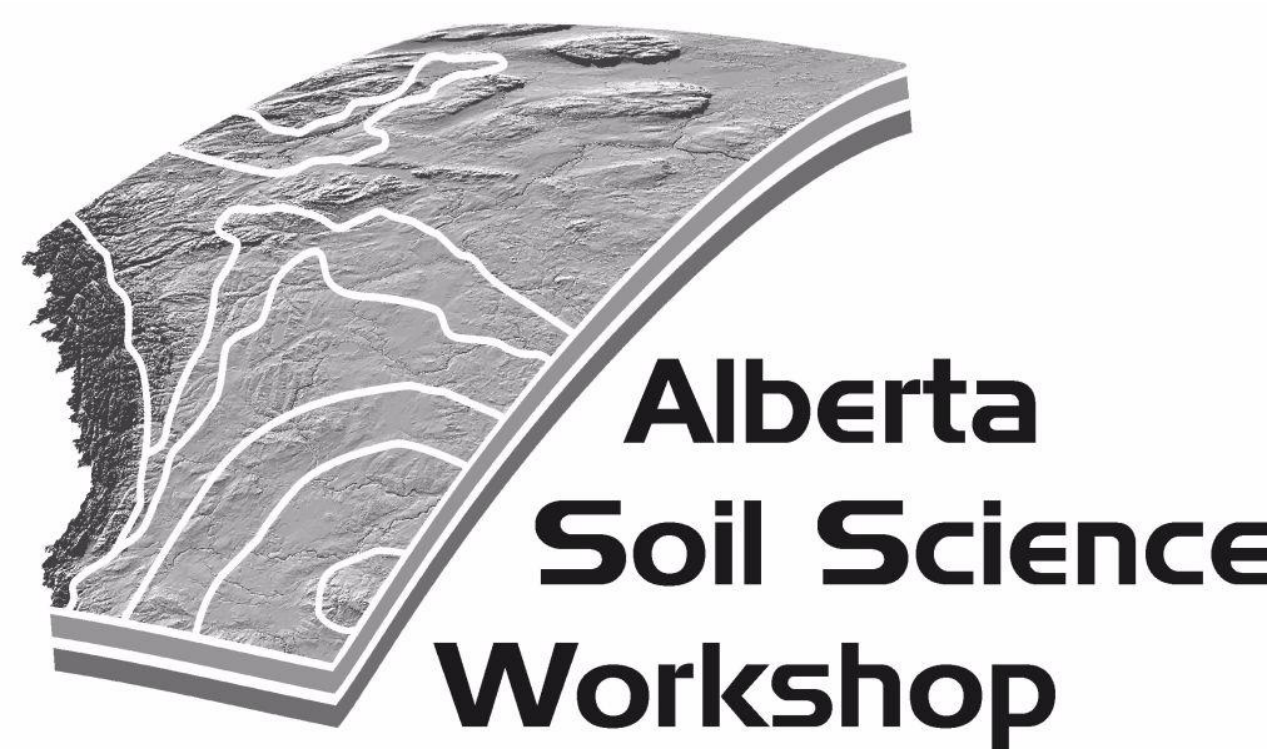
Program for the 56th Annual



Workshop Theme:

Soil Resilience and Extreme Events

February 19 to 21, 2019

Delta Calgary South
Calgary, Alberta

www.soilsworkshop.ab.ca

About the Alberta Soil Science Workshop

The Alberta Soil Science Workshop is held to facilitate regional interaction among professionals in soil science. Typically 100 to150 participants gather for a 1½ to 2 day program that comprises 40 to 60 oral and poster presentations. These include: keynote papers focused on the workshop theme, technical papers within five distinct fields, and volunteer papers. Currently the five technical groups are: Land Use and Rangelands, Soil Fertility, Land Reclamation, and Forest, Riparian and Wetland Soils. This year we have a special technical session on Soil Resilience and Extreme Events.

Workshop participants are professionals from private industry (e.g. consultants in agronomy, pedology, reclamation, remediation, and environmental services; chemists from commercial analytical laboratories), government (federal, provincial, municipal) and academia (universities and colleges). The Workshop is graduate student-friendly, providing an excellent opportunity to enhance presentation skills in a supportive setting (travel bursaries are available for out-of-town students; awards are provided for the best student presentations).

Alberta Soils Tour - 2019

Konstantin Dlusskiy, Ph.D., P.Ag, Chair of Soils Tour

The Soils Tour Sub-Committee is pleased to announce that the next Alberta Soils Tour will take place on May 30 and 31, 2019, in the Central Alberta Region. This 2-day tour will start from Red Deer, AB, and go southeast into the badlands area near Drumheller, AB, finally returning to Red Deer, AB.

The Alberta Soils Tour is held biannually to facilitate regional interaction among professionals, students, and enthusiasts in soil science and related fields. The tour provides hands-on field opportunities for professional development, learning, and collaboration. Typically, 40 to 100 attendees gather for a 2- or 3-day program that consists of investigating sites that represent a range of different soils, as well as abundant networking opportunities.

In 2019, the Alberta Soils Tour will focus on typical soils of Alberta prairies:

- Black and Dark Brown Chernozems,
- Solonetzic soils
- Humic Vertisols, and
- Gleysols, including their saline phases.

The variety of parent materials covered will include glacial till, glaciolacustrine and recent lacustrine sediments, pre-glacial gravels and various types of bedrock.

The organizing committee (Ed Karpuk, Ron McNeil, Bruce Walker, Olga Kulikova and Konstantin Dlusskiy) will arrange for participant accommodations in Drumheller, and is glad to announce Brent Noland (Drumheller Rocks Geo-Tourism) as a dinner speaker.

Registration for the 2019 Alberta Soils Tour will open on March 1, 2019 at the Alberta Soil Science Workshop website (http://soilsworkshop.ab.ca). An announcement will be sent to all subscribers of the ASSW.

The Organizing Committee is also encouraging potential sponsors to support the upcoming event. Sponsorship forms are available at the Alberta Soil Science Workshop website (http://soilsworkshop.ab.ca).

Alberta Soil Science Workshop Organizing Committee

Chair	Janna Casson Alberta Agriculture and Forestry, Lethbridge AB
Past Chair	Dani Degenhardt Natural Resources Canada, Edmonton AB
Treasurer	Len Kryzanowski Alberta Agriculture and Forestry, Edmonton AB
Secretary	Symon Mezbahuddin Alberta Agriculture and Forestry, Edmonton AB
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Technical Session Chairs

Soil Fertility	Len Kryzanowski Alberta Agriculture and Forestry, Edmonton AB
Land Use and Rangelands	Karen Raven Alberta Agriculture and Forestry, Edmonton AB
Land Reclamation	Deo A. Heeraman Wood Environment and Infrastructure Solutions, Calgary AB
Forest, Riparian and Wetland Soils	Bin Xu Northern Alberta Institute of Technology, Peace River AB
Technology and Soil Science	Preston Sorenson Maapera Analytics, Edmonton AB
Volunteer Session	Konstantin Dlusskiy Paragon Soil and Environmental Consulting

Sponsors

We would like to thank the following sponsors for helping make the 2019 Alberta Soil Science Workshop possible.

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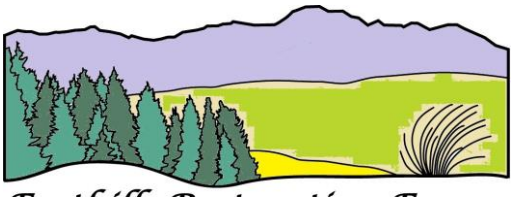

Foothills Restoration Forum

Canada
Natural Resources Canada
Canadian Forest Service

Alberta
Freedom To Create. Spirit To Achieve.
Government of Alberta

Program – 2019 Alberta Soil Science Workshop

Tuesday, February 19, 2019

15:00 – 17:00 PM	Pre-workshop on Pre-disturbance Assessments and EPEA Approval Requirements (Canmore Room)

Wednesday, February 20, 2019

7:00 AM	Registration (Nakiska Ballroom)
7:00 – 8:00 AM	Breakfast (Nakiska Ballroom)
8:00 – 12:00 PM	Plenary Session (Nakiska Ballroom)
10:00 – 10:25 AM	Coffee and Refreshments (Nakiska Ballroom)
12:00 – 1:00 PM	Lunch (Nakiska Ballroom)
1:00 – 2:25 PM	Land Reclamation Technical Session (Nakiska Ballroom) Soil Resilience and Extreme Events Technical Session (Canmore Room)
2:25 – 2:45 PM	Coffee and Refreshments (Nakiska Ballroom)
2:45 – 4:50 PM	Forested, Wetland and Riparian Soils Technical Session (Nakiska Ballroom) Soil Fertility Technical Session (Canmore Room)
4:50 – 6:00 PM	Poster Session (Nakiska Ballroom)
6:00 – 9:00 PM	Cash bar, banquet and local vocalist/guitarist Jennifer Robin will perform www.jenniferrobinmusic.com (Bonavista Ballroom)

Thursday, February 21, 2019

7:30 – 8:30 AM	Breakfast (Nakiska Ballroom)
8:30 – 9:55 AM	Land Reclamation Technical Session (Nakiska Ballroom) Land Use and Rangelands Technical Session (Canmore Room)
9:55 – 10:20 AM	Coffee and Refreshments (Nakiska Ballroom)
10:20 – 11:25 AM	Land Reclamation Technical Session (Nakiska Ballroom) Land Use and Rangelands Technical Session (Canmore Room)
11:30 – 12:00 PM	ASSW Business Meeting and Closing Remarks (Nakiska Ballroom)
12:00 – 1:00 PM	Lunch (Nakiska Ballroom)

Detailed Program

Tuesday, February 19, 2019 – Afternoon

Pre-workshop – Canmore Room

3:00 – 5:00 PM **Predisturbance Assessments and EPEA Approval Requirements**

Elaine Lee-Ho

Paragon Soil and Environmental Consulting

The Alberta Energy Regulator released the *Specified Enactment Direction 001 (SED001) for Conservation and Reclamation Submissions Under an Environmental Protection and Enhancement Act Approval for Enhanced Recovery In Situ Oil Sands and Heavy Oil Processing Plants and Oil Production Sites* in February 2016 (AER 2016). SED001 is a guideline for predisturbance assessments (PDAs), conservation and construction plans (CCPs), annual conservation and reclamation (C&R) report and the Project Level Conservation, Reclamation and Closure Plan (PLCRCP). SED001 replaced the 2014 *Manual 010: Guidelines for the Submission of Predisturbance Assessment and Conservation and Reclamation Plan* and the *Guidelines for Submission of an Annual Conservation and Reclamation Report* (AER 2014). SED001 provides guidance for a relatively new EPEA approval requirement for the PLCRCP. Elaine will describe the requirements in SED001 and highlight the differences between SED001 and previous guidelines. She will also show how PDAs, CCPs, annual C&R report and PLCRCP requirements tie together.

