Québec 2012
Congrès conjoint AQSSS-SCSS
AQSSS-CSSS Joint meeting

Les sols sous un climat en évolution : amis ou ennemis ?

Soils under a changing climate: Friend or foe?

Programme scientifique
Scientific Program




Manoir St-Castin

HÔTELS VILLEGIA
UNE SECONDE NATURE

3 – 8 Juin – *June* 2012

AQSSS
Association québécoise de spécialistes en sciences du sol

Le Sol – Fondement de la Vie
CSSS / SCSS
Soil – Foundation of Life

Avant-propos

C'est pour la troisième fois en 17 ans que l'Association québécoise de spécialistes en science du sol et la Société canadienne de science du sol tiennent leur congrès annuel conjointement. Les deux premiers congrès avaient connu un grand succès, en particulier celui de juin 2007, tenu sur le site de la Station touristique de Duchesnay, et ayant attiré plus de 200 participants.

Cette fois-ci, c'est sous le thème « **Les sols sous un climat en évolution : amis ou ennemis?** » que les membres des deux sociétés se réunissent. À la session plénière, le lundi matin, cinq conférenciers discuteront du rôle, positif ou négatif, que les sols de divers écosystèmes pourraient jouer dans l'évolution de notre climat. En plus d'un **atelier sur la cartographie numérique des sols**, organisé par le Réseau canadien des terres le dimanche 3 juin, plus de **200 communications scientifiques** sur tous les aspects touchant la science du sol seront présentées au cours des trois jours suivant. Fait à remarquer, **77 communications** seront présentées **par des étudiants** participant à l'un ou l'autre des prix remis par nos deux sociétés. Les deux sociétés tiendront leur réunion générale annuelle respective le lundi et mardi soirs. Enfin, **l'excursion terrain** du 7 et 8 juin offrira une occasion unique d'observer des profils de sols se développant sous un gradient climatique contrasté : des basses-terres du Saint-Laurent jusqu'à la taïga.

C'est donc avec une grande fierté que nous vous accueillons à ce congrès conjoint. Nous croyons fermement que le programme scientifique et le cadre enchanteur du Manoir Saint-Castin, situé sur la rive du Lac Beauport, seront propices aux rencontres, à la réflexion et aux échanges scientifiques. Au nom du comité d'organisation, je vous souhaite la bienvenue et un congrès fructueux.

Foreword

For the third time in 17 years, the Association québécoise de spécialistes en science du sol and the Canadian Society of Soil Science are holding a joint annual meeting. The previous meetings were a great success, particularly the June 2007 meeting, held at the Duchesnay resort, with more than 200 attendees.

This year, members of both societies are gathering under the theme "**Soils in a changing climate: Friend of foe?**" At the plenary session, on Monday morning, five invited speakers will discuss the possible role, positive or negative, that soils from different ecosystems may play in climate change. In addition to the **workshop on Digital soil mapping**, organized by the Canadian Land Resource Network on Sunday, more than **200 scientific communications** will be presented on all aspects of soil science during the following three days. Of note, a total of **77 communications** will be presented **by students** participating in the various award competitions of both societies. On Monday and Tuesday night, each society will hold its Annual General Meeting. Finally, on June 7-8, the **field tour** will offer a unique opportunity to see soil profiles developing under a contrasted climatic gradient: from the St-Lawrence Lowlands to the Taiga.

We are delighted to welcome you at this meeting. We strongly believe that the scientific program and the enchanting venue of Manoir Saint-Castin, on the shore of Lac Beauport, will foster productive scientific discussion and networking. On behalf of the organizing committee, I welcome you and wish you a fruitful meeting.

Martin Chantigny
Au nom du comité d'organisation / On behalf of the organizing committee

COMITÉ ORGANISATEUR – ORGANIZING COMMITTEE

Martin Chantigny	Président / Chair
Isabelle Royer	Programme scientifique / Scientific Program
Isabelle Royer	Inscription / Registration
Rock Ouimet	Webmestre et excursion terrain / Webmaster & Field Tour
Lucie Grenon	Trésorière et excursion terrain / Treasurer & Field Tour
Athyna Cambouris	Excursion terrain / Field Tour
Patrice Thibault	Excursion terrain / Field Tour
Louis Robert	Excursion terrain / Field Tour
Gilles Gagné	Excursion terrain / Field Tour

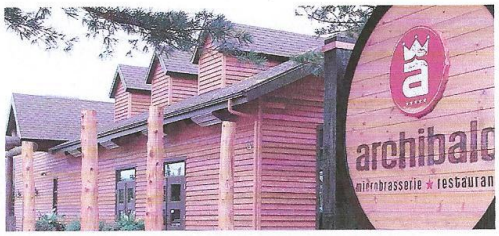
Restaurants à proximité /

Restaurants nearby

Microbrasserie Archibald

Profitez de votre visite chez Archibald pour en apprendre davantage sur le brassage de la bière, la microbrasserie vous ouvre ses portes. Une expérience inoubliable dans un environnement de souvenirs, de bois, de cuir et de fourrure rappelant les chalets québécois d'antan. L'ambiance exceptionnelle de la Microbrasserie Archibald vous transportera. Près d'un foyer, à l'intérieur comme à l'extérieur, venez vivre une expérience culinaire accompagnée de l'une des 11 bières brassées sur place.

Coordonnées :
1021, boul. du Lac
Lac-Beauport
G3B 0X1
Tél.: 418- 841-2224
Sans Frais: 1 877-841-2224
http://archibaldmicrobrasserie.ca/



Menus : http://archibaldmicrobrasserie.ca/Menu/menu.html

Restaurant Le Batifol

Un restaurant aux couleurs chaudes, musique tantôt lounge, tantôt latino, tantôt jazzée, une ambiance décontractée avec terrasse chauffée et intime de style floridien, des salons privés pour vos réunions ou repas de groupe. Au Batifol, en habit, en jeans, en bermuda, chics ou décontractés, tous y sont les bienvenus!

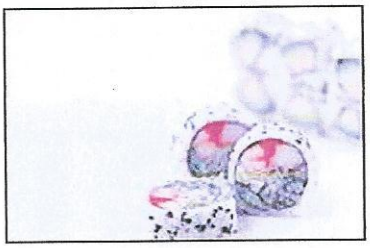
Coordonnées :
995 boulevard du Lac
Lac-Beauport
G3B 0W6
418.841.0414
http://www.lebatifol.com/le-batifol-et-traiteur-des-anges-splash.php

Menu : http://www.lebatifol.com/le-batifol-et-traiteur-des-anges-corporatif.php?id=6

Sushi Shop

Sushi Shop est un pionnier dans le domaine de la restauration santé inspirée. Depuis plus de 10 ans, nous proposons une gamme complète de produits de qualité aux amateurs de sushi. Fabriqués en boutique avec soin et toujours frais du jour, nos produits allient bon goût, santé, simplicité et visent à stimuler vos sens et votre esprit.

Coordonnées :
990, boulevard Du Lac
Lac-Beauport
G2M 0C9
418- 849-9020
http://sushishop.com/fr/



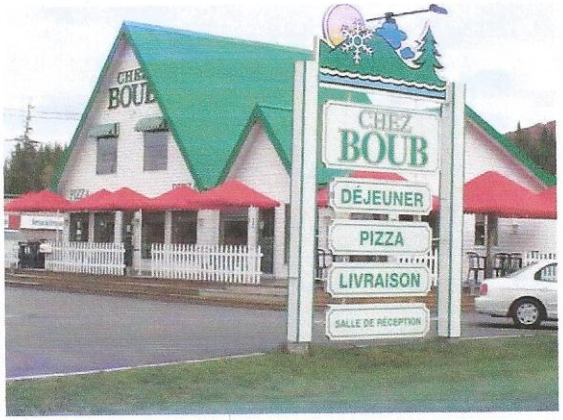
Menu : http://sushishop.com/fr/menu/

Restaurant Chez Boub

Chez Boub offre à sa clientèle un restaurant familial et multiservices pour combler tous les estomacs! C'est dans une ambiance chaleureuse et familiale que l'on pourra profiter d'une cuisine traditionnelle avec des produits maison faits sur place. De plus, tous les jours de la semaine, un copieux déjeuner est servi dès 7h et pourra accommoder les lève-tard puisqu'il est offert jusqu'à 15h.

Coordonnées :
840, boulevard du Lac
Lac-Beauport
G1H 7G1
418-841-2682

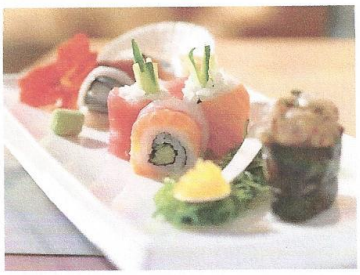
Menu non-disponible



Yuzu Sushi (comptoir pour emporter)

Visitez l'un des comptoirs Yuzu sushi et vous serez transporté dans un univers recherché : décor zen, signature urbaine et service chaleureux! Renouvelant sans cesse ses menus et portant une attention constante et particulière à la qualité et à la fraîcheur de ses produits, Yuzu s'assure de répondre continuellement aux besoins de sa clientèle.

Vivez une expérience sensorielle unique en dégustant vos Yuzu sushis sur place, à la maison ou au travail!



Coordonnées :
360 boul. du Lac
Lac-Beauport
418- 849-8499
http://www.yuzusushi.ca/

Menu : http://www.yuzusushi.ca/pdf/menu.pdf

Restaurant Osoya

Découvrez notre cuisine asiatique surprenante, actuelle et raffinée. Une fusion parfaite entre traditions culinaires de l'Asie et tendances gastronomiques de l'Occident.

Faites-vous plaisir! Laissez-vous tenter par nos créations pleines de saveurs, de parfums et de fraicheur, comme les ailes de canard au soya, gingembre et sirop d'érable, le wok vietnamien *Cao Lâu* au basilic ou encore le calmar au pesto thaï.

Coordonnées :
830, boul. du Lac
Lac-Beauport
G2M 0C9
418-849-0990
http://www.osoya.ca/

Menu : http://www.osoya.ca/documents/OSOYA_Menu_Regulier.pdf

Restaurant Les Frères Tocs

(À 6km du Manoir St-Castin)

Situé dans le boisé de Sherwood à Charlesbourg à quelques pas du Lac Beauport, le Resto Bar Les Frères Toc est l'endroit idéal pour se rassembler, pour prendre un verre, une bonne bouffe et s'amuser entre amis. Ces quatre éléments, rassemblés dans un concept actuel et chaleureux, nous rappellent bien la gourmandise et la joie de vivre du légendaire personnage de la bande dessinée qui nous habite un peu tous. Les Frères Toc c'est aussi un bar à sushis ouvert sept soirs offrant une variété de produits toujours frais et présentés soigneusement.

Coordonnées :
20815 Henri-Bourassa
Québec, Qc
Tel. 418.849.6211
http://www.lesfrerestoc.com

Menu : http://www.lesfrerestoc.com

Sommaire du programme / *Program-at-a-glance*

<table>
<tr><th>Dimanche / Sunday</th><th>Lundi / Monday</th><th>Mardi / Tuesday</th><th>Mercredi / Wenesday</th><th>Jeudi / Thursday</th></tr>
<tr>
<td rowspan="2">8:00 - 16:30
Salle / Room:
St-Castin B

Atelier pré-congrès sur la Cartographie Numérique des sols
Pre-meeting Workshop on Digital Soil Mapping

Organisé par le Réseau Canadien des Terres / Organized by the Canadien Land Resource Network</td>
<td>7:00 - 8:15
Manoir St-Castin
Inscription / Registration

8:30 - 11:45
Salle / Room: St-Castin A
Session plénière / Plenary Session</td>
<td>7:00 - 8:00
Manoir St-Castin
Inscription / Registration

8:00 - 11:45
St-Castin A; St-Castin B; St-Dunstan
Méta-analyse / Meta-analysis
Cartographie / Digital Soil Mapping
Phosphore du sol / Soil Phosphorus</td>
<td>7:00 - 8:00
Manoir St-Castin
Inscription / Registration

8:00 - 11:45
St-Castin A; St-Castin B; St-Dunstan
Azote du sol / Soil Nitrogen
Prop. Sols & eau I / Soils Prop. & Water I
Fertilité et bio. sols / Soil Fertility & Bio.</td>
<td rowspan="3">et / and
Vendredi / Friday
8:00 - 16:30

Tournée post-congrès / Post-meeting tour

Jeudi / Thursday
Des basses-terres du Saint-Laurent à la forêt mixte / From the St.Lawrence Lowlands to the mixedwood forest

vendredi / Friday
De la forêt boréale à la taïga / From the Boreal Forest to the Taiga

Pour plus de détails, voir dans le programme scientifique

For more details, check in the Scientific Program</td>
</tr>
<tr>
<td>11:45-13:00
Dîner / Lunch

13:15 - 14:30
Salle / Room: De La Tour
Affiches et exposants / Posters and Booths

14:30 - 17:15
St-Castin A; St-Castin B; St-Dunstan
Sols froids / Cold Conditions
Sols & env. / Soil & Env.
Projets EPDH / WEBs Projects</td>
<td>11:45-13:00
Dîner / Lunch

13:15 - 14:30
Salle / Room: De La Tour
Affiches et exposants / Posters and Booths

14:30 - 17:15
St-Castin A; St-Castin B; St-Dunstan
Sites long terme / Long-term sites
Sols forestiers / Forest soils
Physique-pédo Physics & Pedology</td>
<td>11:45-13:00
Dîner / Lunch

