systems decomposed faster than in forest systems. Conversely, open pasture had more decomposed and humified lignin.
Enhanced Photoreduction of Nitro-aromatic Compounds by Hydrated Electrons Derived from Indole on Natural Montmorillonite

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ABSTRACT: Theme Category B

A new photoreduction pathway for nitro-aromatic compounds (NACs), and the underlying degradation mechanism are described. 1,3-Dinitrobenzene was reduced to 3-nitroaniline by the widely distributed aromatic molecule indole; the reaction is facilitated by montmorillonite clay mineral under both simulated and natural sunlight irradiation. The novel chemical reaction is strongly affected by the type of exchangeable cation present on montmorillonite. The photoreduction reaction is initiated by the adsorption of 1,3-dinitrobenzene and indole in clay interlayers. Under light irradiation, the excited indole molecule generates a hydrated electron and the indole radical cation. The structural negative charge of montmorillonite plausibly stabilizes the radical cation hence preventing charge recombination. This promotes the release of reactive hydrated electrons for further reductive reactions. Similar results were observed for the photoreduction of nitrobenzene. In situ irradiation time-resolved electron paramagnetic resonance and Fourier transform infrared spectroscopies provided direct evidence for the generation of hydrated electrons and the indole radical cations, which supported the proposed degradation mechanism. In the photoreduction process, the role of clay mineral is to both enhance the generation of hydrated electrons, and to provide a constrained reaction environment in the galley regions, which increases the probability of contact between NACs and hydrated electrons.
China’s Critical Zone Science based CERN

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ABSTRACT: Theme Category D, G

Chinese Ecosystem Research Network (CERN) was launched in 1988 to facilitate long-term research on continental-scale ecological and biogeochemical processes and their interactions with human systems. CERN consists of 40 field stations, representing diverse ecosystem types including croplands, forests, grasslands, deserts, wetlands, lakes, and urban ecosystems. During the past 30 years of monitoring, research and extension, CERN stations produced critical knowledge of long-term patterns and processes in various ecosystems in China, which has been valuable in guiding government policy in preserving and restoring ecosystems across the country.

Recently based on the CERN, China Critical Zone Observatory (ChinaCZO) begun to take shape with a focus on the fundamental questions of the Critical Zone Science. In the next ten years, ChinaCZO, working with our partners, will seek deeper understanding of the links and feedbacks between biological and geological processes, and their interactions with human society. Under the CZ Science framework, six seed stations have been chosen by CERN to establish comprehensive observation systems from the bedrock to the atmosphere. Each seed station is unique in its own way in geology, biogeochemistry, ecohydrology, ecosystem type, and human disturbance history, covering Karst woodlands, Loess grasslands, red soil agricultural fields and subtropical forests. ChinaCZO will work with international partners for solutions to climate change, land use, food production and water quality with a cross-disciplinary approach across multiple temporary-spatial scales.
Mesocosm Study on Fate and Ecologic Effect of Pollutants in Critical Zone

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ABSTRACT: Theme Category B
To study the environmental behavior and ecological effect of typical pollutants in Critical Zone, we established a field mesocosm system with lysimeters installed on-site in Changshu Agroecological Experimental Station, the Chinese Academy of Science (Changshu, Jiangsu, China) (31°32’45”N, 120°41’57”E). Performed over years in the field mesocosm system with rice-wheat rotation planting, our study provided a good insight into the fate of polyaromatic hydrocarbon (PAHs), and polybrominated diphenyl ethers (PBDEs) under field situation. Surface soils were spiked with naphthalene, phenanthrene and decabromodiphenyl ether (BDE-209). Results showed that spiked PAHs in the soil decreased mainly through gaseous losses (>80% naphthalene and >70% phenanthrene mineralized to CO₂ after 1 year). BDE-209 in lysimeter decreased mainly through leaching (about 65% loss after 4 years) indicating risks to groundwater safety. Determination of the vertical distribution of pollutants showed that PAHs and PBDEs were mainly located in the top 0-20 cm layer. In addition, our results showed accumulation of the spiked pollutants in plants especially in grains, which could be a serious problem related to food safety. After 4 years, PAHs showed no significant effects on soil enzyme activities, but PBDEs still showed effects on soil fertility by elevating urease activity and inhibiting protease activity. Future study will focus on the ecological resilience of agricultural system to environmental pollution.
Microbial Community Structure Predicts Groundwater Geochemistry

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Abstract
At the Department of Energy’s Oak Ridge field site, over 20 years of historical and published data for more than 800 groundwater wells is available in a computer queryable database. In this study, we conducted a survey of 99 groundwater well clusters in order to (1) characterize key microbial populations at geochemically distinct locations, and (2) identify associations between environmental gradients and microbial communities. To optimize geochemical diversity, wells were selected using k-medians clustering to group 818 wells into 100 clusters by 14 geochemically similar measurements. At each well, in situ groundwater measurements were
recorded and unfiltered and filtered groundwater samples were collected for both geochemical measurements and analysis of microbial communities. Nucleic acids were collected by filtering water through a 10.0μm pre-filter and 0.2μm-membrane filter and then extracted using a Modified Miller method. Evaluation of divergence of microbial communities across all the wells indicates the microbial communities are fairly distinct. Comparison of microbial communities within each well shows taxa are not as divergent compared to across all wells. Metadata correlations of all the wells show many of the geochemical parameters are independent of each other. To evaluate potential microbial-geochemical associations, a random forest classification system was used and trained on the OTU abundances to predict continuous values for each geochemical parameter. Results indicate that with careful design and a large dataset, the groundwater microbial community structure can be used to accurately predict the water geochemistry.
**Gone or just out of sight? The apparent disappearance of aromatic litter components in soils**

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**ABSTRACT: Theme Category D**

Soil organic matter (SOM) decomposition is tightly linked to critical ecosystems services such as nutrient provision, greenhouse gas mitigation, and resistance to erosion. Uncertainties concerning the mechanisms driving stabilization of organic components hamper efforts to understand and manage global change effects on SOM. In particular, the relative contribution of aromatic compounds, such as lignin and tannins, to stable SOM is hotly debated. For example, we know that lignin depolymerization in litter layers releases water-soluble products that can be transported to depth and are highly surface reactive, hence should strongly sorb to mineral surfaces and be favored for SOM stabilization. Accordingly, flux analyses in soil profiles, biodegradation assays, and sorption experiments indicate that dissolved aromatics that sorb to mineral surfaces can persist in soils for centuries to millennia. In contrast, studies on composition of mineral-associated SOM indicate the prevalence of non-aromatic microbial-derived compounds. Further, successional studies of lands converted from C3 to C4 plants suggest that turnover of lignin in soil can be faster than turnover of bulk SOM. We assert that the contradictions can be explained both by analytical problems and the fact that these conflicting studies are frequently carried out on differing pools of soil organic matter, i.e. surface vs. deep horizons. Commonly used methods may only detect a fraction of the aromatics stored in the mineral soil and we will present an example of this problem for molecular-level lignin data. Briefly, we can demonstrate that the CuO oxidation technique routinely used for lignin measurements does not recover all lignin in mineral soils, i.e. some lignin is irreversibly bound to the mineral and is therefore undetected. Such problems will have to be overcome in order to better quantify the contribution of lignin and other aromatics to SOM stabilization.
Challenges in current process-based soil erosion prediction models

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Quantification of soil erosion has been traditionally considered as a surface hydrologic process with equations for soil detachment and sediment transport derived from the mechanics and hydraulics of the rainfall and surface flow. Under the current erosion modeling framework, the soil has a constant set of erodibility parameters, such as the USLE-K, interrill K (Ki), rill K (Kr) and critical shear stress (Tau-c), which quantify the resistance of the soil against the erosive power of the rain. Recent research findings show both soil erosion (or detachment) and sediment deposition vary significantly as the subsurface hydrologic condition is varied indicating a strong association between the surface and subsurface hydrology in controlling dominant erosion processes. These findings bring up challenges in the current process-based soil erosion model concept, such as the definition of erodibility parameters (Ki, Kr, and Tau-c), quantification of sediment transport capacity and sediment deposition. In this presentation, we will discuss research directions that will advance soil erosion science and new erosion model concepts.
How Critical Zone functions and chemical specific properties interact to regulate contaminant reactivity, mobility, and mean residence time

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ABSTRACT: Theme Category B
In this presentation, environmental processes that control the fate of several chemicals and nanomaterials in the environment will be discussed – where the overall rate of the observed environmental reaction is controlled both by the environment in which the pollution is located, and the properties of the specific pollutant. In the first example, the persistence of numerous polycyclic aromatic hydrocarbons (PAHs) within a nonaqueous phase liquid (NAPL) that has contaminated a river sediment in northwest Indiana for decades will be discussed (PAH concentrations at parts-per-hundred). Research on remedial action designs and ongoing sediment remediation activities at the river will be discussed. In another examples, the properties and photoreactivity of fullerene nanomaterials (buckminsterfullerene and carbon nanotubes) in the environment will be discussed. Another example includes the photoreactivity (in sunlight) of the brominated flame retardant, decabromodiphenyl-ether. This chemical has undergone voluntarily phase-out by industry in the U.S. and has been banned in the EU since 2008. In a final example, how precipitation influence release of steroid hormones from farm fields to agricultural ditches adjacent to manure-applied farm fields will be presented (hormone concentrations at parts per trillion).
Critical Zone Science: An Interdisciplinary Collaborative Landscape

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Abstract

The concept of Critical Zone is enabling the study of earth system processes by exploring relationships that span range of space and time scales through couplings that range from strong to episodic. This ambitious characterization with the goal of developing models that provide predictive capabilities necessitates working across several disciplinary boundaries. In this presentation we will review the broad questions underpinning Critical Zone studies, and progress and opportunities to address societally important and pertinent challenges through trans-disciplinary collaborations.
Increased atmospheric temperature resulting from a changing climate may lead to increased fire severity and frequency. Fire can act as a driving force behind landscape-scale changes in carbon (C) dynamics, including changes in C chemistry, organic matter in soil, and the generation of fire-altered, or pyrogenic C. Fire can increase erosion due to loss of vegetation and generation and deposition of hydrophobic compounds. The Rim Fire burned over 250,000 acres in Yosemite National Park and Stanislaus National Forest in 2013. To capture the effect of the wildfire on soil erosion, sediment fences were established along a single hillslope within the Rim Fire perimeter in three combinations of steepness and fire severity: high severity — high slope; high severity — moderate slope; and moderate severity — high slope. Sediments were collected from the sediment fences after each major precipitation event after the fire, and analyzed for C and nitrogen. Additionally, we used $^{13}$C Cross Polarization Magic Angle Spinning Nuclear Magnetic Resonance spectroscopy to assess changes in C chemistry in soil vs. sediments that eroded at different times after the fire. Overall, higher burn severity sites lost more sediment per square meter than lower severity burn sites. This is likely due to moderate severity burn sites having considerable vegetation remaining post-fire, whereas high burn severity sites having considerable areas of bare soil. The C concentration in the eroded sediments did not differ significantly between burn severities. However, the higher severity burn sites had significantly higher char C concentrations than the moderate severity sites, and the moderate severity sites had significantly higher proportion of the total C, as O- and N-substituted alkyls (i.e. carbohydrates and simple proteins). These results indicate the incorporation of char-C from biomass combustion at high severity sites into sediment makes up a greater component of eroded sediment compared with moderate severity sites.
Identification of critical zone architecture by using GPR in the North China Plain

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ABSTRACT: Theme Category D, F

North China Plain is one of vital grain production plain in China. After long tillage with irrigation, the soil architecture has been changed in a large extent from topsoil to the whole critical zone. These change will make it’s difficult for nutrient movement and plant usage them. Currently, point to point sampling is hard to give regional change of architecture due to the limited sites. It is principle to identify these change in a large scale to understand the process-based movement of nutrients and simulation. Here, GPR (Ground Penetrating Radar) is introduced to identify the critical zone architecture based on a long-term experiment plots which were designed as five treatments and four reduplicates (25 plots in total) to study the influence of nutrients on crop growing since 1990 in the Yucheng Comprehensive Experiment Station of Chinese Academy of Sciences. We use the GPR combined with the soil profile sampling and indoor analysis including soil moisture, particle percentage, pH and other soil physical and chemical parameters. We hope to find a suitable method to identify and interpret the change based on dry and wet season measurement.
Dual Control of Soil Carbon Storage by Microbial Catabolism and Anabolism