Wednesday, February 20, 2019 – Morning

Plenary Session – Nakiska Ballroom

7:00 – 8:00 **Breakfast – Nakiska Ballroom**

8:15 – 8:30 **Welcome and Introduction**
Janna Casson
Alberta Agriculture and Forestry

8:30 – 9:15 **Maintaining Soil Resilience as a Climate Adaptation Strategy**
Dr. David Sauchyn
University of Regina

9:15 – 10:00 **Soil Resilience in the Face of Wind Erosion**
Dr. Frank Larney
Agriculture and Agri-Food Canada

10:00 – 10:25 **Coffee and Refreshments – Nakiska Ballroom**

10:25 – 11:10 **Response of Tailings Sediment Microorganisms to Petroleum Hydrocarbons and their role in Tailings Management**
Dr. Tariq Siddique
University of Alberta

11:10 – 11:55 **Watershed Resistance and Resilience to Extreme Events: Insights from Wildfire in Alberta**
Dr. Uldis Silins
University of Alberta

12:00 – 1:00 **Lunch – Nakiska Ballroom**

Wednesday, February 20, 2019 – Afternoon

Concurrent Technical Sessions

PM	**Land Reclamation** Nakiska Ballroom	**Soil Resilience and Extreme Events** Canmore Room
1:00 – 1:05	**Chair: Deo A. Heeraman** Wood Environment and Infrastructure Solutions	**Chair: Preston Sorenson** Maapera Analytics
1:05 – 1:25	**Initial Soil Development on Reclaimed Land** *Konstantin Dlusskiy*	**Crop Productivity Following Diverse Long-Term Cropping Systems at Bow Island, Alberta** *Eric Bremer, Doon Pauly, Ross McKenzie, Ben Ellert and Henry Janzen*
1:25 – 1:45	**Creating a lunchbox for nursery stock seedlings through addition of organic amendments** *Chibuike Chigbo, Stefan Schreiber, Amanda Schoonmaker and Paulo Mussone*	**Evaluating Range Soil Health at the Stavely Long-Term Rough Fescue Grazing Site** *Bin Zhang, Tim Schwinghamer, Ryan Beck, Walter Willms and Xiying Hao*
1:45 – 2:05	**Growing Woody Plants in Oil Sands Tailings** *Ryan Lalonde, Brad Pinno, Derek MacKenzie and Nicholas Utting*	**Climate Change: Current and Future Impacts on Erosive Rainfall in Calgary, Alberta** *Ben Ethier*
2:05 – 2:25	**Responses of enhanced seedlings to saline conditions** *Chibuzo Ilogu and Jean-Marie Sobze*	**Learnings from Historic Field Screening of Soil Electrical Conductivity in the Environmental Sector** *Mark Beasse*
2:25 – 2:45	***Coffee and Refreshments (Nakiska Ballroom)***	
	Forested, Wetland & Riparian Soils Nakiska Ballroom	**Soil Fertility** Canmore Room
2:45 – 2:50	**Chair: Chibuike Chigbo and Mark Baah-Acheamfour** Northern Alberta Institute of Technology	**Chair: Len Kryzanowski** Alberta Agriculture and Forestry

2:50 – 3:10	**Soil Profile Layering and the Potential for Enhanced Forestland-Wetland Water Exchanges in the Stony Mountain Headwater Catchment Observatory, Northern Alberta** *Scott Ketcheson*	**Modelling N_2O Emissions from green organic fertilizers applied to agricultural soils** *Jiacheng Shen, Roland Treu and Junye Wang*
3:10 – 3:30	**Disturbance of Boreal Peatland Soil Could Modify Carbon and Nutrient Cycling with Implications for Ecosystem Structure and Functions** *Felix Nwaishi, Christine van Beest, Richard Petrone and Merrin Macrae*	**Modeling the Effects of Farmyard Manure and Cattle Slurry in Grasslands on Nitrous Oxide Fluxes using DNDC: A Case Study of two UK sites** *Syed Hamid Hussain Shah and Junye Wang*
3:30 – 3:50	**Distribution Mapping of Soil Profile Carbon and Nitrogen with Laboratory Imaging Spectroscopy** *Preston Sorenson, Sylvie Quideau, Miles Dyck and Benoit Rivard*	**Predicting nitrous oxide emissions following the application of solid manure to grassland in the United Kingdom** *Nigus Demelash Melaku, Junye Wang, Narayan Kumar Shrestha and Rachel E. Thorman*
3:50 – 4:10	**Sudbury Landscape Status Forty Five Years after the Superstack** *Graeme A. Spiers and Peter J. Beckett*	**Biochar and manure effects on greenhouse gas emissions and extractable soil nutrients in Dark Brown Chernozems** *Carlos M. Romero, Chunli Li, Erasmus Okine, Gabriel Ribeiro, Jen Owens, Tim A. McAllister and Xiying Hao*
4:10 – 4:30		**Effect of biochar on greenhouse gas emissions and soil nutrient mineralization in lab-scale incubations** *Chunli Li, Carlos M. Romero, Erasmus Okine, Jen Owens, Tim A. McAllister and Xiying Hao*
4:30- 4:50		**Soil acidification of cultivated fields in Montana: Remediation, adaption, and challenges** *Richard Engel, Clain Jones, Pat Carr and Simon Fordyce*
4:50 – 5:45	***Poster Session (Nakiska Ballroom)***	

5:45 – 9:00	***Cash Bar, Banquet and Entertainment (Bonavista Ballroom)***

Wednesday, February 20 – Afternoon
Poster Session 4:50 – 5:45 PM

1.	**Construction of soil monoliths at the University of Alberta – A lost art** *Sabrina Westra, Sunit Bhanot and Miles Dyck*
2.	**Alkyl polyglycoside and earthworm (*Eisenia fetida*) enhance biodegradation of green waste and its use for growing vegetables** *Xiaoqiang Gong, Suyan Li, Linlin Cai and Xiangyang Sun, Scott X. Chang and Qian Wu*
3.	**Soil-plant relationships of revegetated reclamation sites** *Jessica J. Hudson, M. Derek MacKenzie, Brad D. Pinno and Amanda L. Schoonmaker*
4.	**Celebrating 100 Years of Soil Science at the University of Alberta and 90 Years of the University of Alberta Breton Plots** *The Soils Group*
5.	**Soil Carbon Dioxide and Methane Fluxes as a function of Temperature and Moisture in Fallow, Grass Mix, Spring Rye, Biennial Rye and Perennial Rye** *Keunbae Kim, Guillermo Hernandez Ramirez, Erin Daly, Dick Puurveen, Germar Lohstraeter and Leigh-Anne Powers*
6.	**Assessing the impact of a pre-emergent herbicide on growth and development of woody and herbaceous planting stock in a recently reclaimed mining site** *Mark Baah-Acheamfour, Amanda Schoonmaker, Stefan Schreiber and Eckehart Marenholtz*

Thursday, February 21, 2019 – Morning

Concurrent Technical Sessions

AM	**Land Reclamation** Nakiska Ballroom	**Land Use and Rangelands** Canmore Room
8:30 - 8:35	**Chair: Deo A. Heeraman** Wood Environment and Infrastructure Solutions	**Chair: Karen Raven** Alberta Agriculture and Forestry
8:35 – 8:55	**Phytoremediation Technologies for Restoring Salt and Hydrocarbon Contaminated Soil** *Elizabeth W. Murray, Bruce Greenberg, Ben Poltorak, Jess Spies, Adam Dunn, Kent Cryer and Perry Gerwing*	**Soil Extracellular Enzyme Activity in Rotational Grazing is similar to Conventional Grazing Systems in Alberta** *Dauren Kaliaskar, Bharat Shrestha, Cole Gross, Tien Weber, Scott Chang, Cameron N. Carlyle Edward W. Bork and Mark Boyce*
8:55 – 9:15	**Modelling organic pollutant degradation of reclamation sites in Alberta using a modified DeNitrification and DeComposition model** *Nana Y. Amponsah and Junye Wang*	**Aerial Measurement of Surface Albedo of Rangelands under Different Grazing Management Systems in Alberta** *Bharat M. Shrestha, Scott X. Chang, Edward W. Bork, Cameron N. Carlyle, Mark S. Boyce, John S. Church, Devon E. Worth and Raymond L. Desjardins*
9:15 – 9:35	**Effects of Feedstock Type, Pyrolysis Temperature, and Steam Activation on Biochar Properties and Lead (II) Adsorption** *Jin-Hyeob Kwak, Siyuan Wang, Scott X. Chang, M Anne Naeth, Mohamed Gamal El-Din and Md Shahinoor Islam*	**Soil compaction from farm machinery and its influences on plant physiology** *Kris Guenette and Guillermo Hernandez-Ramirez*
9:35 – 9:55	**Biomimicry of vascular plants as a means of saline soil remediation** *Mathew J.B. Swallow, Gwen O'Sullivan*	**Water Repellency and Hydrophobicity of Some Major Agricultural Crop Residues** *Jim Miller, Mallory Owen, Walter Willms, Xueming Yang, Craig Drury and David Chanasyk*

9:55 – 10:20	***Coffee and Refreshments (Nakiska Ballroom)***	
	Land Reclamation Nakiska Ballroom	**Land Use and Rangelands** Canmore Room
10:20-10:25	**Chair: Deo A. Heeraman** Wood Environment and Infrastructure Solutions	**Chair: Karen Raven** Alberta Agriculture and Forestry
10:25 – 10:45	**Growth Response of Aspen and Alder to Fresh and Stockpiled Reclamation Soils** *Kwadwo Omari and Sanatan Das Gupta and Bradley D. Pinno*	**Canadian Agriculture Partnership (CAP) Prioritization Process** *Karen Raven, David Spiess, Javed Iqbal, Symon Mezbahuddin and David Hildebrand*
10:45 – 11:05	**Bitumen Deposit Laden Soils Affecting Site and Reclamation Potential for Gravel Pit Construction** *Paul Martin and Ashley Easton*	**State of the Prairie – Change over time** *Javed Iqbal, David Spiess, Karen Raven, Livio Fent and Patrick Wensveen*
11:05 – 11:25	**Application of coarse woody debris in land reclamation: Effects on nutrient availability and microbial substrate utilization** *Sanatan Das Gupta and Bradley D. Pinno*	**Overview of the Conservation and Reclamation Directive for Renewable Energy Operations** *Shane Patterson*
11:30 – 12:00	***ASSW Business Meeting and Closing Remarks***	
12:00 – 13:00	***Lunch – Nakiska Ballroom***	

Plenary Session Abstracts

Wednesday, February 20, 2019

Maintaining Soil Resilience as a Climate Adaptation Strategy

Dave Sauchyn
Prairie Adaptation Research Collaborative, University of Regina
sauchyn@uregina.ca

Abstract
The Canadian Prairies are becoming much less cold. This mostly benefits agriculture. Other consequences of climate change are less favourable. The advantages of a warmer wetter winter will be offset by generally drier conditions in summer. This consistent climate change scenario suggests the need to store extra winter precipitation, which will increasingly fall as rain. Soil and water management to increase soil water storage will be an effective strategy to minimize the adverse impacts of changing climate, including the amplification of weather extremes. Climate change is by definition unexpected weather. Scientific evidence points to unprecedented water surpluses and deficits in a warmer climate. Enhancing and maintaining soil structure, resilience and infiltration capacity will be an important adaptation to more variable hydroclimate.

Biography

Dr. Dave Sauchyn is Director of the Prairie Adaptation Research Collaborative at the University of Regina and Professor of Geography and Environmental Studies. His main research interests are 1) the climate and hydrology of the past millennium and how this knowledge of the past can inform our understanding of future climate and water supplies, and 2) planned adaption to minimize the adverse impacts of climate change on the natural capital of western Canada. During 2011-16, Dave co-directed an interdisciplinary study of the vulnerability of agricultural communities to climate extremes in Chile, Argentina, Colombia and Brazil and the Canadian Prairies. Dave is lead author of the Prairie Provinces chapter of the national assessment of climate change due for release in 2020.