13:15 - 14:30
Salle / Room: De La Tour
Affiches et exposants / Posters and Booths

14:30 - 17:15
St-Castin A; St-Castin B; St-Dunstan
Gaz du sol / Soil Gases
Prop. sols & eau II /Soils Prop. & Water II
Pédo-paysage / Landscape Scale</td>
</tr>
<tr>
<td>19:00 - 21:00
Manoir St-Castin

Inscription / Registration

Cocktail
Bar payant /Cash Bar</td>
<td>17:30 - 19:00
Salle / Room: St-Castin B
Assemblée générale de l'AQSSS
AQSSS Annual General Meeting

17:30 - 19:00
Salle / Room: St-Dunstan
Réunion du sous-comité Pédologie
Pedology Subcommittee meeting

Souper libre / Dinner on your own</td>
<td>17:30 - 19:00
Salle / Room: St-Castin A
Assemblée générale de la SCSS
CSSS Annual General Meeting

Souper libre / Dinner on your own</td>
<td>18:30
Salle / Room: St-Castin A

Banquet
Prix de l'AQSSS et de la SCSS
AQSSS and CSSS Awards

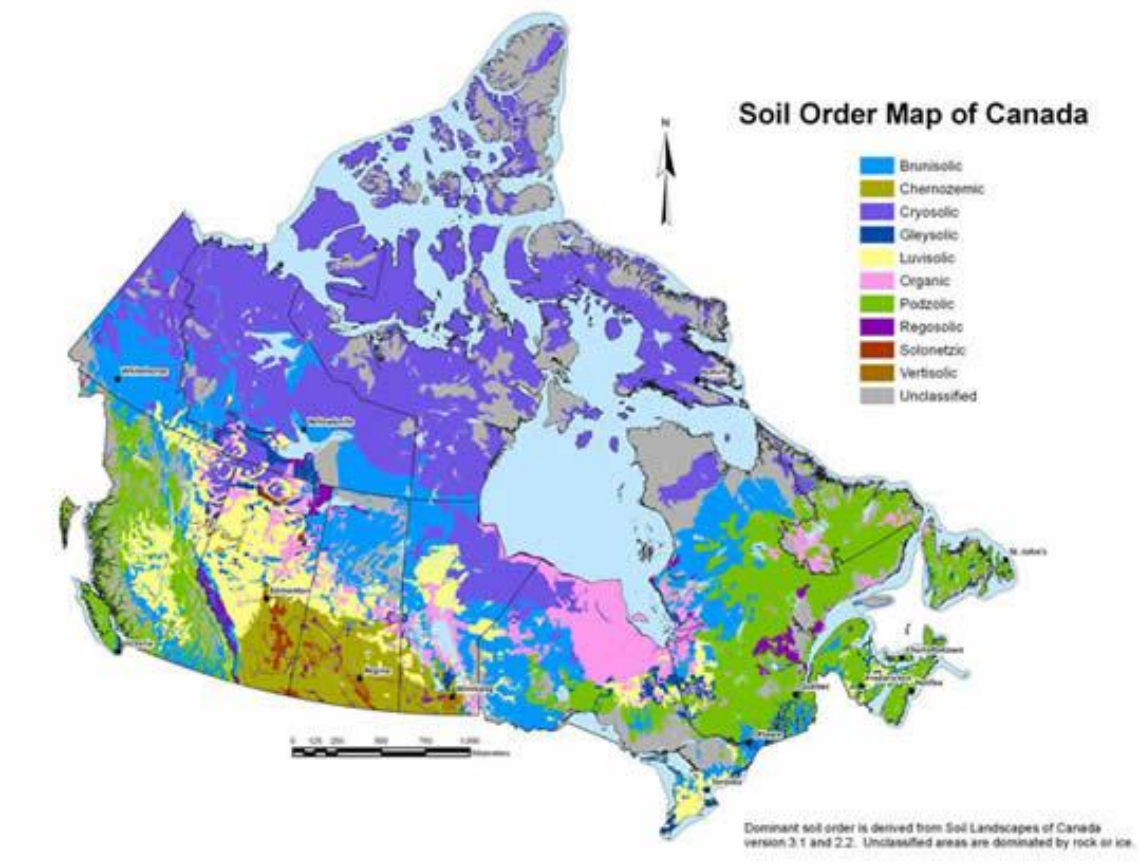
Spectacle musical / Musical Show
Gilles Sioui (Folk & Blues)</td>
</tr>
</table>

Merci à nos commanditaires

Thanks to our sponsors

Canadian Land Resource Network

Meeting 2012



Orthic Gray Brown Luvisol

Orthic Humo Ferric Podzol

Orthic Chernozem

Typic Fibrisol

Photos courtesy of Soils of Canada website (www.soilsofcanada.ca)

Canadian Land Resource Network

June 3rd, 2012

Lac Beauport, Quebec City

The Canadian Land Resource Network (CLRN) is an annual forum for researchers and professionals from across Canada and internationally to exchange information and network on projects, issues, and the latest technologies in land resource management - particularly as related to pedology and soil survey.

The CLRN meeting is an annual event that provides a venue for all levels of government, the private sector, universities and colleges to address soil and land resource issues of national interest. The annual meetings are held in different locations in order to facilitate regional participation and to promote pedology in all regions of the country. The Canadian Land Resource Network meeting is an initiative of land and resource professionals from Agriculture and Agri-Food Canada.

Sponsored by

Dimanche / Sunday, 3 juin - *June* 2012, 8:30 - 12:00

8:30 - 9:00	**Réseau Canadien des Terres / *Canadian Land Ressource Network*** **Inscription / *Registration* (Manoir St-Castin)**
	Modérateur / *Session chair*: Daniel Saurette
9:00 - 9:15	**Mots de bienvenue /** **Opening remarks** **Daniel Saurette, AAFC, Guelph, ON and Michel Nolin, AAFC, Quebec, QC** **Salle / *Room*: St-Castin B**
9:15 - 10:00	**Bob MacMillan** LandMapper Environmental Solutions, Edmonton, AB Evolution and history of digital soil mapping
10:00 - 10:30	**Pause / *Coffee break*** **Refreshments provided**
10:30 - 12:00	**Modérateur / *Session chair*: Pierre-Yves Gasser**
10:30 - 11:15	**Thomas Mayr,** Cranfield University, Bedford, UK Comparing point-based and expert knowledge-based approaches to predictive soil mapping
11:15 - 12:00	**John Gallant** Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia Better quality digital elevation models from global elevation products
12:00 - 13:00	**Dîner / *Lunch***

Dimanche / Sunday, 3 juin - *June* 2012, 13:00 - 16:00

	Réseau Canadien des Terres / *Canadian Land Ressource Network* **Modérateur / *Session chair*: Scott Smith**
13:00 - 13:30	**Hazen Russell** Natural Resources Canada, Ottawa, ON Machine Based Surficial Geological Mapping of Arctic Canada at the Geological Survey of Canada
13:30 - 14:00	**Doug Aspinall** Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON Provincial soil map renewal in Ontario: Honoring legacy mapping through innovative predictive approaches
14:00 - 14:30	**Pause / *Coffee break*** **Refreshments provided**
14:30 - 15:45	**Modératrice / *Session chair*: Isabelle Perron**
14:30 - 15:00	**Aubert Michaud** IRDA, Quebec City, QC DSM to support field water management
15:00 - 15:30	**Michel Nolin** AAFC, Quebec City, QC New technologies for DSM to support traditional soil survey
15:30 - 15:45	**David Kroetsch** AAFC, Ottawa, ON Closing Remarks and Adjourn
16:00 - 17:00	**Optional Session** LandMapR Software Demonstration-Innovation Session Bob MacMillan

Présentations orales / *Oral presentations*

(Indiqué en fonction de la journée et de la session)

(Listed by day and session)

Instructions :

Présentateur :

Les sessions de présentations étant très chargées, vous devez TÉLÉCHARGER VOTRE PRÉSENTATION AU PRÉALABLE.

Présentez-vous dans votre salle au moins ½ heure avant le début de votre session (soit le matin, le midi ou pendant une pause-café) pour télécharger votre présentation sur l'ordinateur prévu à cet effet. Un assistant sera dans la salle, à partir de 7:45 am, pour vous aider.

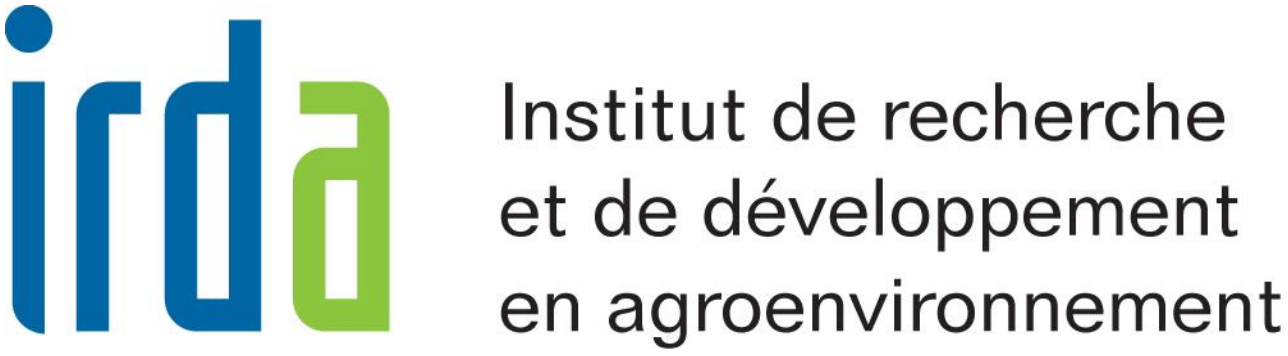
Speakers:

The schedule is very tight, so your presentation MUST BE DOWNLOADED IN ADVANCE.

Make sure you arrive in you session room at least ½ hour before your session starts (i.e either in the morning, at lunch time, or during a coffee break) to download your presentation on the computer. An assistant will be present in the session room, starting at 7:45 am, to assist in loading presentations.

Merci à nos commanditaires

Thanks to our sponsors



Lundi matin / *Monday morning*, 4 juin - *June* 2012, 8:15 - 11:45

7:00 - 8:15	**Inscription / *Registration* (Manoir St-Castin)**
8:15 - 8:30	**Mots de bienvenue / Welcome** **Salle / *Room*: St-Castin A**
8:30 - 11:45	**Session Pléniaire / *Pleneary session*** **Les sols sous un climat en évolution : amis ou ennemis ? / *Soils under a changing climate: Friend or foe?*** **Modérateur / *Chair*: Martin Chantigny**
8:30 - 9:00	**Hugh Henry** U. of Western Ontario Soil functioning in a changing climate: too warm, too dry or too frozen?
9:00 - 9:30	**Serge Payette** Chaire en recherche nordique du CRSNG Soils are surficial paleosols – an insight into podzol profiles as repositories of Holocene forest environments
9:30 - 10:00	**Andrei Lapenis** U. of Albany What can we learn about soil response to climate change by comparing old and new soil samples?
10:00 - 10:15	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**
10:15 - 10:45	**Julien Fouché** CNRS, Université Aix Marseille, France **Warming of Cryosols and thawing of permafrost: one of the most significant feedbacks to climate change from terrestrial ecosystems?**
10:45 - 11:15	**Dan Pennock** U. of Saskatchewan Will the effects of climate change on Canadian agricultural soils even be detectable?
11:15 - 11:45	**Discussion**
11:45 - 13:00	**Dîner / *Lunch***

Lundi après-midi / *Monday afternoon*, 4 juin - *June* 2012, 13:15 - 17:15

13:15 - 14:30	**Affiches et exposants / *Posters and booths*** **Salle / *Room*: De La Tour**	
14:30 - 17:15	**Présentations orales / *Oral presentations***	
	Fonctionnement des sols froids / *Soil functionning under cold condition* **Salle / *Room*: St-Castin A** **Modérateur / *Chair*: Martin Chantigny**	**Évaluation de la qualité des sols et de l'environnement / *Soil and environmental quality assessment*** **Salle / *Room*: St-Castin B** **Modératrice / *Chair*: Isabelle Royer**
14:30 - 14:45	**Martin H. Chantigny** Significance of N losses through gaseous emissions and leaching in the non-growing season in snow-covered agricultural soils	**Inoka Amarakoon (CSSS student)** Degradation of Veterinary Antimicrobials During Composting of Manure Containing Excreted Antimicrobials vs. Manure Spiked with Antimicrobials
14:45 - 15:00	**David Pelster** Rate of freezing is positively related to N_2O emissions during freeze-thaw cycles	**Emma Holmes (CSSS student)** Assessing the Capability of Soil Processes to Reduce the Potential Health Hazards of Naturally Occurring Asbestos (NOA)
15:00 - 15:15	**Claudia Goyer** What are the effects of cold and freezing soils on nitrous oxide emissions, denitrification and denitrifier and nitrifier communities?	**Alison Murata (CSSS student)** Sorbed and aqueous phase chromium speciation during redox-sorption treatment of contaminated water
15:15 - 15:45	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	
15:45 - 16:00	**Suzanne E. Allaire** Gold mine residues and plant growth	**Bernard Gagnon** Disponibilité des métaux suite à neuf années d'épandage de biosolides papetiers et résidus alcalins en grandes cultures
16:00 - 16:15	**Hailong He (CSSS student)** Calibration of TDR for simultaneous measurement of liquid water and ice content in frozen soils using composite dielectric mixing models	**Lekan Olatuyi** Chemical Fractionation of Heavy Metals in Separated and Un-separated Liquid Swine Manure
16:15 - 16:30	**Myles Dyck** In situ measurement of snowmelt infiltration under various snow depths and topsoil cap thicknesses on a reclaimed site	**Lindsey Andronak (CSSS student)** A Comparative Study of In-field and Laboratory Mineralization Rates of 2,4-D and 17β-estradiol
16:30 - 16:45	**Sébastien F. Lange** N_2O et CO_2 production in frozen soils	**Amanuel Oqbit Weldeyohannes (CSSS student)** Analysis of E.coli and Bromide transport from at-grade line sources to shallow groundwater
16:45 - 17:00	**Brian Wallace (CSSS student)** Over-winter dynamics of N_2O from four legume based cropping strategies in Eastern Canada	**Abimbola Ojekanmi** Soil Quality Assessment and Rating for Peat-Mineral Mix Cover Soils in Oil Sands Reclamation
17:00 - 17:15	**Discussion**	**Carolyn Baldwin (CSSS student)** Validating the Wind Erosion Risk Indicator Model using Cs-137: Preliminary Study
17:30 - 19:00	**Assemblée générale de l'AQSSS** ***AQSSS Annual General Meeting*** **Salle / *Room :* St-Castin B**	***Réunion du sous-comité Pédologie*** ***Pedology Subcommittee Meeting*** **Salle / *Room: St-Dunstan***