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ABSTRACT
There is currently little argument that microorganisms are central to soil ecological processes. However, more unknowns exist than knows yet in terms of the knowledge of soil microbes despite of their acknowledged importance in the ecosystems. For example, there remains largely unknowns how the microbe-mediated processes lead to soil carbon storage. Here, I give a presentation based on two aspects: dead microbes and living microbes, both of which have been highlighted under the categories of Soil Biogeochemistry and Microbial Ecology field, respectively. I hypothesize that a richer interpretation via linking these two microbial aspects together is invaluable to understanding the decomposition, transformation and sequestration of soil organic carbon under environmental perturbations, such as land use and climate change. To this end, I define two pathways, in vitro modification and in vivo turnover, that jointly control soil carbon dynamic via microbial catabolism and anabolism. Further, I develop a conceptual framework to understand how microbes act as a pump to accumulate carbon in soils, defined as “entombing effect”. Finally, I discuss potential influential factors that may change the effect, and inspire new areas where we see a promising need for advancing our relevant knowledge.
Multiple-element stoichiometric traits at different trophic levels in a food chain across temperate and subtropical biomes: Patterns of variation and the influential factors

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ABSTRACT: Theme Category A, F
Climate change may significantly alter the status of multiple nutrients in soils, exerting an influence on bottom-up transfer of elements along food chains in terrestrial ecosystems, and affect the ecosystem functioning. Here, with a widespread tree species (Quercus variabilis) and acorn predator (the weevil Curculio davidi), we investigate the stoichiometric traits of macro- (C, N, P, K, Ca, Mg and S) and micro- (Fe, Al, Mn, Na and Zn) in soils, plant tissues (leaves and acorns) and herbivore insects across the temperate-subtropical areas in eastern China. The main results are, i) Concentrations of leaf N, P, K and Mg decreased significantly with mean annual temperature and increased with aridity; ii) A low temperature and short growing season stimulated seeds to accumulate more macronutrient elements in the north to ensure reproductive success, while high soil Ca in the north led plants to allocate less Ca to their acorns; iii) The concentrations of K, Ca and Mg in soils, leaves, acorns and weevil larvae showed different degrees of variation, and only Mg increased across trophic level significantly with different slopes from south to north, and generally decreased with both temperature and precipitation (p < 0.05); and iv) The K:(Mg+Ca) ratio in soils, acorns and weevil larvae showed significant positive relationships with MAP (p < 0.05). Our results showed that variation in plant tissues and weevil larva across sampling area were largely driven by climatic factors, and only climate-correlated variation in Mg element availability can cascade upward to higher trophic levels. These findings help understand the possible effects of climate change on nutrient dynamics of multiple elements in soils, producers and consumers in terrestrial ecosystems.
Microbial Community Changes and Crude Oil Biodegradation in Different Deep Oceans

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Many studies have shown that microbial communities can play an important role in oil spill clean up. However, very limited information is available on the oil degradation potential and microbial community response to crude oil contamination in deep oceans. Therefore, we investigated the response of microbial communities to crude oil in various deep-sea basins from around the world where oil exploration is anticipated (Eastern and Central Mediterranean Sea, Great Australian Bight and Caspian Sea).

In this study, microcosms were set up aerobically with three different treatments: seawater, seawater + oil and seawater + oil + oil dispersant. Samples were taken at three time points for the analysis of oil degradation by fluorescence and GC-MS, and microbial community changes by 16S rRNA sequencing. CO2 evolution followed a similar pattern in all of the basins sampled. The treatment of seawater + oil + dispersant had the highest CO2 production. The amendment of oil lead to a higher CO2 accumulation than seawater treatment. However, they were all much lower than the data from the Gulf of Mexico (GOM). What’s more, the dissolved organic mater revealed that a big portion of oil in the microcosms was degraded in the first several days, which was consistent with the GC-MS results. Oil biodegradation appears to occur rapidly in all of the sites.

In addition, there was a clear succession of microbial communities during degradation of oil. The microbial diversity decreased in all of the microcosms over time. Oil amendment affected how quickly the diversity decreased. The relative abundance of Proteobacteria increased drastically while the relative abundance of archaea decreased. In particular, the percentage of Betaproteobacteria increased in samples from the Central Mediterranean Sea. However, Gammaproteobacteria increased in abundance in the microcosms from the Eastern Mediterranean Sea and Great Australian Bight, which was very similar to GOM.
Functional biogeography of root traits from deserts to tropical forests

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ABSTRACT: Theme Category D, G
Large-scale patterns of plant functional traits are receiving increasing attention for their importance in understanding biogeography of species distributions and ecosystem functions. The biggest gap in this field is probably the understanding of how root functional traits vary across different biomes and the mechanisms driving this variation. Here, we analyzed root trait data (including 13 root traits) of the distal root branch order (first order roots) from 355 species covering six biomes and we identified three major patterns: 1) root morphology varied markedly from tropical forests to grasslands and deserts with very coarse and very thin roots occurring simultaneously in tropical forests but only thin roots in temperate grasslands and deserts, possibly driven by shifting costs in root construction and patterns of resource supply in contrasting biomes; 2) root chemical traits displayed much smaller variation than morphological traits, and biome-level differences were statistically non-significant, possibly indicating stoichiometric homostasis in the metabolically most active root tissue (i.e., first order roots); 3) size-related root hydraulic traits showed very little variation with high degree of in overlap in traits values across biomes, suggesting conservatism in basic root hydraulic design. These findings provide insights into how distal absorptive roots are designed to facilitate the role of roots in overall plant functioning and plant adaptations in different biomes.
Multiple Stable Isotope Approach for Assessing N Sources and Processing in Runoff

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Abstract
Nitrate is a key compound in the cycling of N and its stable isotope composition can yield insights into its sources and microbial transformation. Most ecosystems are limited to 3 sources of nitrate: Microbial nitrification, synthetic fertilizer, and atmospheric deposition. We have recently investigated how nitrifying bacteria incorporate O atoms from O$_2$ and H$_2$O and discriminate against $^{15}$N resulting in simultaneous low or negative $\delta^{18}$O values and negative $\delta^{15}$N values (~ -25‰) in the product nitrate. This is in contrast to our recent survey of synthetic fertilizers, including urea ammonium nitrate (UAN), ammonium nitrate, and nitrate salts, which have positive $\delta^{18}$O values (~24‰) and $\delta^{15}$N values of +1.5 ± 4‰. Atmospheric nitrate oxygen isotopes are also unique. Nitrate in rain and aerosols have elevated $\delta^{18}$O values (50-80‰) and a unique mass independent composition with $\Delta^{17}$O values between 20-32‰. The isotopic uniqueness of the three sources allows for the determination using isotope mass balance mixing models. We have applied these techniques to assess source of nitrate in runoff from urban, semi-arid watersheds. We are currently using the same techniques to assess N runoff in the Intensively Managed Landscape Critical Zone Observatory.
Using Critical Zone (CZ) Science to Understand Soil and Water Processes in the Loess Plateau: Opportunities and Challenges

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ABSTRACT: Theme Category G
The Loess Plateau (LP) is one of the most unique geomorphic unit around the world, characterized by the serious soil erosion, frequent drought, and heavy human activity. Approximately 64×10^4 km^2 in area, the LP today supports a population of about 100 million people. The Grain for Green project implemented since the end of 1990s resulted in the significant changes in the soil and water processes and ecosystem services on the LP. The study on changes of materials cycling in the critical zone (CZ) on the LP with heavy human activity would thus expand the scientific connotation and representative region in the Earth’s CZ’s research. We will discuss the basic characteristics of the plateau CZ, which includes the deep loess deposits, the unique landscapes, the long-term vegetation dynamics and the annual sediment discharge into the Yellow River from the plateau. This presentation will focus on the interaction between vegetation and soil erosion, the coupling of water, carbon and nitrogen cycling, and the development of integrated model in the plateau CZ. Some of the issues are not still well addressed, and thus there are many opportunities and challenges in the study of the plateau CZ. Through experimental investigation, modelling and integration at various spatial scales, we hope to understand the mechanism and spatial heterogeneity of water cycling in CZ of the LP, to clarify the interaction between vegetation and soil erosion and its effects on carbon and nitrogen cycling, and to develop the method for modeling ecosystem service and optimization decision, and thus the optimization of ecosystem service. Furthermore, understand soil and water processes using CZ science can provide scientific and technological support for environmental rehabilitation and sustainable development of the LP.
Linking metal biogeochemical cycles to carbon chemistry

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Abstract: Theme Category: D, E

It is well known by now that minerals and metals impact the longer term persistence of carbon in soil. However, these interactions are not unidirectional or static. In fact, there are many points where the carbon cycling interlocks with the biogeochemical cycles of the inorganic component of soil. These interactions are dynamic and impacted by multiple external drivers. Our work strives to understand the mechanistic details of these linkages and their response to changing conditions. To accomplish this, we frequently turn to high resolution spectromicroscopic techniques that are synchrotron based. Of particular interest is how the redox active metals of Fe and Mn drive not only carbon bioavailability through sorption/precipitation reactions but also carbon mineralization through metal-organic redox reactions or via reactive oxygen species chemistry. These are key processes to understand in order to successfully address the questions of multiple CZO sites that are focus on understanding critical zone carbon and the impact of redox cycling and mineral dynamics.
Carbon stability versus microbial activity in aggregate size fractions across a rice soil chronosequence from Eastern China

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ABSTRACT: Theme Category D, F

Recent studies have shown soil carbon sequestration through physical protection of relative labile carbon intra micro-aggregates with formation of large sized macro-aggregates under good management of soil and agricultural systems. While carbon stabilization had been increasingly concerned as ecosystem properties, the mechanisms underspin bioactivity of soil carbon with increased carbon stability has been still poorly understood. In this study, topsoil soil samples were collected from rice soils derived from salt marsh under different length of rice cultivation up to 700 years from eastern China. Particle size fractions (PSF) of soil aggregates were separated using a low energy dispersion protocol. Carbon fractions in the PSFs were analyzed either with FTIR spectroscopy or with chemical extraction. Soil microbial community of bacterial, fungal and archaeal were analyzed with molecular fingerprinting using specific gene primers. Soil respiration and carbon sequestration from amended maize as well as enzyme activities were measured using lab incubation protocols. While the PSFs were dominated by the fine sand (200-20 μm) and silt fraction (20-2 μm), the mass proportion both of sand (2000-200 μm) and clay (<2 μm) fraction increased with prolonged rice cultivation, giving rise to an increasing trend of mean weight diameter of soil aggregates (also referred to aggregate stability). Soil organic carbon was found most enriched in sand fraction (40-60 g/kg), followed by the clay fraction (20-24.5 g/kg), but depleted in the silt fraction (~10 g/kg). Phenolic and aromatic carbon as recalcitrant pool were high (33-40% of total SOC) in both sand and clay fractions than in both fine sand silt fractions (20-29% of total SOC). However, the ratio of LOC/total SOC showed a weak decreasing trend with decreasing size of the aggregate fractions. Total gene content in the size fractions followed a similar trend to that of SOC. Bacterial and archaeal gene abundance was concentrated in both sand and clay fractions but that of fungi in sand fraction, and sharply decreased with the decreasing size of aggregate fraction. Gene abundance of archaeal followed a similar trend to that of bacterial but showing an increasing trend with prolonged rice cultivation in both sand and clay fractions. Change in community diversity with sizes of aggregate fractions was found of fungi and weakly of bacterial but not of archaeal. Soil respiration ratio (Respired CO2-C to SOC) was highest in silt fraction, followed by the fine sand fraction but lowest in sand and clay fractions in the rice soils cultivated over 100 years. Again, scaled by total gen concentration, respiration was higher in silt fraction than in other fractions for these rice soils. For the size fractions other than clay fraction, soil gene concentration, Archaeal gen abundance, normalized
enzyme activity and carbon sequestration was seen increased but SOC- and gene- scaled soil respiration decreased, more or less with prolonged rice cultivation. As shown with regression analysis, SOC content was positively linearly correlated to recalcitrant carbon proportion but negatively linearly correlated to labile carbon, in both sand and clay fractions. However, soil respiration was found positively logarithmically correlated to total DNA contents and bacterial gen abundance in both sand and clay fractions. Total DNA content was found positively correlated to SOC and labile carbon content, recalcitrant carbon proportion and normalized enzyme activity but negatively to soil respiration, in sand fraction only. Our findings suggested that carbon accumulation and stabilization was prevalent in both sand and clay fraction, only the coarse sand fraction was found responsible for bioactivity dynamics in the rice soils. Thus, soil carbon sequestration was primarily by formation of the macro-aggregates, which again mediated carbon stability and bioactivity in the rice soils under long term rice cultivation.
A Landscape-oriented Approach to Simulate Soil Organic Carbon Dynamics in Intensively Managed Landscapes.