Soil Resilience in the Face of Wind Erosion

Dr. Frank Larney
Agriculture and Agri-Food Canada, Lethbridge, AB
francis.larney@canada.ca

Abstract

The widespread adoption of conservation tillage on the Canadian prairies has pushed wind erosion into the background. However, it can still be an issue on irrigated land where more intensive tillage is used. Also in recent years, wildfires in southern Alberta have led to severe topsoil losses when surface cover is burned off leaving the soil vulnerable to wind erosion. This presentation will address historical wind erosion in Alberta, the conservation tillage revolution of the 1990s, as well as ways of managing soils to increase their resilience in the face of wind erosion. Using examples from simulated erosion experiments at Lethbridge Research & Development Centre, the topics of soil productivity losses due to erosion, and organic amendments as a means of maintaining soil resilience, will also be addressed.

Biography

Dr. Frank Larney is a Research Scientist in Soil Conservation with Agriculture & Agri-Food Canada in Lethbridge, Alberta. He grew up on a farm in Ireland and holds a B.Agr.Sc. (1979) in Agriculture, M.Agr.Sc. (1981) and Ph.D. (1985) degrees in Soil Science from The National University of Ireland (University College Dublin). His research areas include soil physical properties, soil erosion and productivity, soil reclamation, beef feedlot manure composting, soil health, organic amendments, and dryland and irrigated cropping systems. His research is recognized internationally as reflected by 170+ peer-reviewed scientific journal papers, 16 book chapters, 370 conference abstracts/proceedings papers/posters, and 200 technology transfer articles. Dr. Larney was honoured with Fellow Awards from the Canadian Society of Soil Science in 2010 and the Soil Science Society of America in 2012 and he served as President of the Canadian Society of Soil Science in 2013.

Response of tailings sediment microorganisms to petroleum hydrocarbons and their role in tailings management

Dr. Tariq Siddique
University of Alberta, Edmonton, AB
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Abstract
Petroleum exploration and production cause environmental contamination of petroleum hydrocarbons through industrial activities, accidental spills and leaks and improper disposal of wastes. Huge volumes of oil sands tailings containing residual hydrocarbons are produced during bitumen extraction from surface mined oil sands ore, which are deposited in tailings ponds pending reclamation. Like soil environment, tailings ponds harbor diverse microorganisms that show **resilience** and biodegrade residual hydrocarbons under methanogenic conditions, the conditions that also prevail in wetlands/submerged soils. Petroleum hydrocarbons alter tailings sediment microbial community structure by enriching the taxa capable of degrading hydrocarbons. Different tailings sediment microorganisms exhibit their preference to biodegrade those hydrocarbons that are typically present in their environments (tailing ponds). They also sequentially biodegrade hydrocarbons from more labile such *n*-alkanes, mono-aromatics, and *iso*-alkanes to the most recalcitrant such as cycloalkanes under methanogenic conditions. Microbial metabolism of hydrocarbons sustains methanogenesis (methane production) in tailing ponds causing greenhouse gas emissions and drives many other biogeochemical processes in oil sands tailings. Active methanogenesis alters porewater chemistry, transforms crystalline Fe^{III} minerals to amorphous Fe^{II} minerals in tailings, accelerates dewatering and consolidation of fine tailings, releases entrapped bitumen to the surface of water and mobilizes and immobilizes trace metals and other constituents of concerns in tailings. These biogeochemical changes are important in evaluating the sustainability of end-pit lakes where oil sands tailings are covered by cap water (a mixture of oil sands process affected water and fresh water) in post-mining pits in the Athabasca Oil Sands Region. Indigenous microorganisms present in forth treatment-thickened tailings can promote acid rock drainage if these tailings are managed upland under dry reclamation scenario. Overall, our short (~1 year) and long-term (1-7 years) studies reveal profound effects of indigenous microorganisms on tailings biogeochemistry and management, and the results are applicable to other similar upland and wetland environments.

Biography
Dr. Tariq Siddique is an Associate Professor in Soil Chemistry and Environmental Microbiology in the Department of Renewable Resources at the University of Alberta (U of A). He completed his Ph.D. and worked as a Postdoctoral Fellow at the University of California, Riverside, USA. He also worked as a Postdoctoral Fellow at the University of Northern British Columbia and later he took up his NSERC Postdoctoral Fellowship at the University of Alberta before joining the Department of Renewable Resources at U of A. He has been working in the area of environmental biogeochemistry for the last 18 years. Currently, his research focuses mainly on environmental issues/challenges

related to oil sands tailings. His group is engaged in research on investigating biodegradation of hydrocarbons under different redox conditions, microbial metabolic pathways, biogenic greenhouse gas emissions from tailings ponds and indigenous microbial processes affecting the quality of end-pit lake.

Watershed resistance and resilience to extreme events: Insights from wildfire in Alberta

Dr. Uldis Silins
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usilins@ualberta.ca

Abstract

Shifting climates have substantially increased the severity and scope of wildfires in fire prone regions of western U.S. and Canada raising concerns over potential impacts to water resources in key source water regions such as the Rocky Mountains. However, while severe wildfires may represent an upper end-member of watershed disturbances that can impact water, broad generations based on watershed impacts observed in other regions are difficult because these can vary strongly across hydro-geo-climatic regions. Long-term and on-going research on impacts of several particularly severe Alberta wildfires (2003 Lost Ck., 2006 Horse River [Ft. McMurray], and the 2017 Kenow Mtn. wildfire) on hydrology, water quality, and stream health have shown both some similarity, but also substantial departure from wildfire impacts noted in other regions. These have important implications for provincial watershed protection strategies in the face of shifting climates.

Biography

Dr. Uldis Silins is a professor of forest hydrology in the Department of Renewable Resources at the University of Alberta. His research focuses on impacts of climate change associated with natural disturbances, including wildfire and Mountain Pine Beetle, and on forest management impacts on water resources (including snowpacks, flow dynamics, water quality, and aquatic ecology). For the past 15 yrs., he has been leading a large pan-Canadian water research team working on both wildfire and forest management impacts to water with the Southern Rockies Watershed Project.

Land Reclamation Technical Session Abstracts

Wednesday, February 20, 2019 – Afternoon

Initial Soil Development on Reclaimed Land

Konstantin Dlusskiy

Paragon Soil and Environmental Consulting Inc., Edmonton, AB

Corresponding author: kdlusskiy@paragonsoil.com

Abstract

Shortly after initial placement of reclaimed materials on disturbed land, natural soil forming processes start to take place. The intensity of each individual soil forming process is dependent on multiple soil forming factors, including climate (temperature and precipitation), parent material (chemistry and texture of placed materials), topography, and biota (vegetation, microbial community, *etc*.).

It generally takes hundreds of years to reach an equilibrium between soil properties and soil forming factors. Many natural soils across Alberta are not yet at the equilibrium stage (e.g. Regosols, Brunisols, Solonetz, and Anthroposols). To determine success of reclamation it is important to monitor the manifestation of soil properties in order to recognize the moment when reclaimed soils meet requirements of natural Soil Orders of the *Canadian System of Soil Classification*.

In this study, we show three cases of reclaimed soils: 15-year-old reclaimed soils on tailings, 8-year-old reclaimed soils on stripped/placed glacial till material, and 6-year-old reclaimed soils on sandy waste rock pile.

Discoloration of upper topsoil (Aej) and formation of weak granular structure (Ahj) are among the parameters first making appearance. Sub-angular structure and increased redness of upper subsoil (Bm) are parameters showing up at later stage of soil development. Some 15 year-old reclaimed profiles could be already classified as Orthic and Gleyed Sombric Brunisols within some reclamation areas.

Morphological features manifest in reclaimed soils before chemical characteristics. Morphological parameters develop at measurable speed and demonstrate progress of reclamation. Soil classification could be used as an evidence of achieving equal land capability after reclamation.

Creating a lunchbox for nursery stock seedlings through addition of organic amendments

Chibuike Chigbo, Stefan Schreiber, Amanda Schoonmaker and Paolo Mussone

Northern Alberta Institute of Technology.

Corresponding author: chibuikec@nait.ca

Abstract

Resource exploration and extraction is often associated with the disturbance of forested lands. One of the key factors to achieve successful reforestation is the nutritional quality of the topsoil. Poor soils may be treated with inorganic fertilizers, but this practice can encourage the growth of highly competitive non-native species and significantly slow down natural succession of native species. The objective of this study is to develop a nutritional "lunchbox" for tree seedlings based on alfalfa pellets and hydrochar to facilitate improved first year establishment on reclaimed industrial sites.

This project was split into two phases (1) seedling production of *Populus tremuloides* and *Betula papyrifera* with incorporation of four rates of alfalfa pellets and three rates of hydrochar into growth substrate during nursery stock production and (2) out-planting of loaded seedlings into containers with reclamation soil outdoors. Results indicate that Alfalfa pellet significantly increased the leaf and stem biomass of *Populus tremuloides* and *Betula papyrifera* showing that loaded seedlings had superior growth than standard seedlings during stock production. Hydrochar amended seedlings showed no difference in growth during phase 1, but early signs of improved leaf colour in phase 2. In general, loading seedlings with alfalfa pellets or hydrochar could improve field performance in reclamation soils.

Growing Woody Plants in Oil Sands Tailings

Ryan Lalonde, Brad Pinno, Derek MacKenzie

Department of Renewable Resources, University of Alberta, Edmonton, AB

Nicholas Utting

CanmetENERGY, Natural Resources Canada, Devon, AB

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Abstract

The boreal forest of northern Alberta, Canada is home to one the largest oil sands deposits on earth. Removing the bitumen from the sand produces a form of waste known as fluid fine tailings, composed primarily of small mineral particles and water. The tailings contain inorganic salts as well as organic compounds such as naphthenic acids. Dry tailings could potentially be used as a subsoil material in relcamation, however we currently do not have a good understanding of what would happen to tree growth. A greenhouse study was conducted to evaluate how woody plants grow in this tailings material. Beaked willow (*Salix bebbiana*) was planted in tall pots containing tailings on the bottom and topped with different reclamation soils at varying capping depths (0, 5, 10 and 20 cm). The different soil types were forest floor mineral mix (FFMM), a typically upland forest soil that is rich in minerals; peat mineral mix (PMM), an organic based wetland or lowland soil; and a 50/50 mixture, containing 0.5 FFMM and 0.5 PMM. The goal of this study is to determine the impact of different capping depths and soil types on woody plant growth. The results demonstrate that all soil capping depths produced a large increase in aboveground biomass (307.5% for 5 cm, 397.1% for 10cm and 317.6% for 20cm) comparted to the control. The capping soil containing the 50/50 mixture produced the greatest biomass (9.56 g), followed by the forest floor (7.00 g) and peat (5.62 g).

Responses of enhanced seedlings to saline conditions

Chibuzo Ilogu and Jean-Marie Sobze

Northern Alberta Institute of Technology, Edmonton AB

Corresponding author: chibuzoi@nait.ca

Abstract

Soil salinity restricts seed germination and early establishment from natural regeneration, and is a major obstacle for the growth of many native plants. Studies that examine plant response to saline conditions are important for successful planning and re-vegetation of salt-affected sites. The aim of this study was to determine the response of enhanced seedlings to soil salinity including their survival rates, the biomass allocation and yield of each species.
In this study, we examined the effects of soil salinity on *Picea glauca* (white spruce), *Populus tremuloides* (aspen) and *Salix serissima* (autumn willow) seedlings enhanced or pre-treated with saline water. During their production in the greenhouse, the seedlings were periodically watered with saline water at concentrations of 2, 3, and 4 dS/m. After a dormancy period, they were transplanted in saline soils with electro conductivities of 6, 8 and 10 dS/m. This presentation will share the results from each species and soil treatment.