Lundi après-midi / *Monday afternoon*, 4 juin - *June* 2012, 13:15 - 17:15

13:15 - 14:30	**Affiches et exposants / *Posters and booths*** **Salle / *Room*: De La Tour**	
14:30 - 17:15	**Présentations orales / *Oral presentations***	
	Projets Nationaux EPDH : Résultats et défis / *National WEBs Projects: Outcomes and challenges* **Salle / *Room*: St-Dunstan** **Modératrice / *Chair*: Ymène Fouli**	
14:30 - 14:45	**Aubert R. Michaud** Determining critical source areas and BMP placement at catchment scale: Bras d'Henri and Fourchette watersheds WEB's case study	
14:45 - 15:00	**Chengfu Zhang** Assessing impacts of riparian buffers on sediment and nutrients loading into streams at watershed scale using REMM model	
15:00 - 15:15	**Ymène Fouli** Soil Physical and Hydrological Properties of Sloping Perennial Pasture and Annual Cropland of the Prairie Pothole Region of Southeastern Saskatchewan, Canada	
15:15 - 15:45	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	
15:45 - 16:00	**Kara Barnes (CSSS student)** Farm Level Economic Analysis of Nutrient Management BMPs in the Pipestone Creek Watershed	
16:00 - 16:15	**Jim Miller** Watershed Evaluation of Beneficial Management Practices (WEBs) in the Lower Little Bow River watershed: Streambank Fencing	
16:15 - 16:30	**Sheng Li** Preliminary results of a snow survey in the Black Brook Watershed using manual method and a Ground Penetrating Radar	
16:30 - 16:45	**Discussion**	
16:45 - 17:00		
17:00 - 17:15		
17:30 - 19:00	**Assemblée générale de l'AQSSS** ***AQSSS Annual General Meeting*** **Salle / *Room: St-Castin B***	***Réunion du sous-comité Pédologie*** ***Pedology Subcommittee Meeting*** **Salle / *Room: St-Dunstan***

Mardi matin / *Tuesday morning*, 5 juin - *June* 2012, 8:00 - 10:00

7:00 - 8:00	**Inscription / *Registration* (Manoir St-Castin)**	
8:00 - 10:00	**Présentations orales / *Oral presentations***	
	Méta-analyse et analyse compositionnelle en sciences du sol / *Meta-analysis and compositional analysis in soil science* **Salle / *Room*: St-Castin A** **Modérateur / *Chair*: Léon-Étienne Parent**	**Cartographie numérique des sols / *Digital soil mapping*** **Salle / *Room*: St-Castin B** **Modérateur / *Chair*: Daniel Saurette**
8:00 - 8:15	**Nicolas Tremblay** Meta-analyses applied to nitrogen management issues	**Thomas R Mayr** Digital Soil Mapping in support of the Irish Soil Information System
8:15 - 8:30		**Isabelle Perron** Improve Digital Mapping of Soil Surface Texture using High Spatial Resolution Imagery
8:30 - 8:45	**Thomas Kätterer** Long-term effects of agricultural management on crop yields and soil properties - highlights from Swedish long-term field experiments	**Glenn Lelyk** Producing gridded raster soil attribute property maps for the Canadian contribution to the GlobalSoilMap.net project
8:45 - 9:00		**Mohamed Abou Niang** Comparing geostatistical interpolation technics and ε-SVR model to digital mapping of soil surface texture using RADARSAT-2 data
9:00 - 9:15	**Émilie Maillard (AQSSS-CSSS student)** Analyse globale des impacts des effluents d'élevage sur les stocks de carbone du sol	**Jean-Daniel Sylvain** Predicting soil properties using spectral measurements and Independent Component Analysis (ICA)
9:15 - 9:30	**Michaël Leblanc (AQSSS student)** Bases de données pédologiques et de qualité des sols cultivés du Québec	**David Kroetsch** Geospatial modelling of A-Horizon thickness and soil C redistribution in eroded agricultural landscapes
9:30 - 9:45	**Jérôme Goulet-Fortin** Simulation of soil NO_3 content and soil to plant N flux under potato cropping systems in Eastern Canada	**Viacheslav I. Adamchuk** Opportunities and Challenges with Proximal Soil Sensing
9:45 - 10:00	**Lotfi Khiari** Diagnostic foliaire de précision d'un champ de pomme de terre au Québec	**John Gallant** Global data, national DEMs and local soil mapping: An Australian perspective
10:00 - 10:30	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	

Mardi matin / *Tuesday morning*, 5 juin - *June* 2012, 8:00 - 10:00

7:00 - 8:00	**Inscription / *Registration* (Manoir St-Castin)**	
8:00 - 10:00	**Présentations orales / *Oral presentations***	
	Évaluation et modélisation du phosphore du sol / *Soil phosphorus assessment and modelling* **Salle / *Room*: St-Dunstan** **Modératrice / *Chair*: Noura Ziadi**	
8:00 - 8:15	**Cynthia Grant** Improving Phosphorus Management	
8:15 - 8:30		
8:30 - 8:45	**Barbara Cade-Menun** Characterizing soil phosphorus in Canadian agricultural soils with 31P-NMR spectroscopy	
8:45 - 9:00		
9:00 - 9:15	**Aimé J. Messiga** Soil P modeling in agro-ecosystems using a process-based mass-balance approach	
9:15 - 9:30		
9:30 - 9:45	**D. Keith Reid** The Component P Index - narrowing the gap between process-based models and field evaluation tools	
9:45 - 10:00	**Vanita Sachdeva (CSSS student)** Physical and sequential chemical fractionation to assess phosphorus dynamics in biochar-amended soils	
10:00 - 10:30	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	

Mardi matin / *Tuesday morning*, 5 juin - *June* 2012, 10:30 - 11:45

10:30 - 11:45	**Présentations orales / *Oral presentations***	
	Méta-analyse et analyse compositionnelle en sciences du sol / *Meta-analysis and compositional analysis in soil science* **Salle / *Room*: St-Castin A** **Modérateur / *Chair*: Léon-Étienne Parent**	**Cartographie numérique des sols / *Digital soil mapping*** **Salle / *Room*: St-Castin B** **Modérateur / *Chair*: Daniel Saurette**
10:30 - 10:45	**Léon Etienne Parent** L'analyse compositionnelle en science du sol : revisiter le passé et préparer l'avenir	**Kent E. Watson** Preliminary results: Can GIS be used to predict the presence of smectite clays in Luvisolic soils?
10:45 - 11:00		**Scott Smith** Use of weights of evidence statistics to define inference rules to disaggregate soil survey maps
11:00 - 11:15	**Dalel Abdi (AQSSS-CSSS student)** Compositional analysis of soil phosphorus pools	**J. Douglas Aspinall** Predictive Digital Soil Mapping as a Tool for Ontario Soil Map Renewal: Lessons Learned with Different Digital Elevation Models
11:15 - 11:30	**William Natale** Diagnostic nutritionnel du goyavier (Psidium guajava) au Brésil	**Discussion**
11:30 - 11:45	**Serge-Étienne Parent** Analyse de données en sciences du sol avec R	
11:45 - 13:00	**Dîner / *Lunch***	

Mardi matin / *Tuesday morning*, 5 juin - *June* 2012, 10:30 - 11:45

10:30 - 11:45	**Présentations orales / *Oral presentations***	
	Évaluation et modélisation du phosphore du sol / *Soil phosphorus assessment and modelling* **Salle / *Room*: St-Dunstan** **Modératrice / *Chair*: Noura Ziadi**	
10:30 - 10:45	**Tiequan Q. Zhang** Changes of soil phosphorus fractions induced by fertilization and crop rotation in comparison with the virgin forest	
10:45 - 11:00	**Min Sheng** How could cropping practices modify maize P uptake?	
11:00 - 11:15	**Deanna Nemeth** Phosphorus Management for Vegetable Production in Ontario Histosols	
11:15 - 11:30	**Yichao Shi (student)** Seasonal variations in microbial biomass, activity and community structure in soil under contrasting tillage and phosphorus management	
11:30 - 11:45	**Discussion**	
11:45 - 13:00	**Dîner / *Lunch***	

Mardi après-midi / *Tuesday afternoon*, 5 juin - *June* 2012, 13:15 - 17:00

13:15 - 14:30	**Affiches et exposants / *Posters and booths*** **Salle / *Room*: De La Tour**	
14:30 - 17:00	**Présentations orales / *Oral presentations***	
	Sites de long terme : Importance passée, présente et future / *Long-term field sites: past, present and future importance* **Salle / *Room*: St-Castin A** **Modérateur / *Chair*: Dan Reynolds/Craig Drury**	**Les sols sous aménagement forestier et culture d'arbres à croissance rapide / *Soils under forest management and tree crop production*** **Salle / *Room*: St-Castin B** **Modérateur / *Chair*: Nicolas Bélanger**
14:30 - 14:45	**Craig F. Drury** Long-term effects of fertilization and crop rotation on nitrous oxide emissions from soils	**Loïc D'Orangeville (AQSSS-CSSS student)** Changes in soil available N and water with increased soil temperature and atmospheric N inputs in a balsam fir forest
14:45 - 15:00	**Xueming Yang** Impacts of fifty-years of crop rotation and fertilization on SOC and N of a Brookston clay loam in Southwestern Ontario	**Ali Rahi (CSSS student)** Carbon dynamics in forest soils of British Columbia
15:00 - 15:15	**Dan Reynolds** Impacts of 50 years of consistent cropping and fertilization on the physical quality of a Brookston clay loam soil	**Jérôme Laganière** Elemental and isotopic composition of boreal forest SOM reservoirs along a climate transect: Indicators of enhanced SOM decay rates with warming
15:15 - 15:45	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	
15:45 - 16:00	**Zisheng Xing** Water yield, sediment load, and erosivity of a small watershed under a long-term monitoring	**Ryan Hangs (CSSS student)** First Rotation Nutrient Budgets of Willow Biomass Plantations in Saskatchewan
16:00 - 16:15	**Gilles Tremblay** Parcelles de longue durée au site de Saint-Mathieu-de-Beloeil du CÉROM	**Suzanne Brais** Five-year response to ash fertilization in a jack pine stand: soil properties and stem growth
16:15 - 16:30	**Jingyi Yang** Evaluation of DSSAT crop and soil models using maize-soybean rotation data with different tillage in Northeast China	**Rock Ouimet** Provisional soil Ca, K and P thresholds for sugar maple (Acer saccharum Marsh.) in southern Quebec
16:30 - 16:45	**Zou Wenxiu** The effect of long-term fertilization on soil water dynamics, crop yield and WUE in Black soil region in Northeast China	**Fougère Augustin (étudiant AQSSS)** What are the environmental determinants of base cation weathering rates in podzols of the Canadian Shield?
16:45 - 17:00	**Discussion**	**Michael McTavish (CSSS student)** Environmental factors influencing the immigration behaviour and dispersal of the invasive earthworm Lumbricus terrestris
17h30 - 19h00	**Assemblée générale de la SCSS** ***CSSS Annual General Meeting*** **Salle / *Room :St-Castin A***	

Mardi après-midi / *Tuesday afternoon*, 5 juin - *June* 2012, 13:15 - 17:00

13:15 - 14:30	**Affiches et exposants / *Posters and booths*** **Salle / *Room*: De La Tour**	
14:30 - 17:00	**Présentations orales / *Oral presentations***	
	Physique des sols et pédologie / *Soil physics and pedology* **Salle / *Room*: St-Dunstan** **Modératrice / *Chair*: Angela Bedard-Haughn**	
14:30 - 14:45	**Richard J. Heck** Evaluation of the Impact of Fall Cover Crops on Soil Structure in Horticultural Production Systems using X-ray Computed Tomography	
14:45 - 15:00	**Barbara Junqueira** X-ray Computed Tomography of the Microstructure of Topsoils from the State of Rio Grande do Sul, Brazil	
15:00 - 15:15	**Pooyan Rahimy (CSSS student)** Quantifying the influence of wetting and drying on the microstructure of soil crust using fractal analysis of CT imagery	
15:15 - 15:45	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	
15:45 - 16:00	**Darwin Anderson** Rare Earth Elements as Measures of Pedogenesis	
16:00 - 16:15	**Alisha F. Hackinen (CSSS student)** Examining Student Experiences in a Modified Problem Based Learning Approach to Teaching Sustainable Soil Management	
16:15 - 16:30	**Maja Krzic** Virtual Soil Science Learning Resources	
16:30 - 16:45	**Discussion**	
16:45 - 17:00		
17h30 - 19h00	**Assemblée générale de la SCSS** ***CSSS Annual General Meeting*** **Salle / *Room: St-Castin A***	