Thanos Papanicolaou, (University of Tennessee, Knoxville)

Changes of land management in agricultural landscapes can lead to a high degree of spatial heterogeneity and temporal variability in ecosystem properties like Soil Organic Carbon (SOC) redistribution and storage. Moreover, the degree that these changes influence SOC may vary depending on hillslope location and hydrologic events. Most available biogeochemical models, though, are unable to capture this variability, being soil profile models or “point models in space”. To understand these drastic changes of ecosystem properties found in agricultural lands and the effects of different gradients on SOM decomposition, a three pronged approach is needed that incorporates strategic sampling plans following the main flow paths in a field, novel remote sensing techniques to replicate landscape heterogeneity, and landscape evolution models that incorporate the effects of tillage on SOM redistribution in agricultural lands. While the emphasis during the seminar is on hillslope processes the presenter will discuss remote sensing techniques and in-situ monitoring approaches for large scale SOC predictions.
Linking terrestrial ecosystem metabolism and deep mineral formation

Dan Richter, Duke University.

Integrative concepts of the biosphere, ecosystem, biogeocenosis and, recently, Earth’s critical zone embrace scientific disciplines that link matter, energy and organisms in a systems-level understanding of our remarkable planet. Here, we assert the congruence of Tansley’s (1935) venerable ecosystem concept of ‘one physical system’ with Earth science’s critical zone. Ecosystems and critical zones are entirely congruent across spatial–temporal scales from vegetation-clad weathering profiles and hillslopes, small catchments, landscapes, river basins, continents, to Earth’s whole terrestrial surface. What may be less obvious is congruence in the vertical dimension. We use terrestrial ecosystem metabolism to explore how a full accounting of photosynthetically fixed carbon must include respiratory CO₂ and carbonic acid that propagate to the base of the critical zone itself. Although a small fraction of respiration, the downward diffusion of CO₂ and carbonic acid dissolution of primary minerals at depth helps determine rates of soil formation and, ultimately, ecosystem evolution and resilience. Because life in the upper portions of terrestrial ecosystems significantly affects biogeochemistry throughout weathering profiles, the lower boundaries of most terrestrial ecosystems have been demarcated at depths too shallow to permit a complete understanding of ecosystem structure and function. Opportunities abound to explore connections between upper and lower components of critical-zone ecosystems, between soil and stream biogeochemistry in watersheds, and between plant-derived CO₂ and deep microbial communities and mineral weathering.
Fate of the Brominated Flame Retardant Tetrabromobisphenol-A (TPPBA) in Soil

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ABSTRACT: Theme Category B

Tetrabromobisphenol-A (TBBPA) is one of the most commonly used flame retardants and has become a ubiquitous contaminant in soil, water, and sediment worldwide. However the fate and transformation products of TBBPA in the critical zone are still unclear. Using ring-\textsuperscript{14}C-labelled tetrabromobisphenol A (TBBPA), we studied the degradation and transformation of TBBPA in soil under oxic and anoxic conditions. While debromination was the predominant pathway for TBBPA degradation in anoxic soil, aerobic degradation of TBBPA in soil resulted in mineralization (CO\textsubscript{2}), single benzene ring metabolites, and \textit{O}-methylation metabolites. Four primary metabolic pathways are proposed for aerobic degradation of TBBPA in soil, i.e., oxidative skeletal rearrangements, \textit{O}-methylation, type II ipso-hydroxysubstitution, and reductive debromination. The main fate of TBBPA in both oxic and anoxic soil was formation of bound residues. When soil redox potential altered from anoxic into oxic state, almost half of the anoxically formed bound residues were released as TBBPA and lower brominated BPAs, which were then persistent during oxic incubation. In the presence of rice plants, debromination of TBBPA was enhanced, accompanied by accumulation of TBBPA residues in the plants. Our results provide detailed information about fate of the anthropogenic contaminant TBBPA in the important critical zone compartment.
Visualizing Soil Landscapes - Seeing the CZOs in the Larger Context

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2 http://isee.network/

ABSTRACT: Theme Category G

The Critical Zone Observatories were designed to be representative of much larger soil landscapes and ecosystems. But what do these larger landscapes look like, and where does one landscapes transition into a different landscape that may have very different properties? The Integrating Spatial Educational Experiences (Isee) Project utilizes detailed U.S. soil survey data as well as the best available digital elevation models and other data to visualize selected soil properties over several U.S. states. In this presentation I will demonstrate the Isee iPad app and show how it allows one to see both the details as well as the overview as we focus on some soil differences in the immediate area of the Agronomy Center for Research and Education (ACRE). On the bus trip from the Beck Center back to the hotel, there will be an opportunity to see how the Isee app allows one to better understand the various landscapes we traverse, landscapes that have distinctive soils, ecological properties, and advantages and constraints to land use.
Research on the placement of the ecological shelter buffer in the Three Gorges Reservoir Area, China

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**ABSTRACT: Theme Categories F**

Following the implementation of the Three Gorges Dam Project, the water-level variation of the reservoir is opposite to the original season variation which could cause significant negative impacts on the environment. Nonpoint source (NPS) pollution has become a serious problem in the Three Gorges Reservoir (TGR). An urgent need exists to build an ecological shelter buffer (ESB) along the TGR to improve water quality. In TGRA, the reservoir covers more than 1000 km\textsuperscript{2} and stretches some 663 km, and there are more than 400 tributaries of different sizes in total. So, how to design the buffer strip along the shorelines of TGR for NPS pollution control is challenging because of spatial variations in hydrology, topography, slope, landuse and drainage patterns.

This paper proposes an approach that takes the entire watershed into account and considers topographic, soil and land surface conditions to identify the potential sites for building an ESB along the TGR. According to the features of the TGR, a methodology was established for modelling the ESB using geographic information systems (GIS) technology, Remote Sensing, and hydrologic model, and was applied to a small-scale watershed. A grid terrain analysis and a nonpoint source pollution model were combined to help plan the placement of the ESB for water quality benefits at the watershed scale. The methodology described in this study demonstrates its capability as a decision support tool to guide ESB building, support land-use decision making and facilitate environmental policy formulation and evaluation throughout the TGR.
Nitrogen stable isotope composition of various fossil-fuel combustion nitrogen oxide sources

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Nitrogen oxides (NOx = NO + NO2) are important trace gases that impact atmospheric chemistry, air quality, and climate. In order to help constrain NOx source contributions, the nitrogen (N) stable isotope composition of NOx (\(\delta^{15}\text{N-NOx}\)) may be a useful indicator for NOx source partitioning. However, despite anthropogenic emissions being the most prevalent source of NOx, there is still large uncertainty in the \(\delta^{15}\text{N-NOx}\) values for anthropogenic sources. To this end, this study provides a detailed analysis of several fossil-fuel combustion NOx sources and their \(\delta^{15}\text{N-NOx}\) values. To accomplish this, exhaust or flue samples from several fossil-fuel combustion sources were sampled and analyzed for their \(\delta^{15}\text{N-NOx}\) that included airplanes, gasoline-powered vehicles not equipped with a catalytic converter, gasoline-powered lawn tools and utility vehicles, diesel-electric buses, diesel semi-trucks, and natural gas-burning home furnace and power plant. A relatively large range of \(\delta^{15}\text{N-NOx}\) values were measured from -28.1 to 0.3‰ for individual exhaust/flue samples with cold started diesel-electric buses contributing on average the lowest \(\delta^{15}\text{N-NOx}\) values at -20.9‰, and warm-started diesel-electric buses contributing on average the highest values of -1.7‰. The NOx sources analyzed in this study primarily originated from the “thermal production” of NOx and generally emitted negative \(\delta^{15}\text{N-NOx}\) values, likely due to the kinetic isotope effect associated with its production. It was found that there is a negative correlation between NOx concentrations and \(\delta^{15}\text{N-NOx}\) for fossil-fuel combustion sources equipped with catalytic NOx reduction technology, suggesting that the catalytic reduction of NOx may have an influence on \(\delta^{15}\text{N-NOx}\) values. Based on the \(\delta^{15}\text{N-NOx}\) values reported in this study and in previous studies, a \(\delta^{15}\text{N-NOx}\) regional and seasonal isoscape was constructed for the contiguous United States. The constructed isoscape demonstrates the seasonal importance of various NOx sources to particular regions and will be helpful in evaluating the N isotopes in nitrate deposition studies.
Thinning effect on the carbon balance of a coniferous plantation in subtropical China

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ABSTRACT

Thinning is one of the most important measures in forest management in improving forest timber quality and productivity, while planting of native hardwood seedlings in coniferous forest is believed an effective way to accelerate the transformation of a coniferous forest to a near nature forest. But this option may obviously arouse great disturbance in ecosystem carbon balance. What is the effect of thinning in short and long-term scale on carbon budget is of great concern. In this study, we carried out an experiment of thinning followed by planting of native hardwood seedlings in a coniferous forest in subtropical region in 2013, and the ecosystem carbon fluxes were measured automatically with eddy covariance method in both thinned and unthinned stands since 2008 and 2002, respectively. The carbon fluxes between thinned and unthinned stands showed a very good relation during the four-year period of comparison. The results indicated that the thinning-planting treatment had almost no changes in carbon assimilation ability even though the canopy photosynthesis ability obviously reduced due to the rapid decrease in canopy LAI during the first two years after thinning. This might be ascribed to the rapid enrichment of understory plantation and the enhancement of the photosynthetic rate of the left canopy after thinning under more favorite environment conditions. The changes in seasonal variation in carbon assimilation ability were also analyzed.
Spatial-temporal patterns of GPP simulation based on BEPS and LUE models in China from 1982 to 2011

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ABSTRACT: Theme Category F

Terrestrial gross primary production (GPP) constitutes the largest flux component in the global carbon budget; however their spatial-temporal variability and responses to climate change are still largely uncertain. In this study, we estimate terrestrial GPP in China during 1982-2011 using multiple models based on remote sensing data and try to identify the variation trend and regional difference of terrestrial GPP and their response to climate change in China. Eddy covariance flux observation from 2003 to 2011 at seven sites in China was used to validate the three models driven by satellite-derived FPAR/LAI and climate data, and the models well produced the inner-annual and inter-annual variation of GPP. From 1982 to 2011, GPP was estimated as 5.0-6.7 PgC yr\textsuperscript{-1} and found to be increasing at a rate of 10 Tg C yr\textsuperscript{-1}, although trend rates differed by region. The warming climate mainly contributed to the increasing trend in GPP and China’s terrestrial GPP increases 0.11-0.20 Pg C if the temperature increase 1°C. There was a significant and largest uptrend (4.38 Tg C/yr) in Southwest China, which was limited by temperature. There was the slowest increasing rate (0.54 TgC/yr) in Inner Mongolia, which was controlled by precipitation. Significant uncertainties remain in GPP estimates in aspect to remote sensing data and model structure.
Challenges Predicting Decomposition Temperature Responses in the Critical Zone

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ABSTRACT: Theme Category C, D, F

In order to predict how carbon and nutrient storage in the critical zone are altered by climate changes, it is critical to be able to predict the temperature responses of microbial decomposers. Surprisingly, however, rates show a distinct temperature threshold, rapidly increasing above 10 °C, but the mechanisms underlying this pattern are unknown. Temperature responses of litter decomposition are controlled by the kinetics of decomposers’ intracellular metabolism and extracellular plant polymer breakdown. Because microbial activity can be relatively high below 10 °C, we hypothesized that this is caused by low rates of extracellular polymer breakdown below 10 °C.

To test this hypothesis we incubated sandy surface soils with either Acer rubrum 1 cm² leaf litter pieces or leachate for 14 days at 4-20 °C and measured respiration, extracellular enzyme activities, and soluble C, nitrogen, and phosphate. Microbial respiration and enzyme production were less temperature sensitive than C acquisition from plant polymers. In the litter pieces, where extracellular enzymes were required to access polymeric C, enzyme activities and respiration consistently increased with temperature. However, in the soil+leachate, where no polymer breakdown was required for C acquisition, more C was respired below 10 °C than above. Although they increased more slowly below 10 °C, after two weeks extracellular enzyme activities were actually higher at lower temperatures. Thus, low temperatures in the soil+leachate treatment ultimately did not suppress either respiration or enzyme production. Differences in enzyme activities and respiration between treatments suggest that microbes are less efficient at accessing polymeric litter C than soluble C below 10 °C. Litter enzyme activities increased markedly from 8-12 °C, suggesting that warming by 4 °C will have different effects at different temperatures. These results may have implications for how we predict and model the temperature responses of decomposition rates throughout the critical zone.
Landscape influence on soils, nutrient pools, and canopy biomass in a tropical forest

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ABSTRACT: Theme Category A, E, F

The Luquillo Mountains (>1000 asl) stand at the northeastern tip of Puerto Rico and receive up to five meters of precipitation annually. Ancient uplifted shore platforms found around the mountaintops show that the Luquillo Mountains were once small islands a few hundred meters tall, which supported vegetation tolerant of drier conditions. We dated caves formed following the emergence of these shore platforms using cosmogenic $^{10}$Be-$^{26}$Al to constrain timing of burial of cave sediments and established that uplift started 4 Ma ago, consistent with geological constraints, and with cladogenetic studies of species diversification in the mountain fauna. We investigated the propagation of a wave of erosion on the southern side of the mountains. The river knickpoints, found in the Luquillo Critical Zone Observatory, Puerto Rico, are headward migrating instabilities (‘knickpoints’) that represent this front of a wave of erosion propagating from the coastal floodplain towards the mountaintops that often manifest as waterfalls – slowly moving upstream. Downstream of this knickpoint zone, cosmogenic nuclide-derived erosion rates determined from $^{10}$Be concentrations in river sands indicate an increase in erosion rate compared to upstream. This zone, downstream of the knickpoints, shows a sharp increase in weatherable minerals, greater available cations in the soil, and higher canopy height. Upstream of the knickpoint, the saprolite is extremely depleted in nutrients, and that vegetation obtains its nutrients mostly through atmospheric inputs (sea aerosols and Saharan dust). Upstream of the knickpoints, canopy height drops. We present one consequence of this tight coupling between mountain growth, climate change, forest evolution and river incision. Mountain uplift, by altering its climate and its forest cover, has slowed down the wave of erosion and generated the steep, slowly propagating knickpoints that we observe today. We hypothesize that the lower canopy height above the knickpoints stems from nutrient limitation, exacerbated by the slow velocity of the migrating waterfalls.
Title: How do simulations of soil-water movement differ depending on how hydrologic properties are characterized?