Soil Resilience and Extreme Events Technical Session Abstracts

Wednesday, February 20, 2019 – Afternoon

Crop Productivity Following Diverse Long-Term Cropping Systems at Bow Island, Alberta

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Abstract

Crop management has changed dramatically over the past few decades in the Brown soil zone: much less tillage and summer fallow and much more crop diversity. What is the impact of these changes on future crop productivity?

In a long-term plot study at Bow Island, Alberta, we determined crop productivity for three years after completing 24 years of diverse management: wheat-fallow, continuous wheat, wheat-pulse, winter wheat-mustard-fallow, wheat-pulse-fallow and continuous grass management, each with two to six fertilizer treatments. Crop yields were determined with and without application of 80 kg fertilizer N ha^{-1} yr^{-1}.

In the first year, wheat grain yield ranged from 0.8 to 4.5 Mg ha^{-1}, depending primarily on differences in soil N supply as influenced by previous fallow and crop type (pulse crops increased N supply, grass decreased N supply). In the second year, mustard yields were low due to herbicide interactions that required re-seeding. Mustard yields ranged from 0.2 to 0.7 Mg ha^{-1}, depending on N fertilizer rate, compost history and subsoil salinity. In the third year under drought conditions, barley grain yield ranged from 2.7 to 5.6 Mg ha^{-1}, with low yields in previous grass plots with elevated subsoil salinity. Previous rotations reduced N fertilizer requirements when pulse crops were included or fallow was reduced. Overall, impacts of previous crop management on subsequent crop productivity were modest by year 3.

Evaluating Range Soil Health at the Stavely Long-Term Rough Fescue Grazing Site

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Abstract

Previous research prioritized the evaluation of soil health , however, soil health indicators for rangeland soil are not yet well established. Utilizing the long-term grazing site established in 1949 at the foothill rough fescue grassland at Stavely, Alberta, the effects of cattle stocking rate (0, 1.2, 2.4 and 4.8 AUM ha^{-1}, that represented, exclosure, light, heavy, and very heavy grazing) and 20 year exclosion from heavy grazing (inside vs. outside 1998 exclosures) on range soil health were investigated. Soil samples were collected in spring and fall 2016 and again in spring 2017. The samples were analyzed following the Cornell University Comprehensive Soil Health Assessment methods. Vegetation was quantified using species richness, Shannon diversity index, and biomass yield (standing green and litter) for both years. All data were subject to bivariate correlation analysis and multivariate redundancy analyses (RDAs) using “R” statistical software. The RDA results indicated cattle stocking rate, slope position, and 1998 exclosures (2017 data only) explained 42% (2016 fall), 49% (2016 spring), and 61% (2017 spring) of the total variance in the matrix of soil and vegetation response variables. The RDA triplot results for all three sampling dates indicated that soil active carbon, bean shoot biomass (soil root health bioassay), and biomass yield were negatively correlated with cattle stocking rate, while species richness and the Shannon diversity index were independent of cattle stocking rate. Our next steps will be: path analyses to explore the structures of causal relationships, and the development of range soil health indicators. that will be used to develop sustainable grazing management strategies.

Climate Change: Current and Future Impacts on Erosive Rainfall in Calgary, Alberta

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Abstract

For the past 15 years, erosive rainfall (R-Value) was assumed to be a constant and has been used, unchanged, by the City of Calgary and consultants as an integral part of construction site soil erosion modeling and approvals. This modeling and approval process prevents harmful sediment and stormwater contaminants from entering or damaging the municipally owned storm infrastructure and subsequently the Bow River.

But What if erosive rainfall is not constant? Has Climate Change impacted erosive rainfall in Calgary? And if so, has a change in erosive rainfall impacted sediment loss rates from construction sites over the past 15 years? Research conducted as part of a Master's of Science thesis explores how local R-values have changed in the last 20 years, how they may change in the future due to climate change, and what impacts these changes may have on the City of Calgary, the Bow River, and those who live and work here.

R-values for the City of Calgary Huntington Hills rainfall station have increased from 300 to 642. This equates to an estimated increase of 1800-35000tns of soil loss from construction sites depending on what erosion control and prevention measures have been installed.

Over the next 100 years R-values are expected to increase by and average of between 27%-31% depending on the carbon scenario used.

Learnings from Historic Field Screening of Soil Electrical Conductivity in the Environmental Sector

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Historically, a two-sample method that uses lab samples to calibrate field screening has been the industry expectation of soil remediation. Senior industry specialists have come out in support of accurate and precise field screening as necessary for consistently successful contaminant remediation. Soil electrical conductivity (EC) data mined from reports available in the Environmental Site Assessment Repository (1998-2012) suggests field screening has had limited success. Regression analysis of lab results to field screening of EC from 30 sites show an average R^2 of 0.455 ($\overline{x}_{NRMSD}$=22.2%). It is likely these limitations have contributed to the high proportion of failed regulator audits and inflated the cost of liability management. Further review of the data mining shows a small cluster of investigations with both a high R^2 (≥0.9) and a low NRMSD (≤15%). Supporting documents for these investigations show a common method of field EC measurement using a distilled water extraction. This suggests careful field screening using an extraction technique could be used in conjunction with a small number of lab samples to successfully employ a two-sample method. This would result in increased data density that would be beneficial in managing sites and facilitate the development of improved tools to lead field investigations & automate regulatory reporting.

Forestry, Wetland and Riparian Soils Technical Session Abstracts

Wednesday, February 20, 2019 – Afternoon

Soil Profile Layering and the Potential for Enhanced Forestland-Wetland Water Exchanges in the Stony Mountain Headwater Catchment Observatory, Northern Alberta

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Abstract

In Alberta's Boreal Plain, catchment runoff is typically low but spatially variable. Localized landscape soil and vegetation cover types, along with the hydrophysical properties of underlying glacial deposits and regional slopes, are important controls for the partitioning of precipitation into runoff, evapotranspiration, and soil water storage. Hence, different soil hydraulic properties and layering control water storage and runoff potential and affect the volume and timing of runoff generated from forested landforms. Results from this research indicate that soil layering of sharply contrasting hydraulic properties between forest floor organic mossy soil and the underlying mineral soil layers can produce lateral runoff generation at the moss–mineral interface during and immediately following some rainfall events. Here, subsurface layers of non-uniform hydraulic conductivity directed vertical seepage into lateral flow on the hillslopes, which resulted in enhanced hydrologic connections between the forest and adjacent wetland. This phenomenon was observed and quantified at one catchment; however, new field deployments at numerous forestland-wetland interfaces across four additional catchments on Stony Mountain are shedding light on the ubiquity of this process.

Disturbance of Boreal Peatland Soil Could Modify Carbon and Nutrient Cycling with Implications for Ecosystem Structure and Functions

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Abstract
Boreal peatlands are dominant landscape units in the Athabasca oil sands region. These peatlands support vital ecosystem functions such as Carbon (C) and nutrients (e.g. Nitrogen –N and Phosphorus –P) cycling. The anoxic conditions that persist in peatland environment supports the net storage of C and nutrients in peat soil. Natural and anthropogenic disturbances from wildfire and energy exploration respectively, are now common and widespread in this region. These disturbances release C and nutrients that are stored in peat into this nutrient-regulated environment, with potential implication on the nutrient balance of the soil-water-plant system, which could modify the entire ecosystem structure and function. We conducted two independent studies to assess the impact of the Fort McMurray wildfire and industrial disturbance (development of semi-permanent road through peatland) on peatland nutrient balance and availability in the soil-water-plant systems. Our results suggest that relative to pre-disturbance and undisturbed sites, natural and anthropogenic disturbances release bioavailable nutrients, especially P to the environment, which potentially modified the nutrient balance in groundwater and nutrient stoichiometry of plant tissue. Data highlighting the patterns and direction of these modifications will discussed in this presentation.

Distribution Mapping of Soil Profile Carbon and Nitrogen With Laboratory Imaging Spectroscopy

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Abstract

Conversion of arable cropland to forage crops has been proposed as a potential method to increase soil organic carbon (SOC) stocks to sequester carbon and improve soil quality. In this study, intact soil cores were collected from long-term boreal forest soil research plots established in 1980 consisting of: a mixed arable crop and forage agroecological rotation (AE), continuous forage (CF), and continuous grain (CG) rotations. These cores were analyzed using a SisuROCK automated hyperspectral imaging system in a laboratory setting collecting shortwave infrared reflectance data. Samples were then analyzed for SOC and total nitrogen (TN) concentrations by dry combustion to prepare a training data set. Predictive models were successfully built for SOC and TN using a combination of wavelet analysis and Bayesian Regularized Neural Nets. The CF rotation was found to have the highest SOC and TN contents compared to AE rotation for only the top 3 and 4 cm, respectively. These two rotations had comparable concentrations for both parameters for the rest of the topsoil, which was greater than the concentration of SOC and TN in the CG rotation to depths of approximately 12 cm. Increases in both SOC and TN were associated with increased spatial aggregation at fine spatial scales. These results indicate that adding forages to rotations in boreal forest soils increases SOC and TN, however these changes were concentrated in the surface depths.

Sudbury Landscape Status Forty Five Years after the Superstack

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Sudbury, the home of one of the largest nickel mining and smelter complexes in the world, was one of the more industrially devastated regions on earth by the mid-20th century. The impacts of smelter sulphur gases from roast yards through to the more modern smelter operations emitting sulphur gases and metal particulates created a barren, inhospitable landscape of ~17000 ha. The requirement to reduce the emissions profile from the largest smelter complex led to the construction of the 381 m Superstack which, coupled with gas capture technology for acid production and electrostatic precipitators to retain charged particulates, led to reduced emissions and set the stage for an assisted landscape recovery program. Over the past forty plus years the Sudbury Regreening Story, based on effective interaction between community, government and industry, describes the core regional transformation program now recognized globally as a model to emulate.

Despite over a 95% reduction in air emissions since the opening of the Superstack, the accumulation of bioavailable and potentially toxic metal levels in the acid surface soils, accompanied by soil erosion and associated soil nutrient depletion, do continue to impede natural vegetation recovery. The internationally recognized Sudbury Protocol for technogenic barren landscape restoration has evolved from regreening activities that involved application of dolomitic limestone, fertilizer, seeding of agricultural grasses, legumes and planting of tree seedling to a more complete biodiverse restoration strategy. By 2018, 3478 ha had received soil amelioration and *ca* 10 million trees and shrubs had been planted for approximately $32.7 million while employing over 4775 individuals. The outcome of the Regreening Program is a new image for the city and environs which has helped to attract new business enterprises, tourists and encouraged an increased respect for the environment.