Mercredi matin / *Wednesday morning*, 6 juin - *June* 2012, 8:00 - 10:00

7:00 - 8:00	**Inscription / *Registration* (Manoir St-Castin)**	
8:00 - 10:00	**Présentations orales / *Oral presentations***	
	Gestion de l'azote du sol : progrès récents / *Soil N management: recent progress* **Salle / *Room*: St-Castin A** **Modératrice / *Chair*: Cynthia Grant**	**Propriétés des sols et gestion de l'eau I / *Soils properties and water management I*** **Salle / *Room*: St-Castin B** **Modérateur / *Chair*: Aubert Michaud**
8:00 - 8:15	**Bernie Zebarth** Recent progress in understanding and predicting soil N mineralization	**Aubert R. Michaud** Landscape and management drivers of hydrologic regime and water quality from agricultural watersheds
8:15 - 8:30		**Kui Liu** Identification of critical factors affecting N and P losses by spring snowmelt runoff under long-term conventional tillage
8:30 - 8:45	**Athyna N. Cambouris** Precision farming: lessons learned from N management	**Simon-C. Poirier (étudiant AQSSS)** Hydrograph separation procedure to determine the sources of the phosphorus and nitrogen loads in an agricultural watershed
8:45 - 9:00		**Nikola Wagner (étudiant AQSSS)** Hydrochimie des éléments traces et connectivité hydrologique lors d'une crue printanière dans le bassin versant de l'Hermine
9:00 - 9:15	**Noura Ziadi** Soil and plant diagnostic tools to improve nitrogen use efficiency	**Geethani Amarawansha (CSSS student)** Investigating Phosphorus Release from Manitoba Soils under Flooded Conditions: Preliminary Observations
9:15 - 9:30		**Yann Périard (étudiant AQSSS-CSSS)** Modeling root water uptake by Romaine lettuce: linking tipburn damages to water stress
9:30 - 9:45	**Mervin St. Luce (AQSSS-CSSS student)** Anionic exchange membranes as a predictor of nitrogen supply from controlled-release nitrogen fertilizer in potato production	**Vincent Pelletier (étudiant AQSSS)** Régies d'irrigation basées sur le potentiel matriciel du sol en production de canneberge
9:45 - 10:00	**Ben W. Thomas (CSSS student)** Nitrogen mineralization from manure: comparison of methods and emerging technologies for prediction of the soil N supply	**Jean Caron** Amélioration de l'irrigation dans la production de canneberges : irrigation de déficit
10:00 - 10:30	**Pause / *Coffee break*** **Salle / Room: De La Tour**	

Mercredi matin / *Wednesday morning*, 6 juin - *June* 2012, 8:00 - 10:00

7:00 - 8:00	**Inscription / *Registration* (Manoir St-Castin)**	
8:00 - 10:00	**Présentations orales / *Oral presentations***	
	Fertilité et biologie des sols / *Soil fertility and biology* **Salle / *Room*: St-Dunstan** **Modérateur / *Chair*: Mehdi Sharifi**	
8:00 - 8:15	**Thomas Morier (étudiant AQSSS-CSSS)** Use of Hyperspectral Vegetation Indices to Assess Potato Crop Nitrogen Status	
8:15 - 8:30	**Cédric Bouffard (étudiant AQSSS-CSSS)** Utilization of Handheld Optical Diagnostic Tools in Potato Crop to Assess N Status	
8:30 - 8:45	**J. Daniel Gillis (CSSS student)** Effect of an alkaline-treated biosolid on soil pH, CO_2 evolution, NH_4, and NO_3	
8:45 - 9:00	**Jean Lafond** Fertilisation en calcium et en magnésium dans la production du bleuet sauvage	
9:00 - 9:15	**Mehdi Sharifi** The effect of municipal solid food waste compost and fertigation on yield and fruit quality in strawberry plasticulture	
9:15 - 9:30	**Aimé J. Messiga** Soil test P distribution as affected by long term P and N fertilization of a grassland	
9:30 - 9:45	**Khaled D. Alotaibi (CSSS student)** Crop yield, microbial biomass and dehydrogenase activity in a prairie soil amended with biochar and glycerol	
9:45 - 10:00	**Salma Taktek (étudiante AQSSS)** Dissolution biologique des phosphates: Isolements, identification et caractérisation de bactéries solubilisant les phosphates	
10:00 - 10:30	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	

Mercredi matin / *Wednesday morning*, 6 juin - *June* 2012 10:30 - 11:45

10:30 - 11:45	**Présentations orales / *Oral presentations***	
	Gestion de l'azote du sol : progrès récents / *Soil N management: recent progress* **Salle / *Room*: St-Castin A** **Modératrice / *Chair*: Cynthia Grant**	**Propriétés des sols et gestion de l'eau I / *Soils properties and water management I*** **Salle / *Room*: St-Castin B** **Modérateur / *Chair*: Aubert Michaud**
10:30 - 10:45	**Jacynthe Dessureault-Rompré** Prediction of soil N supply in the field using a simple kinetic model	**Silvio J. Gumiere** Modélisation de l'impact d'une couche compacte sur l'efficacité du système de drainage en culture de canneberges
10:45 - 11:00	**Judith Nyiraneza** Corn nitrogen response and residual soil nitrate are affected by soil texture, N rate and growing season conditions	**Ariane Drouin** Prendre en compte de la variabilité spatiale des propriétés des sols dans la régie des champs : le projet ReZoTaGe
11:00 - 11:15	**Alex Woodley (CSSS student)** Nitrogen Dynamics of various Organic Amendments on Cereal Crop Production within Organic Systems in Southern Ontario	**Luan Pan (CSSS student)** Analysis of Information Quality Associated with an Integrated Use of Spatial and Temporal Soil Data
11:15 - 11:30	**Nicolas Tremblay** Reference plots for N management. Do they have a place?	**Junyu Qi** Modification of Soil Temperature Module in Soil and Water Assessment Tool
11:30 - 11:45	**Sina Adl** Quantifying C & N nutrient mineralization through soil food web compartments using stable isotope methods	**Discussion**
11:45 - 13:00	**Dîner / *Lunch***	

Mercredi matin / *Wednesday morning*, 6 juin - *June* 2012 10:30 - 11:45

10:30 - 11:45	**Présentations orales / *Oral presentations***	
	Fertilité et biologie des sols / *Soil fertility and biology* **Salle / *Room*: St-Dunstan** **Modérateur / *Chair*: Mehdi Sharifi**	
10:30 - 10:45	**Ghulam M. Jamro (CSSS student)** Soil Enzyme activities and nitrogen availability in oil sands reclaimed soils: Influence of amendment type, soil depth and sampling time	
10:45 - 11:00	**Michael D. Preston (CSSS student)** Microbial community structure and decomposition processes in peat soils of the James Bay Lowlands, Canada	
11:00 - 11:15	**Benoît Cloutier-Hurteau** Bacterial geography in the rhizosphere –pH gradient and rhizodeposition shape bacterial niches	
11:15 - 11:30	**Thea Whitman (CSSS student)** Black Carbon Effects On Soil CO_2 Emissions and Isotopic Proxies for Black Carbon Decomposition: A Methodological Study	
11:30 - 11:45	**Chen Chen (CSSS student)** Stoichiometry of C:N ratio in earthworm muscular tissue is constant and independent of food quality	
11:45 - 13:00	**Dîner / *Lunch***	

Mercredi après-midi / *Wednesday afternoon*, 6 juin - *June* 2012, 13:15-17:00

13:15 - 14:30	**Affiches et exposants / *Posters and booths*** **Salle / *Room*: De la Tour**	
14:30 - 17:00	**Présentations orales / *Oral presentations***	
	Émissions gazeuses de C et N dans les sols / *Soil gaseous C and N emissions* **Salle/*Room*: St-Castin A** **Modérateur / *Chair*: Philippe Rochette**	**Propriétés des sols et gestion de l'eau II / *Soils properties and water management II*** **Salle/*Room*: St-Castin B** **Modérateur / *Chair*: Tiequan Q. Zhang**
14:30 - 14:45	**Rochette Philippe** Volatilisation de l'ammoniac suivant l'incorporation de l'urée en bandes: Impact du taux d'application et de la profondeur d'incorporation	**Daniel Seeton (CSSS student)** Does ammonia deposition from poultry barn exhaust contribute to nitrate contamination of a vulnerable aquifer?
14:45 - 15:00	**Keith Fuller** Impact of Land Management Practices, Soil Properties and Weather Conditions on Denitrification Losses in Manure-Amended Permanent Forage and Corn-Soybean-Wheat Rotations in Atlantic Canada	**Rezvan Karimi Dehkordi (CSSS student)** Effect of cropping systems on nitrate-nitrogen and phosphorus lost by leaching on a sandy loam soil influenced by swine manure application
15:00 - 15:15	**Zaho Matheos (CSSS student)** Interacting controls on CH_4 and N_2O emissions in restored vs. cultivated wetland soils	**Jingyi Yang** Sensitivity and scenario analysis of Canadian Agricultural Nitrogen Budget model (CANB v3.0) for estimating residual soil nitrogen and N leaching across Canadian farmland
15:15 - 15:45	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	
15:45 - 16:00	**Martin H. Chantigny** Manure storage strategies altered nutrient availability and greenhouse gas emissions following application to soils	**Jonathan A. Lafond** Drainage of cultivated organic soils, evolution of the soil profile
16:00 - 16:15	**Aaron Glenn** Nitrous Oxide Emissions from an Annual Crop Rotation in the Red River Valley, Manitoba	**Tiequan Q. Zhang** Phosphorus loss in tile drains from clay loam soils
16:15 - 16:30	**Paligwende Nikiema** Greenhouse Gas Emissions from Annual and Perennial Crops Fertilized with Solid and Liquid Hog Manure	**Keith Fuller** Impact of land management practices on nitrate loads in tile drainage waters from manure-amended permanent forage and corn-soybean-wheat rotations in Atlantic Canada
16:30 - 17:00	**Discussion**	**Discussion**
18:30 **20:00**	**Banquet** **Prix de l'AQSSS et de la SCSS** ***AQSSS and CSSS Awards*** **Salle / *Room*: St-Castin A** **Spectacle musical / *Musical Show*** **Gilles Sioui (Folk & Blues)**	

Mercredi après-midi / *Wednesday afternoon*, 6 juin - *June* 2012, 13:15-16:45

13:15 - 14:30	**Affiches et exposants / *Posters and booths*** **Salle / *Room*: De la Tour**	
14:30 - 17:00	**Présentations orales / *Oral presentations***	
	Processus du sol à l'échelle du pédo-paysage / *Soil processes at the Landscape scale* **Salle / *Room*: St-Dunstan** **Modérateur / *Chair*: Bert VandenBygaart**	
14:30 - 14:45	**Henry Chau** Factors controlling soil water storage in the Hummocky landscape of the Prairie Pothole region of North America	
14:45 - 15:00	**Bert VandenBygaart** The Nature of Buried Soil Organic Matter in Eroded Cropland	
15:00 - 15:15	**Tony Brierley** Land Suitability Rating System - recent developments and activities	
15:15 - 15:45	**Pause / *Coffee break*** **Salle / *Room*: De La Tour**	
15:45 - 16:00	**Pierre-Yves Gasser** Impact of different resolution climatic data on corn suitability ratings in the Lower Fraser Valley, British Columbia	
16:00 - 16:15	**Ali Latrèche** Évolution actuelle de quelques caractères pédologiques des sols steppiques arides de l'Algérie occidentale	
16 :15 - 16:45	**Discussion**	
18:30 **20:00**	**Banquet** **Prix de l'AQSSS et de la SCSS** ***AQSSS and CSSS Awards*** **Salle / *Room*: St-Castin A** **Spectacle musical / *Musical Show*** **Gilles Sioui (Folk & Blues)**	

Liste des présentations par affiche / *Poster presentation list*

(Indiqué en fonction de la journée et de la session)

(Listed by day and session)

Instructions :

Présentateur :

Les affiches sont exposées pendant toute la journée de votre session. Veuillez installer votre affiche entre 7:00 et 8:00 le matin de votre session et à l'endroit assigné selon le numéro de position qui suit votre titre dans la liste des présentations par affiche. Vous devez être présent à votre affiche de 13:15 à 14:30 le jour de votre session. Assurez-vous d'enlever votre affiche à la fin de la journée.

Presenting author:

Posters are on display for the entire day of your session. Make sure to put up your poster between 7:00 and 8:00 on the morning of your session, on the poster board assigned by the position number following your title in the Poster presentation list. You must be present at your poster from 13:15 to 14:30 the day of your session. Make sure to remove your poster at the end of the day.