Author: Tanja N. Williamson1, Brad D. Lee2

Soil Survey Geographic Database (SSURGO) data are available for the entire United States and are incorporated in many regional and national hydrologic models used by environmental managers. However, SSURGO data does not provide an understanding of spatial variability and only includes saturated hydraulic conductivity ($K_{sat}$) values estimated from particle size analysis (PSA). This study documented model sensitivity to the substitution of SSURGO data with locally described soil properties and alternate methods of measuring $K_{sat}$ in a grassland basin that is part of the Shawnee Hills Loess-Catena Soil-Systems Project. Incorporation of these different soil datasets significantly changed the results of hydrologic modeling as a consequence of the amount of space available to store soil water and how this soil water is moved downslope. Field-measured $K_{sat}$ from locally described soil profiles was different than that estimated from PSA. Subsequently, this caused differences in which soil layers were incorporated into the hydrologic simulations using TOPMODEL, ultimately changing the simulations of soil-water storage. Simulations of free-flowing soil water and the amount of water traveling through pores too large to retain water against gravity were compared to field observations of water in wells at five slope positions along a catena. A comparison of simulated data to observed data showed that the ability to model the range of conditions observed in the field varied as a function of these three soil datasets (SSURGO and local field descriptions using PSA-derived $K_{sat}$ or field measured $K_{sat}$) and that comparison of absolute values of soil-water storage are not valid if different characterizations of soil properties are used. The ability to simulate and compare soil-water storage is critical to demonstrating the benefits of conservation agriculture for the drier conditions forecasted for most of the continental U.S. by the end of the century.

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Organic matter meets minerals: earthworms and erosion

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Mineral-associated organic matter would not be present unless minerals and organic matter meet. This presentation highlights a biotic and an abiotic processes responsible for such interactions to take place. A bioturbation example will be drawn from a chronosequence of earthworm invasion in N. Minnesota, while two hillslopes with distinct climates in SW Australia will be highlighted to stress significance of erosion mechanisms in controlling carbon-mineral interactions. These examples reveal diverse opportunities to examine molecular level interactions between organic matter and minerals at landscape scales.
Separating effects of anthropogenic activities and climate change on vegetation dynamics on the Tibetan Plateau

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The Tibetan plateau (TP) is the largest alpine plateau in the world. It has an average elevation of 4000m and is called the “Third pole” of the world. The TP is a critical zone due to its fundamental ecological and environmental significance to China, even Asia. In the meantime, the TP is a fragile system. In recovering and protecting the system, it is necessary to disentangle the relative contribution of anthropogenic activities and climate change to the ecosystem dynamics. In this study, we integrated remote sensing data, field observation data, and regional annual statistical data, and used statistical model, process model and physiology model to explore the regulating effects of anthropogenic activities and climate changes on ecosystem dynamics on the TP. The remote sensed results revealed that vegetation has gained vigor in most parts of the TP in the past three decades. Grazing, as a main type of anthropogenic activity, contributed approximately 10% of ecosystem dynamics variation on the TP. Temperature has increased an average of 2°C on the TP. In the east TP, where precipitation is relatively abundant, increased temperature has caused improved vegetation vigor and acted as a primary driving factor. Relative to the obvious temperature increment, precipitation exhibited a weak increasing trend on the TP. Enhanced precipitation acted positively on vegetation growth across the entire TP, and precipitation was a primer on vegetation in the west TP. Both remote sensing and physiology process model results pointed to a similar conclusion that climate acted as a primary factor regulating vegetation dynamics, and lowered grazing pressure can facilitate vegetation recovery on the TP. This study would lay the theory foundation for environmental and ecological recovery on the TP and capitalize more efficiently the ecological hurdle function of the TP.
Soil CO₂ efflux and concentration under drip irrigation in dry-land agriculture, China

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Abstract: Chengyi Zhao

In northwest China, plastic mulching is an effective method to increase crop production. Soil CO₂ efflux and concentration in dry-land agriculture can be greatly affected by this cropping system. This study aims to examine whether covering fields with plastic film affects CO₂ emission and concentration in cotton field. The experiment included mulched and non-mulched treatments. Soil CO₂ efflux and CO₂ concentration were measured in the ridges and furrows from July to October in 2013. In the ridges, mean soil CO₂ effluxes were 0.069 and 0.076 g CO₂-C·m⁻²·h⁻¹ for mulched and non-mulched treatments, respectively. In the furrows, mean soil CO₂ effluxes were 0.065 and 0.051 CO₂-C·m⁻²·h⁻¹ for mulched and non-mulched treatments, respectively. In summary, cumulative CO₂ emissions were 546.09 and 548.72 g CO₂-C·m⁻² for mulched and non-mulched treatments. CO₂ concentrations in the ridges were higher in the mulched treatment (ranged from 10.01 to 28.28 mg·L⁻¹) than the non-mulched treatment (ranged from 4.91 to 24.28 mg·L⁻¹). However, in the furrows, we only observed a significant increase in CO₂ concentration of 4.33 mg·L⁻¹ in the mulched treatment relative to the non-mulched treatment at 40 cm depth. In addition, soil CO₂ efflux increased exponentially with soil temperature, and the temperature normalization of soil CO₂ efflux to 10 °C decreased once soil water content was below or above threshold value. Furthermore, plastic mulching also changed the temperature sensitivity of soil CO₂ efflux and the optimal soil water content for CO₂ emission, respectively. On the basis of these results, we found that plastic mulching significantly impacts on soil CO₂ effluxes and CO₂ concentrations in the furrows and ridges, respectively. However, the cumulative CO₂ emissions were not significant reduced. Our results also suggest that the application of bivariate model combined with soil temperature and water content better predicts soil CO₂ efflux both in mulched treatment and non-mulched treatment.

Keywords: Soil CO₂ efflux; Soil CO₂ concentration; Plastic mulch film; Arid region; Cotton field
Impact of Land Use on Soil Organic Matter Preservation: Pore-Scale Mechanisms

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ABSTRACT: Theme Category D, F

Soil organic matter (SOM) determines soil water properties, buffer capacity, and resilience under stresses. This study deals with the effects of land use on the amount and distribution of SOM in soil microstructures, with particular focus on the influence of pore-filling SOM on the hysteretic soil water characteristic (i.e., difference between the main drying and wetting curves), which has been largely ignored in previous studies on water-SOM relations. By taking advantage of differences in X-ray scattering contrast between soil minerals, SOM, and air, which were measured using ultra-small angle X-ray scattering (USAXS) before and after combustion of microaggregates at 350°C, we evaluated the distribution of the total- and SOM-filled porosity within microaggregates. Results show that the SOM preservation arose from the evolution of the architectural system of microaggregates during their formation and stabilization. Land-use options (conversion of soils from long-term cultivation to perennial vegetation through restoration of native tallgrass prairie) and agricultural treatments (conventional tillage versus no-till at two levels of N inputs) with increasing SOM in microaggregates were associated with encapsulation of colloidal SOM by minerals, consequently creating protected SOM-filled pores at the submicron scale within the microaggregate structure. Our water retention measurements showed that the SOM encapsulation in <5 μm diameter pores increased water retention in microaggregates, while land use that either increased or decreased the abundance of SOM-filled pore volume in the microaggregates promoted hysteresis of water retention characteristics due to changes in soil pore structure. The water retention data measured on intact and combusted microaggregates were consistent with USAXS results, indicating that SOM pore-filling could create spatial and kinetic constraints on water flow and microbial access to increase the physical protection of SOM in soil pores and that land use has a great potential for the synergistic retention of water and organic carbon in soils.
Contributions to oral and poster presentations on CZ-related topics included but were not limited to the following theme categories.

**Theme A.** Near surface flux of solid, dissolved, and gaseous C and N from soil, weathered outcrop, and litter organic matter in catchments

**Theme B.** CZ services and functions regulating anthropogenic-sourced contaminant reactivity, mobility, and mean residence time

**Theme C.** Microbially-driven cycling of elements in shallow and deep soil profiles

**Theme D.** Mechanisms of stabilization/destabilization of organic matter in soils

**Theme E.** The role of hydrology and mineralogy in the deep connectivity of dissolved organic matter and associated inorganic elements in the CZ profile

**Theme F.** Climate and land use regulation of C, N, and water cycles in terrestrial ecosystems
Geochemical Response to Temporal Variations in Groundwater Head
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ABSTRACT: Theme Category E, G

Large-scale groundwater sampling events typically span the course of several weeks or months and therefore may contain a significant temporal bias in the data. The overall objective of this study was to determine if temporal variations in groundwater hydrology and geochemistry affected the microbial community structure. Here, we present results on the geochemical response to variations in groundwater head. The field research site, located in Oak Ridge, TN, contains six groundwater monitoring wells with depths ranging from 20 to 71 feet below ground surface. Groundwater samples were collected for geochemical analysis using low flow methods. Down-well data loggers allowed for continual monitoring of pressure, conductivity and temperature. Above-ground data loggers allowed for monitoring dissolved oxygen, redox, and conductivity during groundwater sampling. Hydrologic and groundwater geochemical data were analyzed in order to (1) determine if sampling bias exists as a result of groundwater pumping/sampling, and (2) determine how the stability of the hydraulic head effects groundwater geochemistry. Groundwater head results indicated that the pumping/sampling of wells did not contribute to sampling bias. Initial Groundwater geochemistry results were relatively stable throughout the study. However, shallow wells vary in concentrations of Na$^+$, K$^+$, Ca$^{2+}$, HCO$_3^-$, and CO$_3^{2-}$ following rain events. Geochemical results also indicated distinct differences in water types between deep and shallow wells. By combining variations in groundwater head and geochemical data we hope to better understand geochemical responses to changes in hydrology. The results of this study demonstrated a contrast in stability and response between shallow versus deep wells which may have significant implications on microbial community structure.
Modeling empirical functional relationships between mixtures of anthropogenic contaminants of emerging concern and freshwater fish species biodiversity decline

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ABSTRACT: Theme Category B, G

Biodiversity is essential characteristic of complex life-supporting mechanism of critical zone. A healthy ecosystem is one that has a diversity of organisms across multiple levels of biological organization in terms of relative richness, abundance, function and fitness. This enables a sustainable platform to absorb shocks and preserve the stability and integrity of life-sustaining relationships across various organismal interaction and energy exchange pathways in the living critical zone. Critical zone biological diversity is absolutely essential for the sustainability of earth ecosystems goods and services that form the rudimentary foundation of natural capital provisioning required for enduring complex anthropocentric socioeconomic systems. Freshwater fish species biodiversity is essential for inland surface water ecosystem function, provisioning and regulation. However, 30% of freshwater fish species in North America are considered imperiled, vulnerable, threatened, endangered or extinct due to anthropogenic activities of which aquatic habitat chemical contamination plays a major role. It is therefore imperative to understand the impact of contaminants of emerging concern from intensively managed agricultural and urban landscapes on biodiversity in the critical zone ecosphere. We performed a spatial and temporal critical-empirical analysis of spatial and temporal relevance of the collective and relative correlation-covariance impacts of mixtures of environmentally mobile, prevalent and persistent land-applied agricultural chemicals and physical environmental factors on fish species biodiversity in agro-urban US streams. We investigated the covariant effects of temperature, oxygen concentration, nutrient concentration, dissolved organic matter concentration, and mixture concentration effects of 14 pesticides on fish species biodiversity along a temporal gradient (1997 – 2014) in 6 US agro-urban streams regionally distributed across the US, using applied generalized multivariate regression analysis. We used diversity metrics of Simpson and Shannon Indexes to develop regional empirical multivariate regression models in relation to pesticide mixture expressed as the pesticide toxicity index and other variables, based on statistically significance and evaluated their predictive capacity, as well as spatial and temporal sensitivity. Pesticide toxicity index and nutrient concentration were the most significant contributors to fish species biodiversity loss across regions, with pesticide concentration having the most pronounced statistically significant effect in the mainly urban regional streams in the northeast and nutrient concentration dominating in mainly agricultural streams in the Midwest. This work has extenuating implications for application of towards the development of mechanistic models and the refinement of existing experimental procedures towards understanding and predicting systemic impacts of mixtures of contaminants of emerging concern on cross-trophic aquatic biodiversity in the critical zone.
Environmental microbial community tolerance and adaptation to biocides use in hydraulic fracturing operations

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Hydraulic fracturing (HF) has grown exponentially, with an estimated 700% increase since 2007. In HF operations a cocktail of chemicals, sand, and water is injected into an underground rock formation to create fractures, which enable release of natural gas. In most HF operations, biocides are added to prevent biofouling of equipment and prevent growth of subsurface microbes during gas extraction and avoid gas souring. During extraction some of the injected water returns to the surface carrying with it many of the injected chemicals including the remaining biocides. It has been reported that flowback water has been accidentally released into the environment, potentially exposing streams to HF chemicals such as biocide.