Soil Fertility Technical Session Abstracts

Wednesday, February 20, 2019 – Afternoon

Modelling N_2O Emissions from green organic fertilizers applied to agricultural soils

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Abstract

Livestock manures are commonly applied to agricultural soils to supplement or replace manufactured fertilizers because of the benefits they provide in terms of plant nutrients, soil quality and organic foods. However, due to pathogens and odors generated from the raw manure, composts and digestates are being applied increasingly to agricultural soils instead. This causes concerns about N_2O increase due to high nitrogen contents of digestate and compost. In this study, we developed a submodel of organic fertilizers within the UK_DNDC model, in which the specific properties of pH and ratio of carbon to nitrogen of digestate and compost were added to the UK_DNDC model. Using the modified model, N_2O emissions were simulated from two organic fertilizers (digestate and composts) applied to three farms in the United Kingdom: one growing winter wheat at Wensum (WE) and two grasslands at Pwllpeiran (PW) and North Wyke (NW). The simulated results showed the relative errors (R^2) of the modeled annual cumulative emissions to the measured emissions ranged from -5.4% to 48% for the digestate and from 18% to -98% for the green compost, respectively. The average coefficients of determination at three sites was 0.548 for digestate and 0.354 for green compost, respectively. The corresponding modeled emission factors (EFs) for the digestates and compost were also estimated. This demonstrates that the modified UK_DNDC is a good tool to simulate N_2O emission from digestate and compost fertilizers and to calculate the EFs in the way of a TIER 3.

Modeling the Effects of Farmyard Manure and Cattle Slurry in Grasslands on Nitrous Oxide Fluxes using DNDC: A Case Study of two UK sites

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Abstract

Fertilizer nitrogen has been identified as a significant source of N_2O emissions in agriculture and enhancing soil fertility and crop yields as well. The optimum use of these fertilizers requires the use of process based models such as DNDC for controlling potential contribution to global warming. The objective of this research is to simulate N_2O fluxes from two UK soils treated with Farmyard Manure and Cattle Slurry fertilizers using the DNDC model and evaluate a number of strategies to reduce N_2O emissions such as application of more frequent smaller doses and different methods of application of organic and inorganic N fertilizers.

Two fertilizers including organic and synthetic, i.e. farmyard manure and cattle slurry are applied during the autumn and spring season to two sites located in Pwllpeiran (PW), and North Wyke (NW) in UK. In this study, the DNDC model is simulated for nitrous oxide (N_2O) fluxes emitted from the soils treated with cattle slurry and farmyard manure at two UK farms (PW and NW) for grassland. The results show that annual overall N_2O emissions are 0.9 kg N ha^{-1} y^{-1} for autumn PW treated with cattle slurry, 0.73 kg N ha^{-1} y^{-1} for PW with farm yard manure, 3.46 kg N ha^{-1} y^{-1} for spring PW treated with cattle slurry, 1.08 kg N ha^{-1} y^{-1} for PW with farm yard manure, 0.95 kg N ha^{-1} y^{-1} for spring NW treated with cattle slurry, and 0.52 kg N ha^{-1} y^{-1} for NW with farm yard manure. The observed and predicted steady state long term average N_2o emission are in strong agreement for the calibration and validation period. Analysis of correlation coefficients between N_2O emissions and air temperature, precipitation as well as the time period between fertilizer application and sample analysis (TPFA) for the two sites indicates that N_2O emission is mainly related to TPFA. Also the mission factor (EF) is a strong function of spatio-temporal variation (0-4 %) compared to assumption of IPCC for uniform 1% EF. The nitrous oxide emission is linearly related with N loading under all treatment, seasonality and locations with R^2 ranges between 0.95 and 1. The bottom line is that use of frequent low dose fertilizer compared to one time fertilizer application reduces significantly N_2O peaks fluxes and overall emission (10% for cattle slurry autumn PW, 33% for cattle slurry spring PW, 2% for cattle slurry spring NW). The optimum use of liquid fertilizer using the modeling approach is the future of environmental friendly precision agriculture.

Predicting nitrous oxide emissions following the application of solid manure to grassland in the United Kingdom

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Abstract

Nitrous oxide (N_2O) emission from agriculture contributes to the greenhouse gas (GHG) emission to the atmosphere and is involved in climate change. Model predictions are useful to understand and estimate N_2O emissions associated with manure application. In this study, we evaluated the suitability of SWAT model to estimate the N_2O flux from application of solid manure at two sites (North Wyke and Pwllpeiran) in United Kingdom. The simulated N_2O emission was validated against field observations measured in 2011-2012. The data collected in 2011 was used for calibration, while the 2012 data was used for model validation. The model results showed that the measures for goodness of fit; the Nash-Sutcliffe Efficiency (NSE) and R^2 values were 0.67 and 0.72, respectively for Water Filled Pore Space (WFPS) in the calibration period for North Wyke. The same at North Wyke were found to be 0.68 and 0.69, respectively for the validation period. Similarly, for Pwllpeiran, the model predicted an NSE of 0.55 and an R^2 of 0.69 during calibration and an NSE of 0.63 and an R^2 of 0.71 during the validation period. However, the model resulted in a slightly lower fit for N_2O emissions (NSE = 0.37, R^2 = 0.61 during calibration, and NSE = 0.53, R^2 = 0.57 during validation) for NW, and (NSE = 0.49, R^2 = 0.67 for calibration, and NSE = 0.35, R^2 = 0.68 for validation) for Pwllpeiran. The results revealed that the SWAT model performed reasonably well in representing the dynamics of soil moisture and N_2O emissions following solid manure application to grassland.

Biochar and manure effects on greenhouse gas emissions and extractable soil nutrients in Dark Brown Chernozems

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Abstract

Biochar, a pyrolyzed-thermally degraded form of black carbon (C) may be employed in conjunction with manure to enhance the sustainability of semi-arid drylands. We investigated the effect of biochar and manure on cumulative N_2O, CO_2, and CH_4 fluxes and extractable soil nutrient availability (i.e. PO_4-P, NH_4- N, and water-extractable C) in two surface Dark Brown Chernozems (0-15 cm) of contrasting soil texture [i.e. sandy (SD) and clay loam (CL)]. A laboratory experiment was designed to compare five treatments: (i) non-amended soil (CK); (ii) soil amended with pine wood biochar at 3 Mg ha^{-1} (B); (iii) soil amended with beef cattle manure at 120 Mg ha^{-1} wet wt (RM); (iv) soil amended with biochar manure (i.e. manure from cattle on diet supplemented with 2% of biochar) at 120 Mg ha^{-1} wet wt (BM); and (v) soil amended with B and RM at the aforementioned rates (B_RM). A total of 40 soil columns were prepared and incubated at 21°C (60% WHC) for ten weeks. Cumulative N_2O emissions were unaffected by biochar or manure addition and ranged from 6.0 to 12.4 mg kg^{-1} across soil types. Contrarily, total CO_2 fluxes were increased, on average, 2.1 and 3.7 times (SD and CL, respectively) in manure treatments (i.e. RM, BM, and B_RM) relative to CK and B. Cumulative CH_4 emissions were also ($P<0.05$) affected by biochar and manure amendment. Total CH_4 fluxes were highest in SD B_RM (70.7 mg kg^{-1}) relative to CK and B (<2.6 mg kg^{-1}), and in CL manure treatments (i.e. RM and BM; 23.5-29.7 mg kg^{-1}) relative to CK and B (<1.6 mg kg^{-1}). Biochar-only treatment (B) had no effect on PO_4-P, NH_4-N, and water-extractable C (WEOC) availability. Contrarily, the addition of BM and/or BM and RM significantly increased the amount of PO_4- P released by SD and CL. The concentration of WEOC was augmented within SD and CL manure treatments (i.e. RM, BM, and B_RM; >221.7 mg kg^{-1}) relative to CK and B (<6.2 mg kg^{-1}). The benefits of manure amendment on NH_4-N availability were only observed within CL BM. We conclude that biochar and manure have contrasting short-term effects on greenhouse gas emissions and extractable soil nutrient availability. The extent of such response, however, may differ according to site-specific soil properties. Further research is required to unravel the chemical character of the applied C via biochar- manure interactions, as it may be a key driver regulating the biogeochemistry of calcareous soils in semi- arid southern Alberta.

Effect of biochar on greenhouse gas emissions and soil nutrient mineralization in lab-scale incubations

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Abstract

Biochar has recently emerged as a promising strategy to improve terrestrial C sequestration and mitigate greenhouse (GHG) emissions from agricultural land. The extent and impact of biochar on soil nutrient availability and GHG fluxes in semi-arid drylands are not well understood. A laboratory experiment was conducted using surface sandy (SD) and clay-loam (CL) Dark Brown Chernozems (0-15 cm) to evaluate the impact of pine wood biochar (0, 0.15, 0.5, 3, 10, and 20 Mg ha^{-1}) with (+NP) and without (-NP) NP fertilizer on cumulative N_2O, CO_2, and CH_4 emissions, and soil N (NH_4-N and NO_3-N) and P (PO_4-P) mineralization. A total of 72 soil columns were prepared and incubated at 21°C (60% WHC) for ten weeks. Cumulative N_2O emissions were unaffected by biochar addition or soil type and ranged from 2.7 to 16.9 mg kg^{-1} soil across NP fertilization regimes. Patterns of change in cumulative CO_2 and CH_4 fluxes were also not influenced by biochar. Contrarily, soil type had a major impact on total CO_2 and CH_4 production, with SD soil emitting 1.3-1.7 and 4.7-5.4 times the amount of CL soil (CO_2 and CH_4, respectively). Increased cumulative CO_2 and CH_4 emissions within SD soil were likely regulated by a greater labile, bioavailable water-extractable organic carbon pool compared to CL soil. Similar amounts of NO_3-N were mineralized among soil types. However, CL soil released more available P (12.0 – 14.5 mg kg^{-1}) than SD soil (3.6 – 6.4 mg kg^{-1}), regardless of biochar application rate. Decreases in N_2O, CO_2, and CH_4 fluxes in response to biochar amendment, recently reported by other authors for prairie soils, were not observed in our work. The results of this experiment imply that beneficial effects of biochar amendment might have been masked by site-specific edaphic properties, at least within the amount range and type of added biochar. Further studies are needed to clarify whether if biochar has seasonal effects on GHG fluxes and nutrient mineralization in Dark Brown Chernozems.

Soil acidification of cultivated fields in Montana: Remediation, adaption, and challenges

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Abstract

Farmers in several Montana counties are now experiencing crop growth reductions or complete crop failures as a result of soil acidification and Al toxicity. Historically, acidification was not a problem in Montana because the parent material of most cultivated soils exhibited a neutral to alkaline reaction. However, fertilizer ammonium-N use (including urea) by farmers has grown tremendously in recent decades and is now 3-fold greater than in 1985 leading to a downward trend in soil pH. The objective of this presentation will be to discuss results from recently initiated on-farm trials that include sugar beet lime applications, seed-placed P and cultivar selection; and to discuss some of the challenges to soil acidity remediation Montana. On-farm sugar beet lime strip-trials (6 to 11 ha) have demonstrated this product is effective at raising soil pH within seven months if incorporated with tillage after application. At one farm, lentil (*Lens culinaris*) were observed to exhibit greater early-season biomass and greener tissue in response to sugar beet lime applications that increase soil pH (0 -10 cm) from 4.7 (-lime areas) to 5.9 (+lime areas). Small-plot replicated fertilizer trials have shown that seed-placed P can significantly increase the yield of durum wheat (*Triticum durum*), but the response is affected by liming. Durum yield was found to improve from 1564 kg ha^{-1} without P to 3056 kg ha^{-1} with the addition of 30 kg P ha^{-1} in a high testing P (50 ppm Olsen), very acidic soil (pH 4.4). Conversely, when the pH of this same soil increased to 6.1 with Ag-lime (4.5 MT ha^{-1}) there was no yield benefit from P fertilization. Cultivar selection trials have found that yield benefits ($P < 0.05$) to lime application to acidic soils can be cultivar dependent in spring pea (*Pisum sativum* L.) and canola (*Brassica napus)*. Spring barley (*Hordeum vulgare*) has produced yield and test weight responses to lime in selected cultivars. Overall, yield responses by crop species in large and small-plots trials have been confounded by variances in soil properties at site locations, and interactions created by excessive vegetative biomass and drought during seed-fill. Challenges to soil acidity remediation include proximity to lime source materials and large spatial variances in soil pH that exist across field landscapes. Production issues created by soil acidity will likely grow in scale and intensity in the coming years and decades. On-farm research conducted over a long-time horizon and coupled with education programs will be necessary to understand better how to remediate soils and adapt to this changing condition.