Lundi après-midi / *Monday afternoon*, 4 juin - *June* 2012, 13:15 - 14:30

Session d'affiches et exposants /
Poster session and booths

Salle */ Room: De La Tour*

Présentateur *Presenting author*		Titre *Title*	Position	Étudiant *Student*
Cade-Menun	Barbara	Nutrient loss from Saskatchewan cropland and pasture in spring snow melt runoff	1	
Fouli	Ymène	Freeze-thaw cycles and soil water content effects on infiltration rate and bulk density of three Saskatchewan soils	2	
Chantigny	Martin	Response of the compost springtail (Folsomia candida (Willem)) to cooling temperatures: behavioural avoidance or acclimation?	3	
Eerpina	Ramesh	Soil carbon cycling by Collembola: possible impact of diet switching and low seasonal temperatures	4	CSSS
Andronak	Lindsey	Monitoring of Urban Atmospheric Pesticide Deposition in Winnipeg, Manitoba	5	CSSS
Murata	Alison	Deschampsia caespitosa growth and trace element uptake from contaminated soils	6	CSSS
Tam	Katina	Agricultural water management systems affecting greenhouse gas emissions in Quebec, Canada	7	AQSSS CSSS
Drouin	Ariane	Upgrading standards and procedures for the design of agricultural land development projects	8	
Roddan	Bruce	WEBS I: Riparian Exclusion Fencing for Cattle Impacts on Benthic Insects and Riparian Vegetation in the Salmon River, British Columbia	9	
Sylvain	Claudia	Efficacité des bandes riveraines influencée par le mouvement préférentiel de solutés dans les sols	10	AQSSS
Poon	David	A new algorithm for macropore flow in SWAT for better phosphorus loss estimates	11	CSSS
Saint-Laurent	Diane	Analyse de la variabilité spatiale des teneurs en carbone organique des sols alluviaux soumis à des crues fréquentes en lien avec les changements climatiques	12	
Rasouli	Sogol	Source of erodible particulate organic nitrogen in agricultural tile drainage water determined with 15N and 13C stable isotopes	13	AQSSS CSSS
Patros	Thair	Analyzing and Improving the Water-Table Fluctuation Method of Estimating Groundwater Recharge	14	CSSS
Weldeyohannes	Amanuel Oqbit	In-situ characterization of wastewater flow and transport from at-grade line sources to shallow groundwater	15	CSSS
Parkin	Gary	Estimating Adequate Time Spans for Soil Hydrology Field Experiments	16	

Lundi après-midi / *Monday afternoon*, 4 juin - *June* 2012, 13:15 - 14:30

Session d'affiches et exposants /
Poster session and booths

Salle */ Room: De La Tour*

Présentateur *Presenting author*		**Titre** *Title*	**Position**	**Étudiant** *Student*
Rochette	Philippe	Nitrous oxide emissions following deposition of dairy cattle excreta in Eastern Canada	17	
Carvalho Miola	Ezequiel Cesar	Émissions de N_2O et de NH_3 après apport de lisier de porc: influence du mode d'application et d'un inhibiteur de nitrification	17	AQSSS
Guérin	Julie É.	Influence du travail de sol, de la jachère d'été et du type de culture en rotation sur les émissions d'oxydes nitreux d'un sol de type Udic Boroll des Prairies canadiennes	19	
Guo	Xiaobin	The impact of the degree of soil wetting and drying on nitrous oxide emissions.	20	
Roy	Amal	Nitrous oxide emissions from corn as affected by rate, timing and history of nitrogen fertilizer application	21	CSSS
Sun	Lei	Nitrogen and tillage reversal effects on GHG emissions in a Black Chernozem Soil	22	CSSS
Landi	Ahmad	Effects of dairy manure application on CO_2 flux and $\delta^{13}C$ of soil respiration from a soil with carbonate	23	

Mardi après-midi / *Tuesday afternoon*, 5 juin - *June* 2012, 13:15 - 14:30

Session d'affiches et exposants /
Poster session and booths

Salle */ Room: De La Tour*

Présentateur *Presenting author*		**Titre** *Title*	**Position**	**Étudiant** *Student*
Tavares	Mayra	Image-based micromorphological quantification of porosity in Red Latosols on the Brazilian Cerrado, under sugarcane production	1	
Maia de Oliveira	Larissa	Physical properties of a brazilian latosol (oxisol) under intensively-managed coffee	2	
Andressa da Silva	Érika	Stability of soil aggregates in brazilian inceptisols under intensively-managed coffee production	3	
Jefferies	Danny	Evaluating Microscale Variability Patterns of Canadian Topsoil from X-ray μCT Imagery	4	CSSS
Carducci	Carla	Evaluation of structural changes in brazilian latosol (oxisol) under intensively-tilled coffee, using x-ray computed tomography	5	
Cocciardi	Robert	Rapid determination of soil texture and organic matter with a portable attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectrometer	6	
Fan	Ruqin	Characterizing organic carbon in aggregate inner- and outer-core fractions of soils under different land use systems	7	CSSS
Hangs	Ryan	A Rapid Technique for Separating Willow Roots from Clay Soil Based on Sodium-Induced Dispersion	8	CSSS
Moore	Jean-David	Premières mentions de vers de terre dans trois écosystèmes forestiers du Bouclier canadien	9	
Drouin	Pascal	Contrasting cultivation practices effect on soil bacteria population diversity in a multi-year experience	10	
Rouissi	Tarek	Co-inoculation de Sinorhizobium meliloti avec Azospirillum brasiliense : optimisation des conditions de production d'Azospirillum brasiliense dans les eaux usées d'amidon et études des doses appliquées	11	AQSSS
Chakir	Sanae	Dissolution des phosphates par des champignons et des levures en tandem avec les champignons	12	AQSSS
Abdi	Dalel	Continuous application of papermill and liming materials: any residual effect on the level of microbial biomass C, N and P?	13	AQSSS CSSS
Messiga	Aimé Jean	Phosphorus application in no-till affects the relationship between soil test P and P budget	14	
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Mardi après-midi / *Tuesday afternoon*, 5 juin - *June* 2012, 13:15 - 14:30

Session d'affiches et exposants /
Poster session and booths

Salle */ Room: De La Tour*

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Lafond	Jean	Relationship Between Lowbush Blueberry Leaf Nitrogen, Chlorophyll and Polyphenol Contents	17	
Deng	Hongyuan	Biochar made from pinewood chips modifies denitrificaion process in a sandy loam soil in laboratory	18	AQSSS CSSS
Baril	Benjamin	Teneur en carbone du panic érigé et du sol amendé avec du biochar et une fertilisation microbienne	19	AQSSS
Zhang	Hongjie	Biochar feedstock and biochar effects on soil microbial biomass and activity	20	CSSS
Adl	Sina	Soil aggregate size distribution affected by biochar and biosolids has negative and positive effects on germination, resilience and biological communities	21	
Miller	Jim	Long-term Effect of Fresh and Composted Cattle Manure on the Size and Nutrient Composition of Dry-Sieved Soil Aggregates	22	
Yang	Xueming	Soil Organic Carbon and Total Nitrogen Stocks 10 Years after a Single Compost Addition to Brookston Clay Loam Soil	23	
Gallant	Kyle	Evaluation of Soil Amendments and Cover Crops for Wine Grape Production	24	CSSS
Rozane	Danilo Eduardo	La population de référence et le diagnostic de la composition nutritionnelle (CND) du goyavier (Psidium guajava L.) 'Paluma' au Brésil.	25	

Mercredi après-midi / *Wednesday afternoon*, 6 juin - *June* 2012, 13:15 - 14:30

Session d'affiches et exposants /
Poster session and booths

Salle */ Room: De La Tour*

Présentateur *Presenting author*		**Titre** *Title*	**Position**	**Étudiant** *Student*
Hamdan	Khaled	Characterizing the Spatial Structure of Forest Floor pH, Nitrate, and Ammonium Associated with Bigleaf Maple and Western Hemlock at Multiple Scales	1	
Moore	Jean-David	Liming: an effective treatment to maintain representation and health of sugar maple in acidic and base-poor soils	2	
Duan	Min	Nitrogen Availability Affects Tree Growth on Reclaimed Landscapes in the Athabasca Oil Sands Region in Alberta, Canada	3	CSSS
House	Jason	Water Availability was Related to Forest Productivity on Reclaimed Upland Sites in the Athabasca Oil Sands Region	4	CSSS
Ribaudo	Lisa	Assessing carbon retention and loss in agroforestry systems in Quebec, Canada	5	CSSS
Bolinder	Martin A.	Quantifying climatic influence on soil biological activity for Canadian Ecodistricts using the Introductory Carbon Balance Model concept	6	
Boulmane	Mohamed	Évaluation du stock de carbone organique dans les iliçaies du Moyen et Haut Marocains	7	
Heung	Brandon	Predictive Parent Material Mapping using Topographic Indices: A Random Forest Approach	8	CSSS
Heung	Brandon	Predicting soil development in British Columbia using Random Forest	9	
Sylvain	Jean-Daniel	A spectro-temporal approach to support spatial prediction of soil texture and drainage	10	
Grenon	Lucie	Les sols de Missisquoi : Une approche cartographique par zones physiographiques, pédopaysages et classes de pente	11	
Perron	Isabelle	Digital Soil Mapping Using Morphological and Analytical Soil Legacy Data and Geostatistical Analysis	12	
Aspinall	J. Douglas	An artist's eye assesses soil landscape colour as diagnostic input for predictive digital soil mapping	13	
Smith	Scott	Developing an operational-scale rulebase in ArcSIE for digital soil mapping	14	
Smith	Scott	Application of Two Probabilistic Data-Driven Methods for Digital Soil Mapping in Trout Creek Watershed, British Columbia, Canada	15	
Russell	Hazen	An Emerging Paradigm for Surficial Geological Mapping of Arctic Canada at the Geological Survey of Canada	16	
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Mercredi après-midi / *Wednesday afternoon*, 6 juin - *June* 2012, 13:15 - 14:30

Session d'affiches et exposants /
Poster session and booths

Salle / *Room: De La Tour*

Présentateur *Presenting author*		**Titre** *Title*	**Position**	**Étudiant** *Student*
Xing	Zisheng	Performance of several N fertilization strategies in terms of potato tuber production and reduction of nitrate leaching	18	
Curtis	Lucas	Influence on manure type and timing of application on crop nitrogen utilization	19	CSSS
Ziadi	Noura	Effect of Controlled-Release Urea on NH_3 volatilization and rice production in a rice-wheat rotation in the Taihu region of China	20	
Hangs	Ryan	Soil Nitrogen Supply and Greenhouse Gas Emissions of Short-term and Long-term No-till Fertilized Fields Compared to an Adjacent Native Prairie	21	CSSS
Kaur Khosa	Maninder	Use of nitrification inhibitor 3,5-dimethylpyrazole in estimating net mineralization and denitrification rates in soil	22	
Nyiraneza	Judith	The ability of soil chemical and biological indices to predict soil nitrogen supply of contrasting soils	23	
Stiles	Kyra	Estimation of gross nitrogen transformation rates using the stable isotope pool dilution method: Evaluation of potential sources of error	24	CSSS
Congreves	Katelyn	Application of used cooking oil to minimize nitrogen losses after broccoli harvest: Using 15N to characterize the fate of crop residue derived nitrogen over the post-harvest season	25	CSSS

Tournées Post-Congrès – 7 et 8 Juin 2012 /

Post-Meeting Tour – June 7-8, 2012

Jeudi / *Thursday*, 7 juin - *June* 2012, 8:00 - 16:00

Pédopaysages des basses-terres du St-Laurent

En partance de Lac-Beauport, la tournée se dirigera vers la région agricole de Saint-Catherine-de-la-Jacques-Cartier, reconnue pour sa production de pomme de terre, afin d'y faire un arrêt à la Ferme Cantin et fils où un site expérimental portant sur la gestion agroenvironnementale de l'azote dans la culture de la pomme de terre vous sera présenté (profil de sol de la série Morin, mesure de dénitrification, mesure de lessivage des nitrates, outil de télédétection proximale, suivi de la minéralisation du sol et station météo). L'arrêt suivant se fera à la ferme expérimentale de l'Université Laval de Saint-Augustin où un site expérimental portant sur la fertilisation organique à base de fumiers d'élevage et sur la dynamique du carbone, de l'azote et du phosphore en période hivernale vous sera présenté (description des essais et des équipements scientifiques pour les mesures hivernales et profil de sol de la série Tilly). Par la suite, la tournée longera le chemin du Roy pour se rendre à l'île d'Orléans, un parcours agrémenté par un guide touristique qui nous renseignera sur l'histoire et les beautés rencontrées sur notre chemin. Arrivée sur la magnifique île de Bacchus, du temps sera alloué après le diner pour visiter un kiosque de légumes et d'artisanat ainsi qu'un vignoble. Finalement, le groupe se dirigera pour un dernier arrêt à la Ferme Coulombe de Saint-Jean-de-l'Île-d'Orléans (présentation de l'entreprise et de résultats de recherches effectuées sur les terres de l'entreprise, séries de sols Lafleur, Dauphine et/ou Orléans).