To understand the effect biocides have in HF impacted streams, microcosms were inoculated using stream water impacted by Marcellus shale HF operations (three streams), and as control pristine stream water from the same Marcellus shale area (three streams) was used. Two sets of microcosms were set using the two more commonly used biocides, glutaraldehyde and DBNPA. The microcosms were incubated at ambient temperature over a period of 8 weeks. The microbial community adaptation to biocide was tracked by sampling every two weeks and performing 16s rRNA amplicon sequencing as compared to a biological control (no biocide added). Chemical degradation of the biocide was tracked every week by HPLC (for DBNPA) and GC-FID (for glutaraldehyde), as compared to an autoclaved control to track abiotic degradation of the biocides. Finally, RNA was sampled at time zero and at the end of the experiment to understand what transcripts were upregulated by the presence of biocide, and hence allow the bacteria to adapt and tolerate the biocide. Our aim is that the results of this experiment will help understand the pathways of biocide resistance and the effect they have in the native microbial community.
ABSTRACT: Theme Category F

Characterizing the spatial and temporal variability of small scale runoff responses is essential to distributed hydrologic modeling. To explore the variability of runoff responses, we analyzed surface runoff hydrographs from 12 neighboring hillslopes in central Iowa, USA that were observed for 72 runoff events over a four-year period. These agricultural experimental hillslopes receive various prairie filter strip treatments and drain areas ranging from 0.48 to 3.19 hectares. The distances between them vary from tens of meters to about 3 kilometers. We compared the hydrographs from the remaining 11 hillslopes to the hydrograph at the benchmark hillslope (i.e., hillslope B6 with no treatment). The results showed that: 1) for any individual event in which noticeable surface runoff occurred, the hydrographs from these hillslopes had similar shapes but different magnitudes; 2) for any paired hillslopes, the shape similarity persisted, but the scaling factor (the regression slope between two flow series) changed across events; and 3) for any runoff event, no simple relationship exists between the spatial variation of the scaling factor and the slope, slope length, area, and prairie strip width at the footslope of the hillslopes. Interestingly, we found that for 9 out of the 11 paired hillslopes, 40-70% of the temporal variation in the scaling factors can be explained by the antecedent wetness condition and the maximum hourly rain accumulation. These results suggest that the small-scale surface runoff responses are spatially variable but organized linearly, i.e., shape similarity (or linearity) in space is another feature of the small-scale runoff process. This phenomenon seems to result from the spatial vicinity and small-scale spatial variability of rainfall intensity and antecedent soil moisture.
How Does Clay Flocculation of Harmful Algal Blooms Affect Microbial Community Composition in Water and Sediment?

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Abstract
Clay-based flocculation techniques have been previously developed to mitigate harmful algal blooms; however, despite the effectiveness of clay flocculation, the potential ecological impacts on the microbial community are poorly understood. The microbial community changes in water and sediment samples were investigated in various clay flocculation treatments, including control, clay flocculation, and clay flocculation with zeolite/O2 added zeolite capping. Differences in water community structure between treatments with and without zeolite capping resulted in significant reduction of total nitrogen (TN), total phosphorus (TP) and ammonia (NH4+) concentration and increase of nitrate (NO3-) concentration in zeolite/O2 loaded zeolite capping. Nitrososphaerales, Methylphilale, Nitrososphaerales, and Nitrospirales were enriched in both sediments treated by flocculation with zeolite capping and flocculation with O2 loaded zeolite capping. This suggested that zeolite-capping promoted the bacteria nitrogen cycling activities at the water-sediment interface. Bacteria biomass and species diversity were not altered by clay flocculation. Planctomyces, Pirellulaceae, and Xanthomonadaceae were reduced with reduction of nutrient concentration. Flocculation with zeolite capping resulted in improving microbiological water quality. The relative abundance of ammonia oxidizing bacteria increased fourfold in zeolite capping microcosms, suggesting zeolite promoted absorbed ammonia removal in the benthic zone.
Developed Land Change Impact on Runoff of Contiguous United States Based on L-THIA Tabular Tool

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ABSTRACT

Land use/Land cover change over time, which is dominated by increasing urbanized area/developed land in many locations, has significant impacts on hydrologic processes. Long-Term Hydrologic Impact Analysis (L-THIA) estimates long-term average annual runoff for land use and soil combinations, based on long-term climate data for that area. In this study, a new version of L-THIA called L-THIA Tabular Tool was applied to evaluate developed land change impact on runoff of the Contiguous United States based on the National Land Cover Database (NLCD) for 2001, 2006 and 2011. Results show that 1) urban sprawl/urbanization occurred non-homogeneously across the contiguous U.S. from 2001 to 2011; 2) urban sprawl to suburban areas around metropolitan areas as well as newly urbanized areas within the metropolitan areas results in more medium and very high runoff counties; 3) NAARD values of top ten NAARD states are jointly influenced by high precipitation and increases in developed land; while that of top ten NAARD change percentage states are mainly influenced by high increases in developed land; 4) population can stimulate urban development. However, purely considering population is not a good way to analyze the stimulators of urban development.
How to quantify the impact of environmental change and agricultural practices on soil ecosystems services

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ABSTRACT: Theme Category F

Soils are the central to consideration of what constitutes sustainable development. However, due to direct or indirect human disturbance such as land use change, soil management, land degradation, soil becomes fragile under the global change pressures. Soil carbon and nutrient cycles could be related to the provisioning, regulating, supporting and cultural ecosystem services which they underpin. Given these, characterizing and quantifying soil ecosystem services are main challenges to seek the sustainable soil management for improving soil resilience. In this study, the impact of environmental change and agricultural practices on soil carbon and nitrogen was quantified based on field experiment, dataset statistics and model simulation. We assessed the impact of climate change on crop production based on open-air field experiment, and quantified carbon dynamics and GHG emissions according to meta-analysis and life cycle assessment based carbon footprint approach. The process based ecosystem model, DAYCENT, was evaluated by Chinese cropland dataset. Then greenhouse gas mitigation potential was predicted in Chinese cropland system. From this study, developing the ecosystem service indicators system and assessing the co-benefits or trade-offs between various ecosystem services using multiscale, multi-objectives, multi-factors approaches should be both focused in the process of research; furthermore, model simulation is one of the key approaches for the quantification of soil resilience for ecosystem services.
Development and evaluation of a GIS-based hybrid hydrologic model for spatially distributed rainfall-runoff routing

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ABSTRACT: Theme Category G

A GIS-based conceptually lumped and distributed feature model (hybrid hydrologic model), Distributed-Clark, is developed based on the combined concept of Clark’s unit hydrograph and its spatial decomposition methods to implement hydrologic simulation (runoff routing) for spatially distributed rainfall-runoff flow prediction. In Distributed-Clark, the SCS curve number approach (gridded CN) estimated spatially distributed excess rainfall and GIS-derived time-area diagram (isochrones) based unit hydrographs (a set of separated unit hydrographs) are utilized to calculate a direct runoff hydrograph. Model case studies of single storm event application for four river basins to evaluate the performance of Distributed-Clark using spatially distributed (Thiessen polygon based) rainfall data demonstrate relatively good fit against observed streamflow (direct runoff $E_{NS}$ 0.84, $R^2$ 0.86, and $PBIAS$ 0.86%; streamflow $E_{NS}$ 0.91, $R^2$ 0.92, and $PBIAS$ 0.32%). The results of spatially distributed precipitation applied cases show better fit in comparison with the outputs of spatially averaged rainfall data simulations for Distributed-Clark ($E_{NS}$ of 1.8% and $R^2$ of 2.1% increase in direct runoff) and HEC-HMS ($E_{NS}$ of 15.5% and $R^2$ of 14.8% increase in direct runoff) for the same values of model parameters. Thus, Distributed-Clark is a useful technique to execute spatially distributed rainfall-runoff routing, particularly for storm event flow prediction.
Topography and land use impacts on erosion and soil organic carbon burial over decadal timescales

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ABSTRACT: Theme Category D,F

There is a growing body of evidence to suggest that soil erosion in agricultural landscapes can function as a net carbon (C) sink due to burial of carbon-rich topsoil at depositional sites. It has been argued, however, that soil organic carbon (SOC) degradation during erosion may represent an important source of C to the atmosphere and weaken the overall strength of the erosion-induced C sink. In this study we compare SOC in the top 1.5 m of soil in grassland and cropland landscapes and employ $^{137}$Cs (from atmospheric testing of thermonuclear bombs) as a proxy for soil movement over the past half-century. Using soil depth and terrain attributes calculated from LiDAR-derived digital elevation models, we are able to account for 82 and 83% of the variability observed in SOC and $^{137}$Cs content from grassland sites. For cropland sites, we are able to explain 78 and 50% of SOC and $^{137}$Cs variability, respectively. For cropland sites, slope steepness and curvature play a stronger predictive role than in grassland sites. Comparing SOC and $^{137}$Cs content between grassland and agricultural sites shows that there is not preferential SOC depletion in eroded soils. This suggests that over decadal timescales, for the soils studied here, erosion functions to redistribute SOC around the landscape but does not accelerate SOC decomposition beyond what can be replaced by primary productivity.
Response of soil organic carbon decomposition to temperature across a semiarid elevational-climatic gradient

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ABSTRACT: Theme Category D

Projected increases in mean annual temperatures might alter the amount of soil organic carbon (SOC) currently stored in semi-arid ecosystems by affecting microbial decomposition rates. Given the large global land area of arid ecosystems, changes in soil C in these ecosystems can impact the global C cycle. Yet, uncertainties about the temperature sensitivity of SOC decomposition have hindered accurate predictions of C cycle feedbacks to climate change. This study aims to elucidate how the temperature sensitivity of SOC decomposition varies along an elevational (1000m) and climatic (i.e. mean annual temperature and precipitation) gradient. The study sites are located at Reynolds Creek Critical Zone Observatory in Owyhee Mountains of Idaho, USA. We conducted stratified random sampling of soil up to 0-5cm across sagebrush canopy and inter-canopy areas at four elevations. We hypothesized decomposition of SOC pools at lower elevations to have greater temperature sensitivity (more CO₂ respired per unit C) compared to upper elevations due to a greater activation energy required for decomposition of comparatively lower quality C at lower compared to higher elevations. To assess the response of SOC decomposition to temperature, we used aerobic laboratory incubations (n=40) across a temperature gradient ((15, 20, 25, 30)°C) at constant soil moisture (60% water holding capacity) for 120 days and measured CO₂ resired. Cumulative CO₂ respired increased with increasing incubation temperature. Cumulative CO₂ respired also increased with elevation as upper elevations support greater amounts of C. However, when normalized by SOC, we found that the temperature response of CO₂ respiration was greater in soils derived from lower than higher elevations (p<0.05). These results indicate that the response of SOC decomposition to elevated temperatures differs strongly across the landscape in semi-arid ecosystems.
A reactive transport approach to quantifying microbially mediated reactions, carbon cycling and isotope partitioning in near surface systems