Poster Session Abstracts

Wednesday, February 20, 2019 – Afternoon

Construction of soil monoliths at the University of Alberta – A lost art

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Abstract

Soil monoliths are useful tools in the study and classification of soils outside of field settings.

Their portable nature makes them excellent demonstration and study tools, allowing students to enhance their soil classification skills by observing and comparing a wide variety of soils without leaving the classroom. Monoliths are also an important spatial and temporal artefact of a soil and can be used to visually track the evolution of soils as they mature and respond to climatic conditions and human disturbance.

Time-consuming to build and expensive to construct, soil monoliths can cost as much as $5000 for a single new unit. The University of Alberta hosts an extensive collection of soil monoliths from across Canada, however new monoliths had not been constructed at the University since the International Congress of Soil Science was hosted in Edmonton in 1978.

In 2018 with the impending closure of the Ellerslie Research Station in Edmonton AB, two new soil monoliths were constructed with the goal of preserving a sample of the soil from this site which had hosted numerous research projects of considerable impact in the last 50 years. Details of the soil sample excavation process, the refinement of the samples in the lab, and the preservation and mounting process were all documented with the aim of providing a resource to others who may wish to practice this lost art.

Alkyl polyglycoside and earthworm (*Eisenia fetida*) enhance biodegradation of green waste and its use for growing vegetables

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Abstract

Managing municipal green waste is a challenge to municipalities, partly because of the slow rate of decomposition of green waste during composting due to its high lignin and cellulose contents. Hence, this study evaluated the effect of alkyl polyglycoside (APG), a biosurfactant, and the earthworm *Eisenia fetida* on the composting process. Addition of APG and *E. fetida* significantly increased total bacteria, cellulolytic fungi, phosphate solubilizing bacteria and nitrogen fixing bacteria populations, and the activities of cellulase, urease and alkaline phosphatase in composts as compared with the control. The APG and earthworm treatments also increased surface roughness and porosity of the green waste; Compared with control, APG and earthworm addition increased the degradation rate of TOC, lignin and cellulose by 5.9-17.9, 10.3-32.0 and 10.8-18.8%, respectively, and resulted in better compost quality, as was reflected in the neutral pH, higher cation exchange capacity (CEC) and nutrient concentrations (N, P, K, Ca, Mg, Fe, Cu, Zn, Mn). Final germination percentage and growth rate of tomato, eggplant and pepper seedlings were higher (P<0.05) or similar in all composts produced with the addition of APG and earthworm, while plant growth was lower (P<0.05) in the compost produced with the control than in peat substrate. The combination of APG+*E. fetida* enhanced the decomposition of green waste and improved final compost quality the most.

Soil-plant relationships of revegetated reclamation sites

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Abstract

The presence of native species is a key objective of reclaiming industrial sites. This will ensure species diversity, which is likely to lead to greater resilience of the developing ecosystem. Understanding plant-soil relations across a range of disturbed soil conditions is crucial for successful reclamation of ecosystems. Soils are disturbed during handling and stockpiling, and these processes can lead to changes in physico-chemical properties, including: organic matter content (OM), pH, compaction, and hydrology thereby affecting plants ability to access nutrients and water. Although woody tree species are often planted, there has been less focus on shrubs and herbaceous species. Presently, seed-based deployment of native plant species has constraints to operational use: including a lack of sufficient quantities of native seed, low emergence rates and slow initial growth. Planting a rooted shrub or herbaceous seedling may overcome some of the constraints, but the incremental costs are substantial. This study will present results from an ongoing field study that is examining the growth of native boreal woody tree and shrub species as well as one herbaceous species that was grown as nursery stock and out-planted into contrasting soil environments.

Green alder (*Alnus viridis*), paper birch (*Betula papyrifera*), Bebb's willow (*Salix bebbiana*), white spruce (*Picea glauca*) and fireweed (*Chamerion angustifolium*) were assessed at two sites: a furrowed soil stockpile and a recently reclaimed borrow pit where topsoil had been placed with dozers leaving a track-packed soil surface. Eleven blocks were established across these two sites and each site also contained a range of soil chemical properties, including: pH, electrical conductivity, OM, moisture, temperature, and total nitrogen.

Based on preliminary analysis, the growth response to soil physico-chemical properties varied among species. For example, birch, willow, and fireweed growth was positively correlated with OM and surface bulk density (0-5cm). In contrast, growth of green alder was less responsive to varying soil properties but more strongly associated with site conditions where vegetation competition was lower. Learnings from this study will provide greater guidance on species selection when conducting revegetation of industrially disturbed sites.

Celebrating 100 Years of Soil Science at the University of Alberta and 90 Years of the University of Alberta Breton Plots

The Soils Group

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Abstract

This poster is your invitation to join us for and to learn more about these celebrations in 2019:

Breton Plots 90th Anniversary Field Day – June 20, 2019

100 YEARS OF SOIL SCIENCE AT THE UNIVERSITY OF ALBERTA - Alumni Weekend 2019: Sept. 19-22, 2019; uab.ca/aw2019

Soil Carbon Dioxide and Methane Fluxes as a function of Temperature and Moisture in Fallow, Grass Mix, Spring Rye, Biennial Rye and Perennial Rye

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Abstract

To elucidate the Q_{10} relationship at the field scale, we examined the changes in CO_2 and CH_4 fluxes as a function of soil temperature and water contents. The goal of this research is to derive a model that can predict field CH_4 and CO_2 fluxes based on temperature and moisture. Thus, we selected the following cultivars to create an array of contrasting agriculture systems: spring rye (Gazelle), biennial rye (Hazlett) and perennial rye (ACE-1). Also, fallow and grass mix were also included as reference treatments. In addition to the plant cultivar selection, the influence of N addition was also assessed in all the treatments (with the exception of fallow) by establishing separate sets of replicated plots that were treated with or without N fertilization. These nine treatments with four replications were arranged a randomized complete block design with sites located in Edmonton and Breton, Alberta, Canada. During the growing season, methane and carbon dioxide gases were measured at least weekly using the chamber method. At the same time, we installed data loggers and sensors in the fields to measure soil temperature and water contents hourly. The project was initiated with seeding grass mix, biennial rye and perennial rye treatments on September 2017 while the spring rye was seeded on May 2018. The field sampling encompassed the fall 2017 as well as March to November in 2018, which will enable to examine flux hysteresis during the seasonal change. However, we excluded CO_2 flux data during the crop growing season due to complexity from the photosynthesis of plants within the chambers. As a result, we observed methane and carbon dioxide fluxes variance depending on soil temperature and water content at various depths (7.5 cm, 22.5 cm and 40 cm). Moreover, we hypothesize that methane fluxes are related to evapotranspiration and water use efficiency. The collected data was modelled by Arrhenius equation (i.e., $Fgas = Ae^{-(\frac{E}{RtST})}$), which helps to derive estimations of a flux as a function of the temperature and soil water contents. Likewise, regression equations make possible to estimate the fluxes of field greenhouse gases. We preliminary found that CO_2 flux on the fallow plots at the Breton site is driven by soil water contents and temperature (r^2= 0.6395, RMSEn%= 27). Further interpretation of data will focus on the significance and consistency of these relationships.

Assessing the impact of a pre-emergent herbicide on growth and development of woody and herbaceous planting stock in a recently reclaimed mining site

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Abstract

Vegetation establishment in land reclamation is often affected by high mortality and slow growth of planted species due in part to severe competition from noxious weeds and other undesirable vegetation. Although post-emergent herbicides may be utilized to reduce the coverage of these species, there is also often concurrent mortality of the desirable, target vegetation community through over spraying. A potential alternative could be to utilize pre-emergent herbicides as they are applied prior to planting and inhibit seed-based emergence. However, they have not been tested with concurrent use of planting nursery stock seedlings as the typical purpose of pre-emergent herbicides are to maintain bare ground conditions.

The purpose of this study was to evaluate the survival and early growth of native plant species established following soil pre-treatment with a pre-emergent herbicide. Nursery stock seedlings of 10 native species (Balsam poplar (*Populus balsamifera*), Buffalo berry (*Shepherdia canadensis*), Dogwood (*Cornus sericea*), White spruce (*Picea glauca*), Trembling aspen (*Populus tremuloides*), Green alder (*Alnus viridis*), Pussy willow (*Salix discolor*), Fireweed (*Chamerion angustifolium*), Goldenrod (*Solidago canadensis*) and, Lindley's Aster (*Aster ciliolatus)* were planted into a randomized complete block design with five blocks (a total area ~ 1.1 ha). Within each block, one of four soil treatments was applied: **(1)** pre-planting herbicide application with Torpedo™ at the standard recommended application rate (580 g ha^{-1}) for industrial use, **(2)** pre-planting herbicide application with Torpedo™ at 2x standard application rate for industrial use (1160 g ha^{-1}), **(3)** spot-application release spray approach (twice, post planting) with the conventional herbicide Clearview™ at the recommended application rate (230 g ha^{-1}) and, **(4)** no herbicide (control).

The key findings after two growing seasons were that: **(1)** both herbicide applications do not significantly impair growth and development of the planted native seedlings and **(2)** both herbicide treatments were successful in decreasing undesirable herbaceous species cover. Overall, the Torpedo herbicide constituted a more viable alternative compared to a conventional herbicide because: **(1)** it did not inhibit development of the target woody species, **(2)** logistically it was a straightforward application since it can be sprayed the day prior (or earlier) to planting, and **(3)** it only requires one entry (application) whereas the conventional herbicide spraying approach required two entries post-planting, which is more likely to contribute to herbicide damage to seedlings. Further evaluation of this technique would be needed to ensure that the herbicide does not have undue negative effects on the growth of a range of planted species.

Land Reclamation Technical Session Abstracts

Thursday, February 21, 2019 – Morning

Phytoremediation Technologies for Restoring Salt and Hydrocarbon Contaminated Soil

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Abstract

Earthmaster has successfully developed and implemented plant growth promoting rhizobacteria (PGPR) enhanced phytoremediation systems (PEPSystems™) for cost effective removal of petroleum hydrocarbons (PHCs) and salt from soils. PEPSystems utilizes soil bacteria coated onto the surface of seeds to facilitate the growth of abundant root biomass in impacted soils. This stimulates growth of rhizobacteria to facilitate partitioning of contaminants out of the soil, degrade PHCs, and sequester salt into plant foliage. PEPSystems has been successfully deployed on many sites located across Canadian to remediate contamination in soil. PEPSystems technologies have proven to be very effective in remediating remote/northern areas, where harsh conditions and permafrost exist, and access to landfill facilities is difficult or non-existent, as well as in dryland settings where precipitation and soil moisture can be limiting.