Soils and landscapes of the St-Lawrence lowlands

Starting from the conference site, the field tour will first stop in the agricultural area of Sainte-Catherine-de-la-Jacques-Cartier, an intensive potato production area. At the Farm Cantin et fils, research activities on the agri-environmental management of nitrogen in potato cropping systems will be presented (soil profile of the Morin Series, monitoring of soil nitrogen mineralization, denitrification and nitrate leaching, proximal sensing tools, meteorological station). The tour will then stop at the Université Laval Experimental Farm, located at Saint-Augustin-de-Desmaures, where research activities on the use of farm effluents and soil nutrient dynamics during winter will be presented (soil profile of the Tilly Series, description of field trials and monitoring equipment for the winter period). The tour will then follow the St-Lawrence river shore to get to Orléans Island. A bilingual guide will entertain the group on the long history of that region since coming of the first European settlers. Lunch will be served at the Island's winery, and our last stop will be at the Coulombe farm at Saint-Jean-de-l'Île-d'Orléans (soil profiles of Lafleur, Dauphine and/or Orléans Series, presentation of research activities conducted on the Farm).

Vendredi / *Friday*, 8 juin - *June* 2012, 7:30 - 16:00

Les sols de la forêt boréale du Bouclier Canadien

Cette tournée sur le Bouclier canadien dans les Hautes-Laurentides vous permettra d'explorer le pédopaysage de la forêt boréale canadienne, le plus grand biome du pays. Limitée par la toundra au nord et par les prairies et la forêt de feuillus au sud, elle représente 35% de la superficie totale du Canada et 77% des forêts canadiennes. Au cours de la journée, nous traverserons quatre grands écosystèmes qui forment la majorité de la forêt au Québec, et ce, en relativement peu de distance. De l'érablière à bouleau jaune jusqu'à la taïga, vous aurez l'occasion de constater les changements qui sont en train de se produire dans cette vaste région où la pression de l'homme se fait de plus en plus sentir et où les impacts des changements climatiques sont aussi des plus marqués. Nous visiterons des expérimentations à la Forêt Montmorency de l'Université Laval en lien avec les changements climatiques (dépérissement de l'épinette blanche, dispositif de recherche sur l'impact de la récolte de la biomasse), puis nous continuerons notre chemin pour atteindre le Parc des Grands Jardins où le Dr Serge Payette et son équipe de l'Université Laval y poursuivent des recherches sur des écosystèmes semblables à ceux que l'on retrouve 500 km plus au nord : habitat du caribou, perturbation par les feux, poches de froid. Et bien sûr leurs sols seront au rendez-vous : podzols typiques du Bouclier canadien et sols périglaciaires vous seront présentés. C'est la grande aventure dans la nature dans toute sa splendeur et sa beauté !

Soils and landscapes of the Boreal forest and Canadian Shield

Starting from the conference site, this second tour will provide a unique opportunity to see the landscape and soils typical of the Canadian Shield, the upper-Laurentians, and the Boreal Forest, the largest biome in Canada. Bordered by the tundra on the north and by prairies and mixed wood forests on the south, the Boreal Forest spreads on 35% of the Canadian territory and accounts for 77% of the Canadian forested area. Within a relatively short distance, we will cross four major ecosystems representing the majority of forested areas found in the province of Québec. From the sugar maple – yellow birch forest to the taiga, you will witness the main changes occurring in this vast region where human pressure is increasingly present and climate change is already obvious. We will visit research facilities at the Forêt Montmorency of Université Laval to assess the impact of climate change (spruce dieback, research trial on the impact of biomass harvesting on soils). We will then continue our tour up to the Parc des Grands Jardins, where Dr. Serge Payette and his team are conducting research on cold ecosystems that are more typically found 500 km further north: caribou habitat, disturbances due to fire, and frost hollows. Of course, typical profiles of soils developing under that particularly cold environment will be presented: podzols and periglacial soils. Come and see nature and soils in their utmost brightness!

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Résumés / *Abstracts*

Indiqué par ordre alphabétique /

Listed in alphabetical order

(par ordre alphabétique du nom de famille du premier auteur)

(in alphabetical order of the first author's last name)

COMPOSITIONAL ANALYSIS OF SOIL PHOSPHORUS POOLS

Dalel Abdi[1,2], Noura Ziadi[2], Léon-Étienne Parent[1]
[1]Department of Soils and Agri-Food Engineering, Pavillon Paul-Comtois, Université Laval, Québec, QC; [2]Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, 2560 Hochelaga Boulevard, Québec, QC

During cultivation, soils are perturbed by crop sequences, tillage practices and regular fertilizer application. As a result, the internal soil phosphorus (P) cycle is affected considerably and environmental damage may follow as shown by the eutrophication of surface waters. To monitor these changes, a proximate sequential P fractionation procedure was developed (Hedley method) to extract inorganic and organic P fractions as rapidly plant-available (resin-P, NaHCO3-P), slowly available (NaOH-P), and very slowly available (HCl-P) pools. However, models used to describe P pools changes do not address the interactive behaviour of P fractions constrained to a closed compositional space. Compositional data analysis using isometric log ratio (ilr) coordinates is appropriate for modelling the interactive P pools using sequential binary partitions along reactivity groups of P pools. Our objective was to model changes of P pools in soils, using cultivated Canadian Mollisols (chernozem) as example, in response to time using ilr coordinates. We used a dataset from the literature, where a cultivated soil was analyzed at time zero and after 4, 65, and 90 yr of cultivation. Seven P fractions were assigned to P reactivity groups to compute six ilr coordinates. Using composition at time zero as reference, the Aitchison distance reached a plateau after the 4th year in the Bm horizon compared to continuous change in the Ah horizon. Time changed the P balance of cultivated Mollisols primarily in the inorganic versus organic P pools. The risks of yield loss and environmental damage can be minimized using soil tests that quantify the rapidly bioavailable inorganic P pools and crop management strategies that promote biological P pools.

CONTINUOUS APPLICATION OF PAPERMILL AND LIMING MATERIALS: ANY RESIDUAL EFFECT ON THE LEVEL OF MICROBIAL BIOMASS C, N AND P?

Dalel Abdi[1,2], Noura Ziadi[2], Roger Lalande[2], Bernard Gagnon[2], Léon-Étienne Parent[1]
[1]Department of Soils and Agri-Food Engineering, Pavillon Paul-Comtois, Université Laval, Québec, QC; [2]Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, 2560 Hochelaga Boulevard, Québec, QC

Soil microorganisms play an important role in the cycling of elements by acting as a sink or a source of carbon, labile nitrogen and phosphorus. Microbial activities of soil receiving industrial wastes such as papermill biosolids (PB) can be positively affected, but little is known about PB effects on the microbial biomass carbon (MBC), nitrogen (MBN) and phosphorus (MBP). The objective of this study was to evaluate the residual effect of nine annual applications of PB and different liming materials on MBC, N and P level. Treatments consisted of four PB rates (0, 30, 60, and 90 Mg wet ha^{-1}), three liming by-products (calcitic lime, lime mud, and wood ash, each at 3 Mg wet ha^{-1} with 30 Mg wet PB ha^{-1}), and a mineral N fertilization (120 kg N ha^{-1} in grain corn and 20 kg N ha^{-1} in leguminous) surface applied annually at post-seeding to a loamy soil cropped to grain corn, dry bean and soybean. Three years after the end of the treatments application, soils were sampled from each plot after corn harvest, at the 0 to 15 cm and 15 to 30 cm depth in fall 2011. Results showed that MBC, N, and P contents were higher in the surface horizon (0-15 cm) than in subsurface (15-30 cm). The PB application rate increased significantly MBC and N in the top soil layer only. At the opposite, PB rate had no effect on MBP in the 0-15 cm but increased its level in the subsequent layer. Application of wood ash supplemented with PB largely increased MBP at both depths. Consequently, this study indicates that soil microorganisms immobilize C, N, and P in their biomasses with increasing rate of PB added, even after few years of material application ending. Hence, application of PB alone or combined with liming materials resulted in an improvement of soil biological attributes which can be sustained for years.

OPPORTUNITIES AND CHALLENGES WITH PROXIMAL SOIL SENSING

Viacheslav I. Adamchuk
Bioresource Engineering Department,
McGill University, QC

Proximal sensing of soils is a growing area of science and technology that uses sensing systems to obtain information either close to, or in direct contact with, the target. When deployed properly, proximal sensing systems provide high-density data on the physical, chemical and biological attributes of soil. These attributes help us to better understand the changes in soil conditions influencing crop growth. Accounting for this variability over space and time reduces the negative environmental impact and increases profitability. In recent years, proximal sensing technology has been used to increase efficiency in the use of fertilizers, water, and other production inputs as well as to assess the environment. The main problem is that most sensors respond to more than one agronomic property, which frequently complicates the decision-making process. Sensor fusion is an emerging concept that relies on combining data from alternative sources to increase the certainty of the information obtained. Although appealing, the concept is poorly understood and requires substantial development in both theory and applications. In this presentation, several scenarios for the most promising and cost-effective sensing will be discussed. Specifically, the framework for a new McGill integrated soil sensing strategy will be presented.

SOIL AGGREGATE SIZE DISTRIBUTION AFFECTED BY BIOCHAR AND BIOSOLIDS HAS NEGATIVE AND POSITIVE EFFECTS ON GERMINATION, RESILIENCE AND BIOLOGICAL COMMUNITIES

Sina Adl
Department of Soil Science College of Agriculture and Bioresources, University of Saskatchewan, SK

We used a series of indoor germination studies to explore interactions among aggregate size distribution, as affected by biochar, composted treated biodolids, and municipal solid waste compost. Biosolids and composts were obtained from Halifax waste processing plants, and the biochar was obtained from spruce combustion. Seeds for the study were “road-side mix” available commercially. Treatments included graduated ratios of mixtures of each of the amendments, paired amendments or single amendments. We measured days to germination, germination success rate, sensitivity to drying, root and shoot biomass, root morphology, and the soil biology at a functional group level. Our results indicate the amendments affect aggregate size distribution, and that mixtures producing larger aggregate sizes have negative effects on germination, roots, shoots, and the soil biological communities. The interactions between biochar and the organic amendments also affected germination depending on the treatment, either in a positive or negative way. The negative impacts on the plants were reflected in reduced biological diversity and abundance. These observations raise many questions about the appropriate application mixtures and rates for these amendments.

QUANTIFYING C & N NUTRIENT MINERALIZATION THROUGH SOIL FOOD WEB COMPARTMENTS USING STABLE ISOTOPE METHODS

Sina Adl, Felicity Crotty
Department of Soil Science College of Agriculture and Bioresources University of Saskatchewan

We used stable isotope tracer studies to improve on the resolution of results from radioactive tracer studies, and to improve on older data. The older data from 1970's are used regularly for modeling nutrient transfers through the soil food web into plants and the rest of the ecosystem. Our approach combined natural abundances of the 13C and 15N isotopes in soil organisms, with enriched intact soil columns, and laboratory microcosm experiments. We identified previously undescribed interactions in the food web. In particular we were able to identify the consumers of protozoa in the soil, which include many micro-invertebrates besides nematodes. The results from grazed pastures were compared to an adjacent forest site. The results indicate patterns in soil N and C utilization that are quantifiable. These patterns were quantified separately for labelled bacteria added to soil columns, followed by labelled protozoa cultures to distinguish parts of the pathways. This was followed by microcosm studies of protozoa nutrient uptake and respiration rates. We then focused on the fungivory pathway using labelled fungi in microcosm food webs. The results have accomplished several objectives: we have obtained a more complete description of soil food web pathways; we have improved the resolution of quantifiable nutrient transfer rates and respiration between soil compartments; we have identified new interaction between soil functional groups. These results also indicated errors in the older data used for modeling soil food webs which can be corrected. These improvements impact estimates of soil nutrient utilization and budgeting gas emissions from soil. This presentation includes results from 5 manuscripts and ongoing work.

REVÉGÉTALISATION DE RÉSIDUS AURIFÈRES / GOLD MINE RESIDUES AND PLANT GROWTH

Suzanne E. Allaire[1], Pierre Dutilleul[2], Liwen Han[2], Sébastien Lange[1], Steeve Pépin[1]
[1]Horticultural reserach Center, 2480 Hochelaga, Université Laval, Québec, QC; [2]Department of Plant Science, McGill University, Macdonald Campus, 21111 Lakeshore Road, Ste-Anne-de-Bellevue, QC

Les mines aurifères constituent environ 60% des sommes dépensées pour l'exploitation minière québécoise (Simard et coll., 2006). L'or québécois a fourni plus d'un milliard de dollars en 2009. Ce minerai contient une faible proportion d'or, plus de 99,9996% du minerai est rejeté (Aubertin et coll., 2002) ce qui génère environ 15 millions de tonnes de résidus annuellement (MRNF, 2004). Les résidus comportant moins de risque sont épandus et devraient être revégétalisés. Le succès de la revégétalisation est cependant tributaire de la survie des plantes exposées aux conditions difficiles du milieu et aux hivers rigoureux. La croissance des plantes dépend des propriétés physico-chimiques dans ces milieux poreux comme l'humidité, le drainage, la compaction, l'aération et la stabilité du milieu. Une petite expérience a été menée avec du fétuque rouge dans des résidus aurifères et du sable agricole. Les plants ont poussé dans des chambres à environnement contrôlé, et furent arrosés et fertilisés régulièrement. Puis ils ont été vernalisés et ont été soumis à des conditions hivernales (<0°C) durant neuf mois. Les propriétés des milieux poreux (résidus et sables) et des racines ont été mesurées avant, pendant et après congélation, entre autres à l'aide d'un CT scan aux rayons X i.e. par tomodensiométrie assistée par ordinateur. Des différences entre la croissance, la masse sèche des racines et les propriétés des milieux poreux seront discutées.