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ABSTRACT: Theme Category C,D
Reactive transport models (RTMs) offers a means of synthesizing and testing the ensemble of hydrologic, chemical and biological processes influencing the distribution, composition, fluxes and fate of elements in near surface environments. Recent efforts have extended the capacity of RTMs to directly simulate the partitioning of stable isotopes in hydrogeochemical systems. The utility of incorporating isotopes into RTMs is demonstrated using an example of biogenic sulfur cycling coupled to labile organic carbon oxidation in a shallow aquifer. The addition of sulfur isotopes to the simulated reaction network allowed reinterpretation of a complex dataset, ultimately demonstrating a microbial ‘memory’ or ‘hysteresis’ associated with periodic influxes of organic carbon. These results suggest the potential to identify those processes exercising first order control over carbon fluxes and recalcitrance in Critical Zone systems through an integrated modeling approach. Towards this goal, an isotope enabled RTM is extended to accommodate the three isotopes of carbon (¹²C, ¹³C, ¹⁴C) including stable isotope fractionation and radioactive decay in a multi-component reactive transport network. The capacity to quantify the storage and flux of carbon pools is demonstrated for a simplified flow path in which influent water degrades labile organic carbon, which is then subject to biogenic reduction and mineralization. This demonstration indicates the capacity for RTMs to function as a means of synthesizing and testing observed carbon speciation and reaction parameters and the IML-CZO.
Hill slope and erosional controls on soil organic geochemistry in intensely managed landscapes

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ABSTRACT

Like many regions of North America, the last 100 years of agriculture in the glaciated upper Midwest has lead to a major redistribution of soil carbon and nitrogen on the landscape. Through the natural coevolution of geomorphic, pedogenic, and ecological processes in the critical zone or by punctual changes in these processes as a result of intensive management, landscapes established characteristic hierarchies of physicochemical controls on organic matter stability. In the Intensively-Managed Landscapes - Critical Zone Observatory (IML-CZO) in Iowa and Illinois these processes are being studied with a combination of surface soil geochemical surveys and simulated rainfall/erosion experiments to document how the organic geochemistry of hillslopes, under land management ranging from row crop to restored prairie, are currently evolving, and how they evolved during early management and pre-settlement. Using a combination of soil analyses including elemental, stable isotope, textural, and soil biopolymers (lignin and cutin/suberin fatty acids (SFA)) we investigated the spatial patterns of static surface soil properties and time course rainfall-erosional experiments along the same slopes to gain insight into soil carbon and biopolymer enrichment patterns in east-central Iowa within the Clear Creek Watershed. Both lignin and substituted fatty acid concentration and their molecular ratios highlighted differences in C3/C4 (soy/corn) management activities in surface soils while over 40 years of prairie restoration dramatically altered surface soil profiles. For example, a general pattern in static baseline samples was an enrichment of 15N in soils down slope and an opposite pattern of accumulation/loss of lignin and SFA in topographic highs and lows. Transport of soil particles, associated biopolymers, and elemental and isotope signatures, exhibited distinct patterns based upon both position of the hillslope and directionality of flow with respect to rill/gully direction created by tillage activity. This indicates that particle/chemistry transport and enrichment of organic chemical signatures down slope and into associated flood plains and streams in modern intensively managed systems should be distinct from pre-settlement patterns and help interpret pre- and post settlement alluvium sediment.
Application of modified DRASTIC and SWAT to evaluate integrated aquifer vulnerability in the Cedar Creek Watershed

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ABSTRACT: Theme Category G
Groundwater management is necessary to maintain clean groundwater. Groundwater management has usually been facilitated by either modeling aquifer vulnerability with computational models or monitoring aquifer vulnerability by sampling. Groundwater monitoring has benefits in analyzing groundwater because it can estimate groundwater quality and quantity directly in real time. Groundwater monitoring, however, also has disadvantages because it is complex, difficult to apply for broad areas, and are a costly undertaking. Compared with groundwater monitoring, groundwater modeling is less complex and costly, and it allows evaluation of broad areas.

For efficient groundwater resources management, integrated aquifer vulnerability assessments are required. Integrated aquifer vulnerability assessments are incorporated into a groundwater characterization and risk analysis with tiered approaches for intrinsic vulnerability and hazard potential assessment. Intrinsic vulnerability will be evaluated using a modified DRASTIC which was modified to use high resolution map data and methods to create aquifer vulnerability maps as well as with calibration using Genetic Algorithms (GAs) and statistical methods. Aquifer hazard potential will be evaluated by SWAT which can simulate pollution potential from surface and transport properties of contaminants. The results of hazard potential assessment using SWAT will be incorporated with the results of intrinsic vulnerability assessment using the modified DRASTIC, and integrated aquifer vulnerability assessment will be applied in areas within the Cedar Creek Watershed, Indiana, United States.

It is hypothesized that 1) application of modified DRASTIC and SWAT to evaluate integrated aquifer vulnerability will provide more accurate aquifer vulnerability than application of only DRASTIC or SWAT. 2) For a watershed scale (448 ~ 7,048 km^2) or bigger areas, this approach would be useful to identify critical source areas in which in-depth estimation could be conducted by a three-dimensional finite-difference groundwater model and aquifer monitoring could be carried out.
**Fate of the Brominated Flame Retardant Tetrabromobisphenol-A (TPPBA) in Soil**

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ABSTRACT: Theme Category B

Tetrabromobisphenol-A (TBBPA) is one of the most commonly used flame retardants and has become a ubiquitous contaminant in soil, water, and sediment worldwide. However, the fate and transformation products of TBBPA in the critical zone are still unclear. Using ring-$^{14}$C-labelled tetrabromobisphenol A (TBBPA), we studied the degradation and transformation of TBBPA in soil under oxic and anoxic conditions. While debromination was the predominant pathway for TBBPA degradation in anoxic soil, aerobic degradation of TBBPA in soil resulted in mineralization (CO$_2$), single benzene ring metabolites, and $O$-methylation metabolites. Four primary metabolic pathways are proposed for aerobic degradation of TBBPA in soil, i.e., oxidative skeletal rearrangements, $O$-methylation, type II ipso-hydroxysubstitution, and reductive debromination. The main fate of TBBPA in both oxic and anoxic soil was formation of bound residues. When soil redox potential altered from anoxic into oxic state, almost half of the anoxically formed bound residues were released as TBBPA and lower brominated BPAs, which were then persistent during oxic incubation. In the presence of rice plants, debromination of TBBPA was enhanced, accompanied by accumulation of TBBPA residues in the plants. Our results provide detailed information about fate of the anthropogenic contaminant TBBPA in the important critical zone compartment.
Regulation of various material combinations on the contents of phenolic acid and microbial functional diversity in tomato-planting soil

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ABSTRACT: Theme Category C, G

How different organic materials and fertilizers benefit soil health under tomato continuous cropping in greenhouse. The effects of different treatments consisting of chicken manure + straw + K₂SO₄ (MRK), chicken manure + K₂SO₄ (MK), straw + chicken manure (MR), chicken manure (M) on the contents of ferulic acid, cinnamic acid, β-hydroxybenzoic acid, benzoic acid and microbial functional diversity in soil were analyzed by capillary electrophoresis (CE) and Biolog-ECO methods. The control included none organic materials or fertilizers (CK). Different materials combination remarkably reduced the contents of phenolic acid in the soil compared to CK, especially for MRK treatments. The contents of soil β-hydroxybenzoic acid and benzoic acid were decreased by 7.11% - 57.04% and 81.84% - 83.32% in MRK than that of other fertilization treatments, respectively. Different organic material and fertilizers combinations improved the utilization efficiency of carbon sources by soil microorganism. The diversity index indicated that Shannon and MchIntosch diversity index in MRK were increased by
3.93% - 10.07% and 6.22% - 27.47%, respectively, when compared with other materials treatments. Principal component analysis showed that the microbial functional diversity were caused by carbon sources of amino acids, carboxylic acid, polymer and phenolic acids in M treatment, but by carbohydrates or amine carbon sources in MR treatment. Two microbial diversity indices had negatively correlated with the contents of ferulic acid, cinnamic acid, β-hydroxybenzoic acid and benzoic acid. Combined application of chicken manure+straw stalks+K₂SO₄ could enhance the microbial functional diversity, reduce the contents of phenolic acid and maintain soil health under continuous tomato cropping in greenhouse.

**Keywords:** Chicken Manure ; Rice Straw; K₂SO₄ ; Tomato; soil Microbe ; phenolic acids
Integrated use of scanning open-path FTIR with multiple open-path and closed path analyzers to determine emission from field-scale inorganic fertilizer treatments

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INTRODUCTION

Open-path Fourier transform infrared spectroscopy (OP-FTIR) is a remote sensing approach widely applied to measure greenhouse gases nowadays. OP-FTIR not only acquires data rapidly but detects multiple components simultaneously and moreover, provides more representative information from the targeted field, such as providing real-time data at a relatively high temporal resolution (seconds), path-integrated gases concentration less prone to artifacts induced by point-based sampling and spatial survey monitoring. However, there are potential issues influencing the spectral analysis, such as the absorption features of non-targeted gas species, H₂O and CO₂ usually, could interfere spectral analysis. Recent studies also indicated that the other ambient factors influence the quality of spectra acquired from the field. For example, wind speed induced vibration of the retro-reflectors at the other end of the optical path from the FTIR lead to misaligned optics, which may reduce the signal strength as well as increase the noise of an interferogram. Temperature fluctuation not only induces scintillation of optical beam along the path but also changes the characteristic absorption feature of target gases, which causes the nonlinear phenomena in the quantification. Difference frequency generation (DFG) laser-based N₂O analyzer measures N₂O in the mid-infrared wavelength. This technology determines the quantitative N₂O measurement with ppb-level sensitivity and highly accuracy by providing single-line and high resolution laser absorption spectroscopy. Thus, DFG laser-based N₂O analyzer associated with synthetic open path sampling system (SOP-S) can be used as a benchmark to understand the accuracy of the concentration of N₂O determined by OP-FTIR and understand the potential influence of ambient factors in the environments on the determination of GHGs concentration.
Optimal implementation of green infrastructure in Trail Creek Watershed using L-THIA-LID 2.1 model

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Abstract:

The adverse impacts of urbanization on hydrology and water quality can be reduced by applying green infrastructure. In this study, the optimal implementation of green infrastructure using Long-Term Hydrologic Impact Assessment-Low Impact Development 2.1 (L-THIA-LID 2.1) model were conducted in the 152.88 km² Trail Creek Watershed with National Land Cover Dataset (NLCD) 2001 and predicted NLCD 2050 from the Land Transformation Model for the following environmental concerns: runoff volume, Total Suspended Solids (TSS), Total Phosphorous (TP), Total Kjeldahl Nitrogen (TKN), and Nitrate+Nitrite (NOx). To attain the same runoff volume and pollutant loads as in 2001 for 2050 land uses with no green infrastructure, the runoff volume, TSS, TP, TKN, and NOx for 2050 needed to be reduced by 10.8%, 14.4%, 13.1%, 15.2%, and 9.0%, respectively. The corresponding annual costs of implementing green infrastructure to achieve the goals were $2.08, $0.79, $1.59, $1.86, and $0.79 million, respectively. To attain the runoff volume and pollutant loads of 2001 for 2050 land uses, the runoff volume optimized scenario cost the most, but it did not reduce all pollutant loads to 2001 level.
Annual costs of reducing 2050 runoff volume/pollutant loads to different levels were also studied, which shows that the annual cost greatly increased with reduction amount. To explore the reductions and costs of applying optimized scenarios in watershed management plans, NOx, TKN, and TP optimized scenarios were applied in the watershed. Results show that none of the three optimized scenarios for the current goal were able to simultaneously reduce TKN, NOx, and TP by 15%, 15%, and 25%. Other optimized scenarios could be explored to obtain simultaneous reductions that would meet these levels. The optimized scenario of reducing TKN by 45% can meet the goal of simultaneously reducing TKN, NOx, and TP by 45% with an annual cost of $20.2 million.
Using Critical Zone (CZ) Science to Understand Soil and Water Processes in the Loess Plateau: Opportunities and Challenges

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ABSTRACT: Theme Category G
The Loess Plateau (LP) is one of the most unique geomorphic unit around the world, characterized by the serious soil erosion, frequent drought, and heavy human activity. Approximately $64 \times 10^4$ km$^2$ in area, the LP today supports a population of about 100 million people. The Grain for Green project implemented since the end of 1990s resulted in the significant changes in the soil and water processes and ecosystem services on the LP. The study on changes of materials cycling in the critical zone (CZ) on the LP with heavy human activity would thus expand the scientific connotation and representative region in the Earth’s CZ’s research. We will discuss the basic characteristics of the plateau CZ, which includes the deep loess deposits, the unique landscapes, the long-term vegetation dynamics and the annual sediment discharge into the Yellow River from the plateau. This presentation will focus on the interaction between vegetation and soil erosion, the coupling of water, carbon and nitrogen cycling, and the development of integrated model in the plateau CZ. Some of the issues are not still well addressed, and thus there are many opportunities and challenges in the study of the plateau CZ. Through experimental investigation, modelling and integration at various spatial scales, we hope to understand the mechanism and spatial heterogeneity of water cycling in CZ of the LP, to clarify the interaction between vegetation and soil erosion and its effects on carbon and nitrogen cycling, and to develop the method for modeling ecosystem service and optimization decision, and thus the optimization of ecosystem service. Furthermore, understand soil and water processes using CZ science can provide scientific and technological support for environmental rehabilitation and sustainable development of the LP.
Selective dissolution experiments for the characterization Fe-C associations in highly weathered tropical subsoils