PEPSystems was deployed in situ at a remote site in northern Canada in 2008 to treat historical oil and gas related impacts. Between 2008 and 2010, the surface soil across the lease site (~2,100 m^3), which contained elevated salt levels, was successfully remediated. Between 2011 and 2017, multiple layers of PHC contaminated soil excavated from on-site pits and sumps (~5,375 m^3) was placed onto the treatment area and successfully phytoremediated. Backfilling the excavations and re-contouring the site using the treated soil was completed in 2018 and re-vegetation of the site is under way. PEPSystems was deployed at 3 sites in northern Alberta in the fall of 2011 to successfully treat multiple layers of soil (~9,250 m^3) containing PHC contaminants using a constructed treatment facility. In March 2017, the last remediated soil layer was removed, the treatment areas were decommissioned, and the sites were re-contoured. PEPSystems was deployed at the site of a former gas plant located in an agricultural area in southern Alberta in 2015 to treat soil contaminated with PHC. In the first 2 years of phytoremediation, approximately 5,000 m^3 of PHC contaminated soil was successfully treated to applicable criteria using PEPSystems technologies. In the following 2 years, the remaining 3,000 m^3 was successfully treated. PEPSystems was deployed in the summer of 2010 at a salt contaminated agricultural site in southern Saskatchewan with the objective of revegetating the site to at least 70% of background area plant growth levels and to reduce soil salt levels over time. After three growing seasons, the project objectives were achieved. The strategies utilized and cost benefits realized using phytoremediation will be discussed for each of the projects.

Modelling organic pollutant degradation of reclamation sites in Alberta using a modified DeNitrification and DeComposition model

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Abstract

One common anthropogenic pollution source in Canada is disused or inactive oil and gas well sites. Therefore, meeting the challenge of cleaning up inactive and abandoned oil and gas well sites will go a long way to help meet the environmental and economic sustainability goals in Alberta and Canada. Organic pollutants, such as hydrocarbon, and Polycyclic aromatic hydrocarbons (PAHs), are common and persistent pollutants of concern at oil and gas well sites. Phytoremediation is usually one of the most common processes for remediating soils contaminated with PAHs but the efficiency and cost of this approach is substantially dependent on environmental factors because soil properties, vegetation and weather conditions can significantly affect soil temperature, soil moisture and soil microorganisms, which determine the rate of soil PAHs and other hydrocarbon compounds. A process-based model of the organic pollutant degradation can improve understanding of ecological and environmental drivers and processes. In this paper, we modified DeNitrification-DeComposition (DNDC) to simulate dynamics of organic pollutant degradation in soils of abandoned oil and gas well sites. This new version of DNDC-Organic Pollutants, called DNDC-OP, coupled the rates of pollutant degradation with dynamics of soil, vegetation and climate, such as soil moisture and temperature. The model was parameterized and the sensitivity of the parameters was analyzed and was tested and validated against datasets of four soil PAHs, pyrene, fluorene, chrysene and anthracene at three different abandoned oil and gas well site locations in Alberta, Canada. The simulated results were in good agreement with the measured data with an average relative deviation (R^2) of 21% and the Root Mean Square Error (RMSE) of 4.5-9.1 at all the three sites. We evaluated also the influence of the environmental factors, such as soil temperature and moisture, on degradation of PAHs. The degradation of all four PAHs increased with increasing soil moisture content. An increase of soil temperature from 10°C, 20°C and subsequently to 25°C resulted in increased disappearance of all four PAHs from the three well sites. This shows that this model can be used for a tool of evaluating PAH degradation for effective reclamation strategies.

Effects of Feedstock Type, Pyrolysis Temperature, and Steam Activation on Biochar Properties and Lead (II) Adsorption

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Abstract

To facilitate the reclamation of land and oil sands process water, novel reclamation materials need to be developed that are economical, can be made with readily available materials, and are efficient in removing contaminants of emerging concern. Biochar is one of those promising materials, and its properties and utility differ with feedstock type and production condition, including pyrolysis temperature and post-pyrolysis activation treatment. The objective of this study is to determine relationships among feedstock type, pyrolysis condition, including pyrolysis temperature and activation, and biochar property, and to test lead (II) adsorption capacity on produced biochars to demonstrate the potential use of biochar for the removal of metals from oil sands process water.

Locally available feedstocks, including softwood sawdust, canola (*Brassica napus* L) and wheat (*Triticum*) straws, and cattle manure pellets were used to produce biochars using pyrolysis at 300, 500 and 700 °C for two hours (heating rate 10 °C min^{-1}) with or without steam activation. The produced biochars were characterized and tested for their adsorption capacities of lead (II), which is a common contaminant in oil sands process water.

Biochar properties and lead (II) adsorption capacities were dependent on feedstock type, pyrolysis temperature and steam activation. Sawdust biochar had the lowest pH and the highest surface area. Increasing the pyrolysis temperature increased, with a few exceptions, biochar pH, surface area, and carbon content, but decreased nitrogen content. Steam activation increased biochar pH, surface area, and carbon content. Surface functional groups of biochars were different depending on feedstock type, and the surface functional group concentrations decreased with increasing pyrolysis temperature, but there was no change in their concentrations following steam activation. For non-activated biochars, canola and wheat straw biochars produced at 700 °C had the highest lead (II) adsorption capacity, at 108 and 109 mg g^{-1}, respectively, and the lowest for sawdust biochars, regardless of the pyrolysis temperature (43-62 mg g^{-1}). Steam activation increased lead (II) adsorption capacity for most biochars, with the highest for canola straw biochar produced at 700 °C (195 mg g^{-1}) and the lowest for sawdust biochars (41-69 mg g^{-1}). Biochar adsorption followed Freundlich adsorption model, indicating multilayer adsorption on the surface. More than 90% of lead (II) (100 mg L^{-1} initial concentration) was adsorbed on the biochar surface within 1-3 hours of the kinetic study, and the adsorption with time followed the 2nd order kinetic model. The results of this study will help select the most appropriate biochars for the application in our effort to optimize biochar properties for metal and/or transitional metal removal from oil sands process water.

Biomimicry of vascular plants as a means of saline soil remediation

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Abstract

Soil salinization impacts millions of hectares of land around the world and threatens many soil ecosystem services. Impacts of soil salinization are long lasting and impact agriculture productivity, reduce plant diversity and cause increase soil erosion due a reduction or loss in surface vegetation. Generally, remediation of saline soil relies on soil washing methods and phytoremediation to translocate salts below the rooting depth of plants. However, standard methods can often be unsuccessful as leached salts are able to return to the rooting zone through subsequent capillary rise in the soil. Surface application of iron (III) ferrocyanide has been used to remediate salt contaminated soil as the ferrocyanide complex induces salts to efflorescence at the soil surface as water evaporates rather than crystallizing within the soil matrix. However, surface application of iron (III) ferrocyanide tends to be less successful in clay textured soil and does not workwell when subsequent reapplications of water are made for further salt removal. In this study we investigate a biomimetic approach to desalinate soil by mimicking the capillary transport mechanisms employed by vascular plants.

Our approach uses evapotranspiration to translocate saline soil water above the soil surface where it is effloresced with ferrocyanides. After 30 days of treatment, the biomimetic approach used 2.1 pore volume equivalents of water and was able to reduce the concentration of salts from 8% (g·NaCl/g·soil) to 0.8% (g·NaCl/g·soil), resulting in a reduction of soil EC from 120mS/cm to 14 mS/cm. Our findings indicate that the method, with further refinement and expansion to field based trials, could be an effective tool to desalinate soil and reduce global soil salinization.

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Growth Response of Aspen and Alder to Fresh and Stockpiled Reclamation Soils

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Abstract

Soil stockpiling is a common reclamation practice used in oil sands mining in the boreal forest region of Canada to conserve soil resources; but stockpiling may have detrimental effects on soil quality and plant growth. We examined growth response of trembling aspen (*Populus tremuloides* Michx.), a fast-growing early successional tree, and green alder (*Alnus viridis* (Chaix) DC. ssp *crispa* (Ait.) Turrill), a nitrogen-fixing shrub, to stockpiling and fertilization treatments on two reclamation soils (forest floor mineral mix (FFMM) and peat mineral mix (PMM)). Aspen and alder seeds were planted and their growth monitored for four months in the greenhouse. We found that unfertilized stockpiled FFMM supported significantly higher aspen and alder aboveground biomass than the other fresh and stockpiled soils. Phosphorus and potassium supply rates were highest in stockpiled FFMM and were positively correlated with aboveground plant biomass. There was no significant difference in aspen and alder aboveground biomasses between unfertilized fresh FFMM and PMM soils. Aspen grown in combination with nitrogen-fixing alder did not experience competition or facilitation except on fresh PMM, where aspen height declined. Fertilization increased both aspen and alder growth and eliminated differences in growth between soil types and stockpiling treatments. Our study showed that individual soil properties are more important for revegetation purposes than type of soil or stockpiling treatment.

Bitumen Deposit Laden Soils Affecting Site and Reclamation Potential for Gravel Pit Construction

Presenter: Paul Martin, B.Sc., P.Ag.

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Abstract

During an Environmental Impact Assessment (EIA) for a proposed gravel pit operation in northern Alberta, the soil and vegetation team encountered a unique soil type. The study area was predominantly comprised of coarse textured, glaciofluvial terraces exhibiting a robust gravel, cobble and stone content. These terraces were assumed to have been formed post-glacially as part of the Clearwater-Athabasca spillway creation. However, the expected soil moisture regime commonly associated with these types of deposits was not reflected in the vegetation observed onsite. The species present were typical of higher moisture and nutrient regimes than would be common for typical sand and gravel deposits. This presented a bit of a puzzle and upon pedogenic inspection, it was discovered that the majority of the profiles contained "hard pans" of horizontal, overlapping, sequentially laid bitumen deposits of variable thickness and degree of consolidation/degradation.

Based on evaluation of both the vegetation and soil specialists, it was hypothesized that the existence of the specific plant community within the location was directly related to the presence of the bitumen layers. Likely, the bitumen layers act to restrict internal soil drainage to a point where soil moisture is accessible to plants for a prolonged duration. The resulting reduction in internal drainage, though highly variable, thus mimics the internal drainage of finer textured materials more commonly associated with a higher soil moisture regime. If the project area is then destined to be disturbed, resulting in the irreversible fracturing of these layers, reclamation now becomes a challenge. Re-creation of these thin layers would be an impractical feat, extremely expensive, and likely not possible at all. How then should we determine the appropriate reclamation end points? If the in-situ materials/horizons cannot be reclaimed to match either the pre-disturbance or the control area, how then could we achieve an equivalent plant community? Identification of these types of potential challenges for reclamation is part of the purpose of an EIA and are ones which should be discussed and addressed prior to disturbance. Will your approval require you to meet the pre-disturbance species composition, habitat quality, etc. at the time of reclamation? Will these standards be impossible to obtain once the critical bitumen layers are broken up? Can you better set up yourself, or your client, in the future for successful reclamation and closure?

This presentation will discuss details of the soils encountered, their hypothesized genesis, the associated plant community, the unique site-specific relationship between soil and vegetation, and the resulting Conservation and Reclamation Plan discussions which were required.