About 60% of all money spent for Quebec mining is associated with gold mining. More than 99.9996% of gold ore is rejected, generating more than 15 million tonnes of residues per year. Plant population should be established on the least toxic residues in order to improve environmental quality of these areas. Plant growth and survival depends upon climate and properties of the residues such as moisture, drainage, aeration and stability. An experiment was conducted with Festuca rubra sp on fine gold mine residues and on agricultural sand under controlled condition. Once plants were grown, they were placed under winter conditions during 6 months. Several physical properties of both porous media and X-ray computer tomography (CT scan) analyses were conducted before, during and after freezing. Differences between growth and porous media properties will be discussed.

CROP YIELD, MICROBIAL BIOMASS AND DEHYDROGENASE ACTIVITY IN A PRAIRIE SOIL AMENDED WITH BIOCHAR AND GLYCEROL

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Pyrolysis of organic materials and transesterification of vegetable oils are popular technologies that are employed to produce biogas and biodiesel, respectively. The thermal decomposition of organic materials in absence of oxygen (pyrolysis) generates biochar as a co-product whereas biodiesel production results in glycerol. Due to their high content of C, both co-products have a potential use as soil amendments. Therefore, the objective of this study was to investigate the direct and residual effects of a single application of biochar and glycerol over a 3-year period in a cultivated Brown Chernozem in southwestern Saskatchewan. Parameters evaluated included crop yield, soil microbial biomass and dehydrogenase activity. The experimental treatments included one rate (2000 kg C ha^{-1}) of biochar (BC) and glycerol (GL) applied alone or with urea-N, one rate (100 kg N ha^{-1}) of urea (UR) alone, along with an unamended treatment as a control. In the first growing season following addition of amendments, biochar addition alone had no significant effect on canola yield. Combination of biochar with urea at 50 kg N ha^{-1} significantly increased the crop yield over the control, providing a similar yield to urea when applied at 100 kg N ha^{-1}. Glycerol tended to cause a reduction in crop yield due to N immobilization. Amendments application did not have a significant impact on soil microbial biomass C content. Dehydrogenase activity in soil treated with glycerol was higher when compared to the control. No residual effects of the biochar or glycerol amendments on crop yield or measured soil microbial parameters were evident during the second or third year after application.

DEGRADATION OF VETERINARY ANTIMICROBIALS DURING COMPOSTING OF MANURE CONTAINING EXCRETED ANTIMICROBIALS VS. MANURE SPIKED WITH ANTIMICROBIALS

Inoka Amarakoon[1], Srinivas Sura[2], Dani Degenhardt[3], Francis Zvomuya[1], Tim McAllister[4], Francis Larney[4]
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Spiking of manure with veterinary antimicrobials (VAs) is common in studying the fate of these additives in the environment even though the spiked VAs may not accurately reflect the behavior of VAs that have been administered directly to an animal. This study compared the dissipation of chlortetracycline (CTC), sulfamethazine (SMZ) and tylosin (TYL) during composting of manure that had been spiked with VAs vs. manure that contained excreted VAs. Manure where steers had been fed (kg^{-1}): (i) 44 mg chlortetracycline, (ii) a mixture containing 44 mg each of chlortetracycline and sulfamethazine, (iii) 11 mg tylosin, and (iv) no antimicrobials (control) was collected. Antimicrobial-free manure was spiked with VAs targeting the concentration of excreted VAs in manure. Manure was sampled for 30 days in fixed intervals. Temperatures >55°C were reached during composting. Temperature did not vary ($\alpha = 0.05$) between excreted and spiked and also among control vs. antimicrobial containing manure. According to preliminary results, antimicrobial concentration in manure decreased exponentially. Dissipation of chlortetracycline from excreted CTC and CTC mixed with SMZ and spiked CTC followed first order kinetics. Percent dissipation of antimicrobial during composting was greater ($\alpha = 0.05$) for excreted CTC than for spiked CTC mixed with SMZ. In contrast, percent dissipation was greater for spiked SMZ than for excreted SMZ. This study reveals that the spiked CTC and SMZ may not dissipate in the same way as when these antimicrobials are excreted after administration to an animal. These findings suggest that future studies on the environmental fate of antimicrobial should be performed with excreted antimicrobials.

INVESTIGATING PHOSPHORUS RELEASE FROM MANITOBA SOILS UNDER FLOODED CONDITIONS: PRELIMINARY OBSERVATIONS

Geethani Amarawansha[1], Darshani Kumaragamage[2], Don Flaten[1], Mario Tenuta[1], Wole Akinremi[1] and Francis Zvomuya[1]

[1]Department of Soil Science, University of Manitoba, MB; [2]Environmental Studies Program, University of Winnipeg, MB

Phosphorus (P) release from soils under flooded conditions differs widely depending on soil properties. Most soils often show an enhanced release of P due to anoxic conditions caused by flooding, increasing the environmental risk of P transfer to adjacent water bodies, whereas some soils show a lower release of P when flooded. Information on release patterns of soil P under temporarily waterlogged conditions in flood-prone Manitoba soils is required to properly design and operate drainage systems suitable for different soil types, including restored wetlands. This would in turn help minimize P loadings to surface and ground waters. Therefore, we conducted this study to examine the behavior of P release from different soils in Manitoba under water-logged conditions. Twelve representative surface soils were collected from across Manitoba covering a wide range of soil test P concentrations with no history of recent applications of manure or P fertilizer. Nutrient treatments included solid dairy cattle manure applied at 100 kg P ha^{-1} of soil and unamended soil. Soils were placed in incubation jars to a depth of 8 cm and gradually flooded with RO water to a depth of 5 cm above the soil surface to simulate flooding and develop anoxic conditions. Rhizon-flex soil solution samplers were placed in the soil at a depth of 5-cm for soil pore water sampling. Ponded surface water and soil pore water were sampled once a week for eight weeks and analyzed for dissolved reactive P (DRP). Concentrations of DRP in soil pore water increased in all soils with flooding. In two of the twelve soils, DRP concentrations in ponded water were stable over the entire flooding period. However, in ten of the twelve soils, concentrations of DRP in ponded surface waters increased by 2-14 fold after 21 days of flooding compared to 1 day after flooding. Between 28 and 56 days after flooding, DRP concentrations in both surface and pore-water appeared to be stable in most soils with few exceptions. However, the variation of pore and surface water DRP concentrations was highly variable among soils indicating the need to further investigate factors governing such variations of DRP released to surface and pore-water when flooded.

RARE EARTH ELEMENTS AS MEASURES OF PEDOGENESIS

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The Rare Earth Elements (REEs) are the 14 naturally occurring elements of the lanthanide series, from lanthanum (La, atomic number 57) to lutetium (Lu, 71). Despite their total content in sediments and soils of only 120 to perhaps 200 µg g^{-1} and none occurring as a specific mineral, they are well-studied by geochemists, and possible tracers of pedogenetic processes. REE composition was determined by inductively coupled plasma/ mass spectrometry (ICP-MS). A calcareous glacial till from Saskatchewan has a consistent total REE concentration of 137 µg g^{-1}, with those of even atomic number in higher concentration than their odd-numbered neighbors. Losses are based on using zirconium, present in the resistant mineral zircon as an index, and calculating enrichment factors. Weathering losses during pedogenesis are surprisingly consistent among all REEs. Losses from the Ae horizons of Gray Luvisol and Luvic Gleysol soils are 30 to 40%, somewhat less in the argillic (Bt and Btg) horizons, with gains in Cca horizons. Concretions from a Luvic Gleysol soil were enriched in iron, manganese, phosphorus and REEs. The Ah and Cca horizons of a Rego Black soil had gained both REEs and pedogenic carbonate. Patterns of change with weathering suggest the occurrence of REEs mainly in apatite in the parent material, and as pedogenic carbonates in Cca horizons. The REE content of a quartz-rich sandy aeolian material is about 40 µg g^{-1}, with inconsistent indications of pedogenesis both in a modern soil and a paleosol. Markedly higher REEs just below a charcoal enriched Ah in the paleosol indicate a different material, perhaps volcanic ash. Our work indicates the value of REEs in pedogenetic studies, both as measures of weathering and indicators of parent material origin.

STABILITY OF SOIL AGGREGATES IN BRAZILIAN INCEPTISOLS UNDER INTENSIVELY-MANAGED COFFEE PRODUCTION

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Intensive land preparation frequently causes a reduction in aggregate stability, leaving the soils more susceptible to erosion. The management system under study involves early spring (November) planting the coffee crop into furrows 0.60 m deep, which have previously received high applications of gypsum (equivalent to 28 t ha-1) and necessary initial fertilization, on terraced land. Subsequently, the inter-rows are planted with Brachiaria spp. and a rigorous foliar analysis monitoring program is used to determine ongoing nutrient requirements. The study area is located on a farm (Agricultural Piumhi-2) belonging to the Piumhi Agricultural Company, in the city of Vargem Bonita, Brazil. The objective of this study was to evaluate the stability of aggregates in a Cambissolo Háplico distrófico Tb típico (Inceptisol) under this intense coffee production system. Bulk soil samples were collected from the depths of 0.03, 0.05, 0.20, 0.40 and 0.80 m, along the coffee rows. The samples were air dried and passed on sieves of 7 mm and 4 mm; aggregates retained on the smallest sieve were selected for subsequent laboratory analysis. Twenty-five g of this material was pre-moistened for 12 hours, then placed into a nest of sieves (2.00, 1.00, 0.50, 0.25, and 0.105 mm diameter opening) and agitated in a vertical oscillation apparatus for 15 minutes. The material retained on each sieve was transferred to aluminum containers with the aid of water jets and then dried at 105-110 ° C for 24 hours. The data was subjected to analysis of variance and the mean values were compared by the Scott Knott test at 5% probability. The decrease in indices of aggregate stability, with depth, was significant for the mean weight diameter (MWD) and geometric mean diameter (GMD). The predominance of aggregates larger than 2 mm (macroaggregates), independent of depth, suggests that these management practices favored the formation of water-stable aggregates.

MONITORING OF URBAN ATMOSPHERIC PESTICIDE DEPOSITION IN WINNIPEG, MANITOBA

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Bulk atmospheric deposition, consisting of both rainfall and particulate matter, is an example of a non-point source by which pesticides can enter surface waters. A variety of pesticides are applied in the City of Winnipeg for which the occasional use of malathion to control adult mosquito populations is most often debated by its citizens. The objective of this study was to monitor deposition levels of seventy-two pesticides at two locations in southern Winnipeg. Bulk deposition samples were collected weekly during the periods of May to September 2010 and 2011. Rainfall volume and intensity were also recorded. Twenty-four individual pesticides or their metabolites were detected during the two years; twenty were herbicides, three were insecticides and one was a fungicide. The top five pesticides detected were similar for both sites and both years, with glyphosate and 2,4-D in all four site-years. MCPP and MCPA were found in three out of four site-year combinations and malathion and AMPA in two. 2,4-D had the highest rate of detection in 2010 with 94% of samples having detectable levels. 2,4-D, glyphosate and MCPP had the highest rates of detection in 2011 (100%). Malathion was detected in 42% of the samples during 2010 and only occurred from late June to August, the majority of which followed application of malathion by the City of Winnipeg. In 2011, malathion was not applied by the city, which was reflected in the frequency of detection (9%). Atrazine, a chemical with generally very low usage in Manitoba, was detected in 44% of the samples with the majority of detections occurring from May to July, possibly reflecting spring applications of the herbicide in the United States. No legacy pesticides (α-HHC, γ-BHC) were detected in any of the samples. In addition to being detected in weeks with rainfall, certain pesticides such as glyphosate and 2,4-D were detected during a week without rainfall, demonstrating that deposition of particulate matter is a contributor to overall atmospheric deposition of those pesticides.

A COMPARATIVE STUDY OF IN-FIELD AND LABORATORY MINERALIZATION RATES OF 2,4-D AND 17B-ESTRADIOL

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Understanding the rate of mineralization of pesticides and natural steroid estrogens in soil is crucial to the estimation of the persistence and transport of these chemicals in the landscape. Mineralization studies are usually performed in a laboratory using incubators to control temperature. However, very limited information exists to how representative these laboratory studies are in relation to in-field mineralization. The overall aim of this research is to quantify the mineralization of 2,4-D (a pesticide) and 17β-estradiol (a natural steroid estrogen) in 10 Manitoba soil series under both laboratory-controlled and field conditions. The soils ranged in texture from sandy loam to heavy clay. Preliminary results from two field seasons and one laboratory study will be presented here, along with the newly designed in-field microcosm technique. For the study, the two chemicals (carbon-14 radiolabelled 2,4-D and 17β-estradiol) were added to the ten soils in microcosms (5 replicates) and all microcosms were installed using a randomized block design in the Ap-horizon of a field. Temperature sensors installed both in soil profiles in the field and in the field-installed microcosms were used to observe the effect of temperature on mineralization rates. In the laboratory, the soils incubated at a constant temperature as well as at fluctuating temperatures (simulating the conditions observed in the field). All soils were kept at a constant water content (80% field capacity). Mineralization from each soil-chemical-temperature combination were measured on an approximately weekly basis for 100 days. Data were used to calculate first-order chemical mineralization rate constants and to obtain the total amount of the chemical mineralized at 100 days. Soils were ranked from the highest to lowest rates of mineralization, and from the highest to lowest amounts of total mineralization and the rankings of the soils under various research method designs were compared. Rates and amounts of mineralization will be correlated to selected soil properties. The results of this research will be used to determine which research method is most effective to estimate mineralization under field conditions, while considering the practicality of each method.