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ABSTRACT: Theme Category D

Tropical forest soils contribute disproportionately to the poorly-characterized and persistent deep soil carbon (C) pool. Highly-weathered, and often extending one to two meters deep, these soils also contain an abundance of semicrystalline, Fe- and Al-containing short-range-order (SRO) minerals. SRO minerals are capable of soil organic matter (SOM) stabilization through sorption or co-precipitation, a faculty enhanced by their high specific surface area (SSA). As such, SRO-mediated organomineral associations may prove a critical, yet matrix-selective, driver of SOM stabilization capacity in tropical soils, particularly at depth. Surface (0-20 cm) and subsoil (50-80 cm) samples were collected from 20 quantitative soil pits dug in the Luquillo Critical Zone Observatory (LCZO), located in northeast Puerto Rico. Selective dissolution procedures were used to isolate distinct forms of Fe-C interactions: (1) sodium pyrophosphate to isolate organo-mineral complexes, (2) hydroxylamine and (3) oxalate to isolate SRO phases, and (4) inorganic dithionite to isolate crystalline Fe oxides. Extracts were analyzed for dissolved organic C (DOC) and Fe and Al concentrations to estimate SOM associated with each mineral phase. Preliminary results suggest that SRO-mediated organomineral associations are significant contributors to observed C storage in subsoils, but that these mineral phases do not represent the majority of the soil C stock. Methodological issues associated with the selective dissolution experiments will be discussed, as well as the planned extension of the experiments to soils from the Calhoun CZO.
Features of Fe-Mn nodules in southern Indiana Loess with a fragipan horizon

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ABSTRACT: Theme Category G

Despite extensive research, little is known about how features of Fe-Mn nodules vary relative to genetic horizons of loess and soil forming environments. In this research, nodules were collected according to loess genetic horizons from SEPAC and wet sieved into 4 groups; including 2-1 mm, 1-0.5 mm, 0.5-0.25 mm, and 0.25-0.1 mm. Physical, chemical, micro- and macro-morphological features of nodules and their soil matrix were determined as a function of soil depth. The Ap horizon was determined to contain the highest proportion of nodules. These were derived from the subsurface horizon due to high erosion in the past. The small sized nodules concentrated in the Ap horizon were predominantly related to high SOM. In addition to the Ap, the Btx1 and Btx2 also contained a large fraction of nodules. Additional observations and chemical composition analysis using scanning electron microscope (SEM) with energy dispersive X-ray spectroscopy (EDS) were conducted on 2-1 mm and 1-0.5 mm nodules. Different micro-morphological features, including a complex Fe-Mn-oxide matrix with mineral grains consisting of predominantly quartz and feldspar, were observed. Nodules were consistently grouped into rough and smooth types. Brown nodules have a low Mn/Fe value (< 1), whereas black nodules have a high Mn/Fe value (> 1). Micro-morphology of Mn-rich, Fe-rich, and Mn-Fe-rich regions were observed inside nodules from different horizons. Fe and Mn diffused and precipitated within the matrix with an extensive micro-pore system. Examination of soil thin sections from perched water zones showed brown spherical Fe-Mn nodules with sharp boundaries and more densely differentiated fabric.
Do plastic film mulching and fertilizer application enhance the carbon flux from plant to soil and its immobilization by microorganism?

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ABSTRACT: Theme Category F

Plastic film mulching and fertilizer application enhanced the plant and microbial biomass in China. Do these practices facilitate photosynthetic carbon (C) transform belowground and improve soil microbial activity? The objectives of this study were to trace photosynthetic C flux from plant to soil and assess its immobilization by microorganism after the application of mulching (with or without plastic film mulching) and fertilizer (no fertilizer, medium-level organic manure, and high-level organic manure). In-situ $^{13}$C pulse labeling of maize was conducted during the shooting stage. We found, the percentage of net fixed $^{13}$C distributed belowground decreased from, on average, 22% on the 1st day to 28% on the 6th day after labeling. And the percentage was larger 10% in no fertilizer than in organic manure with or without mulching application. Although the amount of microbial immobilization $^{13}$C was higher, the lower $^{13}$C retained in soil was incorporated into microbial biomass C (MBC) in rhizosphere soil than in bulk soil. No fertilizer enhance the amount of $^{13}$C in MBC and the allocation of $^{13}$C fixed in soil to MBC in bulk soil compared with organic manure application with or without mulching at the end of labeling. These results indicated the strong growth of maize promoted the transformation of photosynthetic C from rhizosphere soil to bulk soil during the shooting stage. No fertilizer application regardless of mulching enhanced the C flux belowground and soil microbial activity. C allocation and sequestration in plant- soil- microbial systems could be controlled by maize growing stage and agricultural practices.
Weathering and erosion control organic carbon stock and stabilization in a forested soil from the Feather River, California

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ABSTRACT: Theme Category D

Weathering process breaks down rocks into soils producing mineral surface area (SA) to adsorb organic carbon (OC), which is increasingly regarded as one of the most critical factors for stabilizing OC in soils. In addition to weathering, hillslope processes redistribute minerals and associated OC from the upslope to downslope positions. However, our mechanistic understanding of how weathering and erosion control OC sorption on mineral surfaces is lacking. Here by combining density fractionation of soil OC, mineral specific SA (in the unit of m²g⁻¹), and particle sizes analysis, we addressed this knowledge gap along a forested hillslope transect in the Feather River area, California. Topographic locations did not significantly affect OC concentrations in the investigated soils. Depositional hollow had significantly larger amount of coarse fragments and clay particles than the eroding area presumably reflecting grain-size sorting during sediment transport of which mechanism is sensitive to local topography. Furthermore, total SSA generally increased from <5 m²g⁻¹ at the surface to 14.3 m²g⁻¹ in subsoils. Depositional soils appear to have greater capacity to adsorb OC as indicated by the greater mineral SA. Mineral SA inventories were more than twice larger in the depositional hollow than in the eroding locations. Mineral SA created by removing OC was interpreted as OC-occluded. Greater mineral SA was OC-occluded in the eroding part than in the depositional hollow, suggesting that soil minerals are less occluded by OC and thus have greater availability to adsorb additional OC in the depositional environment. The occluded SA was significantly positively and linearly correlated with SOC concentration, and the greater OC storage in hollow soils appear to be largely due to their thicker soils. Overall, depositional soils stored more OC and mineral SA than the eroding locations. These results highlight that topography and erosion significantly control soils’ capacity to store and stabilize OC.
Effects of erosion rates on soil carbon inventories and carbon-mineral interactions across a denudation gradient in a steep mountain ecosystem in Sierra Nevada, California

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ABSTRACT: Theme Category A

Hillslope geomorphic processes not only erode and redistribute organic carbon (C) but also affect the thickness and coarseness of soils storing C in rugged landscapes. In order to better understand direct and indirect links between erosion and soil C sequestration in rugged soil-mantled landscapes, we attempt to (i) quantify inventories of organic C in soil and (ii) identify and quantify geomorphic and biogeochemical mechanisms regulating organic C inventories and carbon sorption on mineral surface. We determined soil organic C concentrations and inventories, BET mineral specific surface area (SSA), and stable carbon isotope (δ¹³C) ratios in soil and saprolite along three soil-mantled hillslope transects with drastically different erosion rates (POMD, 30 mm kyr⁻¹; FTA, 130 mm kyr⁻¹; and BRC, 300 mm kyr⁻¹) within the Feather River, California. Erosion rates had been previously determined using ¹⁰Be. Concentrations of organic C in fine fractions (<2 mm) varied little despite the ~10 fold increase in erosion rates, which is in agreement with erosion-independent SSA of the same size fraction. However, organic C concentrations and SSA in the saprolite decreased with increasing erosion rates. Organic C inventories in the POMD and FTA soils were significantly greater than those of BRC soils, although no significant difference was observed between the POMD and FTA soils’ C inventories. This trend occurs largely because higher erosion rate results in soils with higher coarse fractions and subsequently lower amounts of SSA. The result further indicated that nonlinear negative relationships exist between erosion rates and organic C inventories in soils. Overall, enhanced erosion reduces the soils’ potential to store C in steep landscapes largely by constraining weathering that breaks down coarse rock fragments and generates SSA. This highlights that the coupling between weathering and erosion processes plays a key role in biogeochemical cycle in steep landscapes.
Using high throughput sequencing methods to identify keystone bacterial species in recalcitrant terrestrial organic matter transformation

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Abstract: Theme Category G.
The microbial transformation of terrestrial organic matter, particularly recalcitrant lignin and hemicellulose, is a significant but poorly understood phenomenon. 16S rRNA gene amplicon sequencing and metagenomic sequencing are relatively inexpensive molecular tools to quickly assess microbial diversity and functional genes in response to different carbon sources. Using sequencing and bioinformatics, we aim to elucidate the diversity and metabolic potential of bacterial communities subsisting on lignin and hemicellulose in laboratory cultures. Seawater microcosms were incubated with an added concentration of purified lignin or xylan. CO₂ respirometry and enzyme assays showed high microbial activity on both substrates. Using an Illumina MiSeq platform, both amended cultures and unamended controls were sequenced for 16S rRNA gene amplicons and metagenomics. Reads were annotated using Qiime and MG-Rast. Annotated data was compared in detail using phyloseq, vegan, and DESeq2 in R. From our initial results, several species belonging to phylum of Proteobacteria, Flavobacteria, and Firmicutes significantly increased in abundance when lignin or hemicellulose was added. Groups of functional genes related to carbohydrates and aromatic catabolism significantly increased in abundance. Our methods may uncover important species that have been previously overlooked for terrestrial organics degradation.
Surface soil carbon stabilization and microbial PLFA composition in temperate and sub-tropical oriental oak stands of East China

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ABSTRACT: Theme Category D, F

Forest ecosystems contain large amounts of soil organic carbon (SOC) that may be sensitive to climatic change. However, we still lack a clear understanding of how forest SOC will respond in a warming future. We examined the influence of climate on the quantity and quality of SOC for organic and surface mineral horizons in seven oriental oak (Quercus variabilis) forest sites in East China, three in the warm temperate climatic zone and four sub-tropical. The temperate zone sites contained higher amounts of SOC in forest floor horizon (0.96 vs. 0.42 kg m\(^{-2}\) in sub-tropical zone), but similar amounts of SOC in the 0-10 cm mineral horizon (2.97 vs. 3.22 kg m\(^{-2}\)). We used a combination of nuclear magnetic resonance (NMR) spectroscopy and elemental and isotopic composition to characterize SOC chemistry. The SOC in the sub-tropical zone appeared to be relatively more stabilized based on significantly higher alkyl/O-alkyl ratios at the 0-2, 2-5, and 5-10 cm depths; also, using phospholipid fatty acid (PLFA) technique, we found that both microbial biomass and fungal-to-bacterial ratio at the 0-10 cm depth decreased with increasing MAT and MAP along this latitude; the links between surface SOC stabilization and microbial PLFA composition need further investigation. Soil OC exhibited increases in \(\delta^{13}C\), \(\delta^{15}N\) and decreases in C/N with depth for all the seven sites, indicating an increase in its degree of decomposition. Our analysis suggests that warming climate could result in loss of less stabilized SOC from surface soils in temperate zone forests.
Molecular fingerprinting how soil organic matter drives changes in soil functions