Application of coarse woody debris in land reclamation: Effects on nutrient availability and microbial substrate utilization

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Abstract

Coarse woody debris (CWD) is an essential component of natural forested ecosystem, which has direct influence on soil conditions including physical and abiotic properties, microbial functions and nutrient availability. However, its effects on reconstructed environment such as in oil sands reclamation sites have not been well studied. In the current study we examined the effects of variable level of CWD (no, low, moderate and high) on nutrient availability and microbial substrate utilization in two reclamation soils, forest floor mineral soil mix (FFMM) and peat mineral soil mix (PMM), commonly used in upland reclamation in northern Alberta, and in post-fire natural benchmark soils. Nutrient availability varied mostly between soil types; however, greater total inorganic N and P availability were observed at 'Low' (>0 - 30%) level of CWD in both PMM and FFMM soils, whereas the availability of these nutrients were greater at 'Moderate' (>30 – 75%) level of CWD in benchmark soils. Significant ($p<0.05$) differences in microbial substrate utilization were also observed among soil types and CWD levels as indicated by the community level physiological profiles (CLPP) analysis. Highest substrate utilization rate was found at 'Moderate' level of CWD in FFMM and natural soils, and at 'No' CWD in PMM soil. A decreasing trend of carbohydrate and phosphorus substrate utilization with increasing CWD cover was observed in the reclamation soils, which suggest a potential decline in C mineralization and P availability at high (> 75%) level of CWD. Microbial functional richness was also low under high CWD cover in these soils. In general, a low level of CWD seems beneficial for nutrient cycling and microbial functions in the reclamation soils.

Land Use and Rangelands Technical Session Abstracts

Thursday, February 21, 2019 – Morning

Soil Extracellular Enzyme Activity in Rotational Grazing is similar to Conventional Grazing Systems in Alberta

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Abstract

Grasslands cover a quarter of Earth's surface and provide food for over a billion people. Grazing management practices that promote soil quality and health may produce livestock more efficiently while maintaining ecosystem goods and services such as soil carbon (C) storage. Our study compared how conventional grazing (non-AMP) and adaptive multi-paddock (AMP) grazing systems differentially affect key extracellular enzyme activity (EEA) responsible for soil nitrogen (N) and C cycling. AMP grazing is a rotational system employing high densities of cattle placed in small paddocks for short periods, followed by lengthy post-grazing recovery periods. Twenty-two ranch pairs were studied across Alberta, Canada, stratified across the aspen parkland, mixed prairie, and boreal transition regions. Each pair had one AMP ranch and one conventional grazing (N-AMP) ranch. Soil samples were collected from three slope positions (high, medium, and low) from 0-15 cm depth and bulked in one composite sample for each ranch. A soil incubation experiment was subsequently conducted on soils using three moisture contents (permanent wilting point, 40% of field capacity, and field capacity) and two temperature regimes (+5 °C and +25 °C). The activity of four enzymes involved in soil C and N cycling (β-1,4-glucosidase, β-1,4-xylosidase, β-d-cellobiosidase, and N-acetyl-β-glucosaminidase) were measured on day 1, 13, and 102 of the incubation. β-1,4-xylosidase and β-d-cellobiosidase activity stayed flat during soil incubation. β-1,4-glucosidase and N-acetyl-β-glucosaminidase activity declined at day 13 then increased in day 102 and was remarkably similar to day 1. The study results demonstrate that moisture and temperature affected EEA. All enzymes increased their activity by increasing temperature (+25 °C) or moisture (FC) or both factors together without interactions. While soil EEA varied markedly among pairs of ranches situated across the study area, ranches grazed with the AMP system did not differ in EEA relative to ranches subject to Non-AMP grazing.

Aerial Measurement of Surface Albedo of Rangelands under Different Grazing Management Systems in Alberta

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Abstract
Removal of atmospheric carbon dioxide and management of solar radiation are two possible strategies to mitigate climate change. Surface albedo, the fraction of reflected incident solar radiation, has a major influence on the energy balance of the Earth, and therefore the climate. Surface albedo changes with alterations to land cover and associated management. Grasslands, a major reservoir of terrestrial carbon, have been subject to changes in land use activities, but few studies have evaluated the specific effects of grazing management on their surface albedo. Several challenges exist in obtaining representative albedo in grazed environments, and the widely used point-based albedo measured at weather stations may not be representative at larger spatial scales. However, use of emerging technology such as unmanned aerial vehicles (UAV) can address such limitations. In our project we used two UAV-mounted pyranometers, one facing upward and another facing downward, to simultaneously record incoming solar radiation and reflected radiation, respectively, and calculated the surface albedo. Our objective was to compare the effect of adaptive multi-paddock (AMP) and conventional (Non-AMP) grazing management practices on the surface albedo of rangelands. AMP grazing, a modified rotational grazing practice, involves dividing a pasture into smaller paddocks and stocking cattle at high densities for short periods, followed by a lengthy post-grazing recovery period. AMP grazing is believed to increase soil carbon, improve water holding capacity and increase nutrient availability, relative to Non-AMP grazing practices. We hypothesized that the surface reflectance of ranches under AMP grazing would be lower as the vegetation growth during the resting period is faster compared to ranches under Non-AMP grazing systems. We measured biweekly surface albedo in 24 (i.e. 12 pairs of AMP and N-AMP) ranches from July to September 2018 across a climate gradient in Alberta. The late-growing-season mean albedo of ranches was positively correlated with field soil moisture ($P < 0.0001$, $R^2 = 0.3$) and was generally lower ($P < 0.0001$) during the growing season, July and August (≤ 27.0%) than in September (~ 40.0%). However, spatially it decreased with increased aridity of the ranches ($P < 0.01$). The least squared average surface albedo of ranches also was lower ($P < 0.05$) under AMP grazing (27.6%) than from ranches under Non-AMP grazing (29.2%). We conclude that the surface albedo of rangelands varies regionally with growing conditions, seasonally with vegetation development, and differs based on whether the AMP grazing is being used.

Soil compaction from farm machinery and its influences on plant physiology

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Abstract

An analysis of commercial agriculture sites within Alberta contrasted soil properties of conventional traffic (compacted soils) to controlled traffic regimes (un-compacted soils). Our results exhibited total porosity improvements up to 15% in the absence of traffic. Substantial changes within the soil at these field sites led to a greenhouse experiment where faba beans (*Vicia faba* L.) were grown in soil conditions that simulated common traffic management regimes. Physiological changes in the faba beans were tracked through plant and sensor-based measurements and separated by treatments of dry bulk density and volumetric water content. The widest disparity in the faba beans occurred between treatments with a bulk density of 1.2 g cm^{-3} (representing un-compacted soils) and 1.4 g cm^{-3} (representing compacted soil from machinery traffic). Furthermore, treatments with a relatively high water content offset some of the negative physiological changes within the compacted soils, while treatments with a relatively lower water content displayed differences in faba bean physiology that would be common in field growing conditions.

Water Repellency and Hydrophobicity of Some Major Agricultural Crop Residues

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Abstract

Water repellency of agricultural crop residues may increase rainfall interception, reduce soil infiltration, and increase runoff on sloping cropland. We conducted a laboratory study to measure water repellency and hydrophobicity of 30 major agricultural crops (grass, legume, cereal, oilseed, pulse, specialty crops). Crop samples (mostly above-ground) were collected within 50 km of Lethbridge, Alberta, Canada in 2017 and 2018. Water repellency (WR) was measured using the water drop penetration time (WDPT) and molarity of ethanol (MED) test. Hydrophobicity was also measured as the ratio of hydrophobic CH- to hydrophilic CO-functional groups using Fourier Transform Infrared (FTIR) spectroscopy. The WDPTs of the 30 agricultural crops ranged from 8.3 to 2438 s, suggesting that crop species influenced WR of the dried and undecomposed residues. Needle-and-thread grass (*Stipa comata Trin. & Rupr.*), blue grama [*Bouteloua gracilis (Kunth) Lag. ex Griffiths*], and western wheatgrass (*Agropyron smithii Rydb.*) were the most WR crops based on WDPT. Fababeans (*Vicia faba*), mustard (*Sinapis alba L.*), and sweet clover (*Melilotus officinalis*) were the least WR crops. Mean WDPTs were significantly ($P \leq 0.05$) greater for grass than cereal by 31 times, but mean values were similar for grass, legume, oilseed, pulse, and specialty crops. Significant differences in WDPT also occurred among crop species within each of the six crop types. A significant positive correlation occurred between WDPT and hydrophobicity ($r=0.54$); and between hydrophobicity and C/N ratio ($r=0.77$). Overall, crop type and species may influence WR of crop residues and should be considered in the hydrologic balance.

Canadian Agriculture Partnership (CAP) Prioritization Process

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Abstract

Imagine if there was a way of improving how Federal Provincial Territorial program funding delivery that makes a meaningful, objective, and relevant contribution to advancing the adoption of agricultural land use practice change. Practice changes that give priority to addressing or reducing the largest economic and environmental risks encountered by agriculture producers and the organizations that represent them. At the same time, imagine if there were varied and competing, spatial criteria that go into the evaluation of specific project's potential that are applying for funding under the previously described program. What would happened if a tool could remove a significant amount of the administrative burden accessing the relative merits of potential projects vying for funding from the program described earlier? Finally, is there a means of creating a baseline for evaluating the effectiveness of the previously described program upon its completion? Agriculture and Forestry, Canadian Agriculture Partnership (CAP) programming under the Environmental Sustainability and Climate Change strategy is testing an approach to address these questions through a multi-criteria decision mapping facilitation, analysis, and decision mapping process.

This methodology facilitates the gathering of knowledge and heuristics from a group of experts and agriculture industry leaders brought together to understand and address land use related issues specific to a local area and discuss the factors that contribute or detract from solving these land related issues. This information combined with spatial statistical analysis, processing, and modeling allows for a visual of the factors and priority areas. This presentation will describe the approach, methodology, and results from a multi-stakeholder and provincial perspective to support program decision making.

State of the Prairie – Change over time

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Abstract

Native cover is crucial for the healthy soils and provide soil resilience while maintaining biodiversity of an ecosystem. Native vegetation has always been under threat from historical and ongoing clearance, urban sprawl, overgrazing, invasive species and other land-use changes. Monitoring these changes are crucial for conservation planning and reassessing the land-use policies. The objective of this project was to evaluate native cover conditions in the Grassland and Parkland Natural Regions of Alberta using the available inventories and remote sensing. More precisely, to quantify the change and remaining native cover from the early 1990's (Time 1) to the present day (Time 2) and then summarize and report on the changes by Natural Region, Natural Sub-Region, Ecodistricts, Administrative Areas, and Land Tenure (Public versus Private).

Remaining native cover in both Grassland and Parkland natural region was determined by evaluating eleven separate datasets that best represented the change. The results from the three Grassland Natural Region datasets show that native cover has remained quite stable in this region; the relatively small increases or decreases (+2% to -2%) are within the error margins of the three sets of data. The total amount of native cover left in the Grassland Natural Region is about 48%. The Parkland Natural Region also showed similar insignificant change (about -2%) but the amount of native cover comparatively less. The total amount of native cover is 20% and localized mostly in the east and SW part of the region. Most of the region contains 10-15% native cover. Data stratified by administrative areas reveal similar trends. Those areas adjacent to the large cities of Calgary and Edmonton showing the greatest loss in native cover with the Counties of Rocky View (-8%), Parkland (-5%) and Strathcona (-5%) showing the largest losses. The Kainai Indian Reserve lost the most native cover between 1990 and 2010. The loss was about 19%. Canadian Forces Base (CFB) Suffield and CFB Wainwright contained the greatest amount of native cover at 98% and 92%, respectively. Obtaining reliable and consistent data was the main challenge in the study.

Overview of the Conservation and Reclamation Directive for Renewable Energy Operations

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Abstract

In 2018 the Government of Alberta amended the Conservation and Reclamation Regulation to include renewable energy operations as a specified land activity and released the Conservation and Reclamation Directive for Renewable Energy Operations. The directive contains the conservation and reclamation requirements for the generation of electricity from wind, solar, and geothermal. The presentation will outline the conservation and reclamation related requirements from initial application through to reclamation certification.