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Abstract

Soil organic matter (SOM) is a mixture of heterogeneous compounds with different decomposability. It was hypothesized that SOM composition can register the dynamics of soil functions under changing environment. Applying advanced 13C NMR spectral editing techniques, the objectives of the studies were to quantify the compositions of molecular structures and compounds of organic matter of Mollisols in China and to develop molecular indicators to register dynamics of contrasting soil functions with land use conversion, cultivation time and organic amendment. In the land use conversion study, restoration of grassland for 28 years from a 100-year cropland can recover soil physical and chemical properties completely, but not soil microbial biomass. In addition, SOM content increased during restoration at the same speed of SOM loss during cultivation. Moreover, long-term cultivation led to large increases recalcitrant compounds such as lignin, charcoal and carbonyl and sharp decreases in the labile compounds such as carbohydrates and lipids. Restoration of grassland caused little changes of the proportions of both labile and recalcitrant fractions. All three soils contained fused-ring aromatics, and the aromatics were oxidized only in native and restored grassland. These results suggested molecular structures and compounds can be used to fingerprint the changes in contrasting soil functions during land use conversions. In the cultivation time and soil type study, principle component analysis of 13 functional groups of SOM demonstrated that 1) surface soils were separated from subsoils in both Phaeozems and Chernozems; 2) Subsoils, but not surface soils were largely separated due to cultivation time for both soil types; 3) the separations among the subsoils were contrasting, indicating oxidization of charcoal in Phaeozems and oxidization of original SOM in Chernozems.
These results indicated that prolonged cultivation without enough organic carbon input to subsoils may cause more degradation of soil fertility in Chernozems than in Phaeozems. In the organic amendment study, priming effect was studied by addition of $^{13}$C labeled and depleted glucose and the results demonstrated that the priming effect increased with increasing soil depth and increased organic input. SOM content decreased due to low input and increased due to high input. Microbially-derived residues such as (CH$_2$)$_n$ and O-CH increased, while all functional groups, either labile or recalcitrant, of the native SOM decreased during 43-d incubation and transformation of added glucose. These findings first provided molecular evidences of SOM turnover and renewing driven by priming effect and demonstrated that all functional groups were not preferentially decomposed, which is vital for maintaining multiple soil functions.
Environmental fates of tetracycline resistance genes originating from swine feedlots in river water

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ABSTRACT: Theme Category B and C

Tetracyclines are antibiotics commonly used in swine farms to treat disease and promote growth. However, there are growing concerns regarding the discharge of animal feces into the environment owing to the potential for development and dissemination of tetracycline resistance genes (TRGs). In this study, farming wastewater from one Chinese swine farm as well as river water from seven locations downstream of the farm was sampled. Polymerase chain reaction (PCR) showed that 12 TRGs, including 6 efflux pump genes (tet(B), tet(C), tet(D), tet(E), tet(G) and tet(L)), 5 ribosomal protection proteins (RPPs) genes (tet(O), tet(M), tet(Q), tet(W) and tet(S)), and 1 enzymatic modification gene (tet(X)), were present in all wastewater and river water samples. Quantitative real-time PCR (qPCR) showed that the abundance of tet(C), tet(X), tet(O), tet(M), tet(Q) and tet(W) decreased with downstream flow. Among the detected TRGs, tet(C) had the highest abundance, ranging from 459.5 copies/16S rRNA copies in wastewater to 33.8 copies/16S rRNA copies in river water samples collected from the last location. Furthermore, pig-specific Bacteroidales 16S rRNA genetic marker was quantified by qPCR to determine the level of fecal pollution in the river water. Bivariate correlation analysis confirmed that the total relative abundance of the 6 TRGs was significantly correlated with the level of swine feces in the aquatic environment ($R^2= 0.63$, $p < 0.05$), suggesting that swine feces mainly contributed to the spread of TRGs in the river water.
Separating effects of anthropogenic activities and climate change on vegetation dynamics on the Tibetan Plateau

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The Tibetan plateau (TP) is the largest alpine plateau in the world. It has an average elevation of 4000m and is called the “Third pole” of the world. The TP is a critical zone due to its fundamental ecological and environmental significance to China, even Asia. In the meantime, the TP is a fragile system. In recovering and protecting the system, it is necessary to disentangle the relative contribution of anthropogenic activities and climate change to the ecosystem dynamics. In this study, we integrated remote sensing data, field observation data, and regional annual statistical data, and used statistical model, process model and physiology model to explore the regulating effects of anthropogenic activities and climate changes on ecosystem dynamics on the TP. The remote sensed results revealed that vegetation has gained vigor in most parts of the TP in the past three decades. Grazing, as a main type of anthropogenic activity, contributed approximately 10% of ecosystem dynamics variation on the TP. Temperature has increased an average of 2°C on the TP. In the east TP, where precipitation is relatively abundant, increased temperature has caused improved vegetation vigor and acted as a primary driving factor. Relative to the obvious temperature increment, precipitation exhibited a weak increasing trend on the TP. Enhanced precipitation acted positively on vegetation growth across the entire TP, and precipitation was a primer on vegetation in the west TP. Both remote sensing and physiology process model results pointed to a similar conclusion that climate acted as a primary factor regulating vegetation dynamics, and lowered grazing pressure can facilitate vegetation recovery on the TP. This study would lay the theory foundation for environmental and ecological recovery on the TP and capitalize more efficiently the ecological hurdle function of the TP.
Title: **Rebuilding Soil health with Forest Industry Residuals**

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Intensive vegetable production can degrade soil quality and make crops more susceptible to soil-borne pathogens. Many soil-borne pathogens, particularly *Phytophthora capsici*, are becoming increasingly problematic because they have wide host ranges, can survive in soil for years, and are now resistant to many commonly used fungicides. Indiana has a significant forest industry with residual products that could be used to rebuild soil quality and help suppress soil-borne pathogens. Amending soil with complex organic substrates has previously been demonstrated to reduce disease severity in some trials, though the mechanisms are not well understood. The chemical composition of the amendments and stimulation of resident soil microbial communities are likely to play a role in pathogen suppression. We collected soil from a farm with a recent outbreak of *P. capsici* and amended it with one of four forest industry residues alongside a control (no amendment) treatment. The treatments were saturated with water and left to incubate for one month. Soil samples were collected after 0,1,3,7,14,21,28 days and subject to various assays to quantify changes in the abundance and activity of key microbial groups. After 28 days, susceptible pepper seedlings *cv. Capsicum annuum*, were transplanted into soil from each treatment. After one month, plants will be collected from each plot and roots will be rated for disease severity, and plant root and shoot biomass determined. Results-to-date indicate that these treatments have dramatic effects on the composition of soil microbial groups. Future experiments will be conducted using soil enriched with 13C so we can track how much of the carbon in the amendments are utilized by soil microbes, and sequestered in soil. Results of these studies will have important implications for helping vegetable growers build soil organic matter, and help manage soil-borne pathogens.
Effects of Biochar Application History on SOC Stability: Effect of Moisture Regime on Soil Organic Carbon Mineralization from Cropland in China

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\textbf{ABSTRACT: Theme Category D, F}

Biochar application has been widely reported as an effective means of abating climate change by sequestering carbon. Much more attentions were paid to study soil priming effect under biochar application. However, little information about changes of soil organic carbon (SOC) stability is available a few years after a single biochar application at present. To classify this issue in dryland under biochar amendment history, the study selected Alfisols, a typical dryland located in Tai’an in Shandong province, three years after a single biochar application. Three treatments without biochar (C0) and with biochar at 20t ha\textsuperscript{-1} (C20) and 40t ha\textsuperscript{-1}(C40) was carried out to investigate the effect of biochar on SOC mineralization in laboratory incubation under different water statuses. The results indicated that the dynamics of SOC mineralization preferably followed the first-order kinetics. Soil moisture regimes affected significantly the SOC mineralization intensity which decreased with soil water holding content (WHC) increase. Under the 25\% WHC, 50\% WHC and 75\% WHC conditions, the apparent intensity of mineralization of SOC under C20 and C40 decreased by 27.16\%~46.70\% (25\%WHC), 21.02\%~32.04\% (50\%WHC), 14.72\%~30.67\% (75\%WHC) compared to C0, respectively. Furthermore, there was significant difference in response of microbial biomass carbon, soil organic carbon and metabolic quotient to the water status with biochar addition. As a result, biochar could keep the stability of the microbial biomass carbon and reduce SOC mineralization under low moisture content. Therefore, the results indicated that biochar application has the important significance for soil carbon sequestrating and maintaining the stability of soil organic carbon in agricultural soil.
Occurrence of erythromycin resistance methylase (erm) genes driven by environmental antibiotics in urban soils

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ABSTRACT: Theme Category B, G

The occurrence of environmental antibiotic resistance genes (ARGs) are often attributed to selective pressure from discharge of treated wastewater. However, the effects of environmental factors and natural production of antibiotics on the development of ARGs have not been fully investigated. This study evaluated the occurrence and distribution of erythromycin resistance methylase (erm) genes in urban soils in a city without impact of treated wastewater. Correlations were identified between erm genes, environmental antibiotics, and biosynthesis genes. Among the soil samples collected from 46 sampling locations, ermA, ermB, ermC, ermD, ermF, ermG, ermT, and ermY genes were detected with detection frequencies between 20% to 80%, and their abundance ranged between 5.95×10^1 to 6.94×10^6 copies/g dry soil. Absolute abundances of ermB, ermC, ermD, ermG, and ermY were positively correlated with PKS gens (p<0.042), and relative abundances of ermB, ermC, ermF, and ermY genes were positively correlated with erythromycin (p<0.002), suggesting that the occurrence of ARGs in soils are driven by naturally produced antibiotics. No correlation was observed between erm genes and metals, except between ermD and Cd and As. Both type I PKS and type II PKS biosynthesis genes, which are responsible for biosynthesis of polyketides, such as erythromycin, were detected in 100% of the soil samples, and their abundances were relatively high (5.77×10^2-9.39×10^6 copies/g soil). The absolute abundances of PKS genes were both positively correlated with cell biomass, ammonium, and fluoride, while the relative abundances of type I PKS gene and type II PKS genes were correlated with different types of metals and nutrients. The wide occurrence of erm genes in urban soils without impact of treated wastewater suggest that ARGs could still occur due to naturally produced antibiotics and their potential health risks should be further investigated.
Adsorption and Oxidation of Fulvic Acid by Birnessite
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Abstract: Manganese (Mn) redox cycles are coupled to carbon (C) cycles in numerous natural environments, such as during long-term litter decomposition in forest ecosystems and in suboxic marine sediments. It remains, however, unclear how Mn and C interact with each other during the coupled cycling. In this study, dissolved organic matter (DOM) (fulvic acid) was reacted with birnessite (δ-MnO₂) in batch experiments at various pHs (4, 6 and 8) and solid/FA mass ratios (1, 10 and 100) under anoxic conditions over 25 days to examine the reaction mechanism in the absence of O₂. Results show that at a given reaction time, FA concentration increased while dissolved Mn concentration decreased with increasing pH, suggesting that low pH favors the reaction. Synchrotron-based X-ray diffraction and atomic pair distribution function analyses indicate that at pH 4 and 6, Mn(II) adsorbed on the vacancies of δ-MnO₂, and the adsorption loadings increased with increasing time for all solid/FA ratios. At pH 8 and solid/FA = 10, Mn(III) was increasingly enriched in the birnessite MnO₆ layers. In contrast, at solid/FA = 1, a large amount of Mn(II) was adsorbed on vacancies with negligible Mn(III) formed in the birnessite structure. These results suggest that an array of complex interactions between DOM and birnessite, including adsorption and oxidation on birnessite surfaces as well as potential complexation between Mn (II, III) and FA in solution, could be involved in the coupling of Mn and C cycles. The ongoing research is to characterize the chemical alteration of FA due to oxidation by birnessite.
Effects of straw return to deep soil with urea amendment on soil organic carbon fractions in a semi-arid temperate corn field

Hongtao Zou, Jia Lu, Meng Xu, Wen Li, Qingfeng Fan, Xiuli Dang, Yulong Zhang

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ABSTRACT: Theme Category D, F

Straw return in agricultural field is an important soil management practice to improve soil quality, such as increase soil organic carbon (SOC) contents. However, few studies have been conducted to assess the effects of straw return to deep soil with urea amendment on soil labile organic carbon (C) fractions. This study was conducted in the Northeastern China, located in the semi-arid temperate climate zone, which is mainly corn production region. A field experiment was used to evaluate the effects of corn straw return to deep soil with urea amendments on labile organic C fractions. Different amounts of corn straw, i.e. no straw return (CK), 400 kg ha\(^{-1}\) straw (S\(_{400}\)), 800 kg ha\(^{-1}\) straw (S\(_{800}\)), 1200 kg ha\(^{-1}\) straw (S\(_{1200}\)), and 1600 kg ha\(^{-1}\) straw (S\(_{1600}\)), respectively, were return to soil at 40 cm depth. Urea was applied to adjust soil C/N ratio to 25, which is ideal for maximum decomposition. After two years, microbial biomass C (MBC), easily oxidized organic C (EOC), dissolved organic C (DOC) and light fraction organic C (LFOC) were measured at three soil depths (0-10, 10-20, and 20-40 cm). MBC increase was observed under S\(_{800}\) treatment. However, straw return decreased DOC content, the lowest DOC was observed under S\(_{800}\) treatment in 0-20 cm soil. The decrease of DOC might be because straw return increased the degradation and leaching of original soil DOC. The highest LFOC content was still S\(_{800}\) in 10-40 cm.
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