PREDICTIVE DIGITAL SOIL MAPPING AS A TOOL FOR ONTARIO SOIL MAP RENEWAL: LESSONS LEARNED WITH DIFFERENT DIGITAL ELEVATION MODELS

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Soil classification mapping of southern Ontario's agricultural regions took over eight decades to develop. This work was published as county-level soil survey map products. Their map scales (1 inch to 2 miles to 1:20,000) differ between counties. Some time after the Ontario government's adoption of Geographic Information System (GIS) technology, these soil maps were digitized. This process resulted in map unit polygons that are both distorted and displaced from their original “soil concept” landscape positions. This occurs to varying degrees across the different map regions and the province as a whole. This map product accuracy issue was made apparent only after the development of province's first digital elevation model (DEM). It has a 10m X 10m resolution with a relatively coarse vertical elevation accuracy on the order of 2.5m. Display and examination of the “legacy” digital soil map polygons on newer, higher-resolution DEM's, like those crafted from Light Detection and Ranging (LiDAR) data clouds and through other means, further accentuates these soil polygon accuracy issues. The DEM is the foundation for predictive digital soil mapping (PDSM). Several DEM options have been evaluated for use in renewing Ontario's digital soil maps. PDSM attempts, with the first provincial DEM product, lacked the precision necessary to delineate the “meso-scale” soil landscape features essential for meaningful soil map unit boundary delineation in subtle relief regions. Assessments were made with both LiDAR and survey contour-derived DEM products with sub-metre vertical elevation accuracies. They were developed at 5m X 5m resolution and have superior “meso-scale” topographic feature delineation. They permit high-quality digital soil map renewal. A corresponding, high-resolution hydrologic network must be enforced to condition the high-resolution DEM's. These DEM's must provide accurate stream channel delineation - even in heavily-vegetated areas. Without this level of stream network detail, PDSM work, based on land surface morphologies, is limited to open agricultural field areas. This is critically important to our PDSM approach which delineates digital “mapping masks” for soil landscape feature areas, that are bounded seamlessly by the channel network in the DEM.

WHAT ARE THE ENVIRONMENTAL DETERMINANTS OF BASE CATION WEATHERING RATES IN PODZOLS OF THE CANADIAN SHIELD?

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Environmental factors such as climatic conditions, soil chemical properties and their mineralogical composition are known to affect the rate at which base cations (BC) are released from soil minerals through weathering reactions. Consequently, assessing the impact of a given individual factor on the weathering rates of BC under field conditions is a challenge. The objectives of this study were: 1) to estimate the long-term weathering rates of BC for 21 forested watersheds using the soil profile mass balance method and; 2) to develop models linking the main environmental determinants of mineral weathering to long-term release rates of BC. The watersheds are located in southern Quebec and present a range of hydroclimatic conditions, soil properties (pH, organic carbon and mineralogy) and forest cover. Average long-term estimates of annual BC weathering rates were 0.20, 0.11, 0.12 and 0.08 kmolc ha^{-1} an^{-1} for Ca, Mg, Na and K, respectively. These values were well within the range of rates (0.008 to 0.62 kmolc ha^{-1} an^{-1}) reported for similar environments. Using analysis by Akaike's Information Criterion with small sample correction (AICc), principle component analysis (PCA), partial correlation analysis and a forward selection procedure, we developed plausible models which accounted for up to 60 (Ca), 67 (Mg), 31 (Na) and 57% (K) of the variance of weathering rates for the 21 catchments . Differences and similarities between the models as well as the significance of variables will be discussed.

ASSESSING THE KINETICS OF SOIL TEST P DEPLETION USING SEQUENTIAL EXTRACTIONS

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Soil P depletion in the absence of P fertilizers often requires several years of cultivation before no further reduction is observed. This highlights the large P buffering capacity of the soil in maintaining equilibrium between non labile and labile P forms. We described the kinetics of P depletion of three unfertilized soils with varying physico-chemical characteristics: 1) a clay loam soil [L'Acadie, corn-soybean rotation since 1992], 2) a coarse sandy loam soil [Lévis, timothy grassland since 1998], and 3) a silty clay soil [Normandin, barley monoculture since 1997]. Soil samples were collected in 2001 (L'Acadie), 2006 (Lévis), and 2010 (Normandin) and they were submitted to 16 sequential extractions, one per day, using a Mehlich-3 (M3) solution. The cumulative amounts of P extracted after 16 sequential extractions were 252, 212, and 424 mg kg^{-1} Mehlich-3 P (PM3) for the soils from L'Acadie, Lévis, and Normandin, respectively. For the same three soils, the amount of extracted PM3 from the first to the last extraction decreased respectively from 30.1 to 9.8, 27.2 to 7.6, and 45.6 to 15.1 mg kg^{-1}. The extraction-dependent kinetics of PM3 depletion was described by a logarithmic model for the soils at L'Acadie [$Y = -8.7 \ln(x) + 32.3$; $R2 = 0.97$; $P < 0.001$], Lévis [$Y = -7.6 \ln(x) + 27.7$; $R2 = 0.98$; $P < 0.001$], and Normandin [($Y = -11.2 \ln(x) + 47.8$; $R2 = 0.85$; $P < 0.001$]. The depletion rate, described by slope, was greater for the soil from Normandin, followed by those from L'Acadie and Lévis. Although different amounts of P were extracted from the three soils, the equilibrium phase for soils from L'Acadie and Lévis was reached at PM3 values between 10 and 8 mg kg^{-1}. In contrast, for the soil from Normandin the trend of PM3 shows that additional extractions will be needed before reaching the equilibrium phase. We conclude that, for these three soils the kinetics of soil P depletion follows a logarithmic function, but the depletion rate depends on the initial soil P, with greater depletion rate for soils with high initial P.

VALIDATING THE WIND EROSION RISK INDICATOR MODEL USING CS-137: PRELIMINARY STUDY

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Agri-environmental indicators are utilized to provide a glimpse into the overall environmental performance of the agriculture sector. Agriculture and Agri-Food Canada (AAFC) utilizes the Wind Erosion Risk Indicator model (WindERI), in combination with risk indicators for water and tillage erosion, to determine soil erosion risk on cultivated soils in the Prairie Provinces. The WindERI utilizes soil and landform data from the Soil Landscapes of Canada map series, land management data, and long term climate records. These data are then applied to the Wind Erosion Equation which employs climatic parameters, soil texture and landform factors, and vegetative cover to calculate the potential wind erosion risk of an area. Using the radionuclide 137Cs as a tracer, rates of total soil erosion can be estimated, allowing the WindERI to be validated. Three fields and two reference sites, located in southern Alberta, were sampled in the summer of 2011 and subsequently examined. This semi-arid area is classified as high risk for wind erosion based on AAFC's current WindERI calculations. Surface samples (0-5 cm) and sectioned core samples (up to depths of 60 cm) were collected parallel to the prevailing wind direction. Sub-samples were air-dried, manually disaggregated and analyzed for 137Cs activities using High-Purity Germanium gamma spectrometers. Preliminary analysis indicates that full core inventory values for 137Cs from one field site, the grassed corners of this field site and a nearby reference site are not significantly different. The 137Cs profiles within the cores from this field site, its grassed corners and the reference site do not show evidence of appreciable sedimentation. The 137Cs activity levels of surface samples collected show no evidence of appreciable sedimentation either. Further study will calculate total erosion rates from 137Cs inventories. Estimated total erosion rates will be compared against model-estimated wind and tillage erosion rates for validation of the WindERI. This study will, for the first time, provide solid validation for the WindERI and provide policy makers with a reinforced scientific tool to evaluate existing programs and policies, and to anticipate the impacts of changes to them. Thus, allowing Canada's agricultural sector to better achieve economic, environmental and social sustainability.

TENEUR EN CARBONE DU PANIC ÉRIGÉ ET DU SOL AMENDÉ AVEC DU BIOCHAR ET UNE FERTILISATION MICROBIENNE

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Le panic érigé (Panicum Virgatum), comme biomasse énergétique, pourrait être amendé avec du biochar, des bactéries fixatrices d'N ou solubilisant le P comme solution potentielle pour réduire les émissions équivalentes en CO_2. Du biochar a été appliqué au taux de 10 t MS ha^{-1} sur un loam sableux à la ferme expérimentale de l'Université Laval. Différents traitements d'amendements ont été comparés avec un plan expérimental en tiroir: soit des taux de fertilisation minérale telle que recommandée et une demi-dose, du biochar à 10 t ms ha^{-1} et une fertilisation microbiologique avec des bactéries qui favorisent soit la fixation de l'azote atmosphérique ou la solubilisation du phosphore. Le biochar forme les parcelles principales et les autres les sous-parcelles. Les teneurs en C de la biomasse aérienne, racinaire et du sol ont été mesurées dans ces parcelles ainsi que les propriétés physico-chimiques du sol. L'impact des traitements sur les teneurs en C ont été comparées après deux années de croissance. La communication discutera des effets des traitements sur le

potentiel de séquestration du panic érigé amendé avec du biochar et des bactéries.

Reducing greenhouse gas emissions by decreasing N input and producing biomass energy is an appealing option for climate change mitigation. Switchgrass (Panicum virgatum) was planted on a sandy loam at Laval University research station near Quebec City. The plots were treated with 10 t of dry matter ha^{-1} of biochar, N-fixing and P-solubilizing bacteria in a split-plot experimental design. Biochar was the main plot, the other treatments the sub-plots. Biomass C, root C and soil C contents from all treatments were compared after two growing seasons. Soil properties were also measured. The presentation will discuss the impact of different treatments on C contents and potential C sequestration by comparing the different treatments.

FARM LEVEL ECONOMIC ANALYSIS OF NUTRIENT MANAGEMENT BMPS IN THE PIPESTONE CREEK WATERSHED

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Nutrient management on annual cropland is a beneficial management practice (BMP) designed to reduce soil and water pollution caused by the excessive application of fertilizer by producers to maximize crop yields. Designed as environmental conservation tools the economic feasibility of producer adoption of agricultural BMPs must also be investigated. The purpose of this paper is to identify the private costs and benefits associated with nutrient management practices in the Pipestone Creek Watershed of south-eastern Saskatchewan. A representative farm simulation model was developed to estimate the on-farm impacts of competing nutrient management techniques. A crop farm and a mixed farm, beef cattle and crops, are both used in the analysis. Monte Carlo simulation is used to incorporate the risks of agricultural production into a farm net cash flow (NCF), from which a net present value (NPV) is generated. The NPV is used to compare the economic costs and benefits of nutrient management BMPs at the farm level. The base scenario of a consistent yearly rate of fertilizer application is compared to the BMP of a one-third reduction in the yearly fertilizer application rate, and to the BMP where yearly fertilizer application rate is a function of target yield and nutrient carryover from the previous year. Understanding the private costs and benefits of BMP adoption has broader applications as a tool in the public valuation of conservation technologies, and in the development and analysis of policy for land use change and environmental improvement.

RESPONSE OF THE COMPOST SPRINGTAIL (FOLSOMIA CANDIDA (WILLEM)) TO COOLING TEMPERATURES: BEHAVIOURAL AVOIDANCE OR ACCLIMATION?

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Collembola are an important component of the soil meso-fauna that is believed to contribute significantly to C and N cycling. Cold temperatures of winter and shoulder seasons could limit their locomotor activity thereby affecting their diet choices and influencing their role in C cycling. Information on the impact of cold temperatures on the activity of Collembola in arable soils is sparse and frequently circumstantial. The strategies available to Collembola in preparation for survival to cold temperatures are (1) behavioural escape migration to deeper soil layers and (2) acclimation through physiological changes. The relative contribution of the two strategies was investigated by determining the thermo-preference range, the chill coma temperature threshold and the vertical distribution in soil microcosms of warm- and cold-acclimated individuals of the widely distributed Folsomia candida (Willem).

QUANTIFYING CLIMATIC INFLUENCE ON SOIL BIOLOGICAL ACTIVITY FOR CANADIAN ECODISTRICTS USING THE INTRODUCTORY CARBON BALANCE MODEL CONCEPT

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Climatic data are of particular importance because they control important processes related to the modeling of agroecosystems, e.g., they are used in dynamic soil organic carbon models to calculate temperature and moisture effects on soil biological activity. We are using the Introductory Carbon Balance Model (ICBM) concept to estimate soil biological activity, i.e., the ICBM re variable. This is done using standard meteorological data (mean daily temperature, total precipitation and potential evapotranspiration), a soil water model, and commonly used assumptions with respect to the relationships between temperature, soil water content and biological activity. This allows us to examine regional differences in the potential for soil organic carbon (SOC) sequestration as a balance between annual carbon inputs to soil and soil biological activity. The concept is being adapted for Canadian soil and climatic conditions, and some validation has been done with data from Canadian long-term field experiments. We are now using a daily climatic database developed by scientists at ECORC for Canadian Ecodistricts: re was calculated for 23 Ecodistricts with agricultural activity in the Province of Quebec for the time period 1975 to 2002. The potential usefulness of including the soil biological activity factor as a variable (among other indices) in our meta-climate file is discussed. It would be used therein to describe both inter- and intra-annual variation of the effects of climate on soil organic matter (C and N) dynamics among Ecodistricts.

UTILIZATION OF HANDHELD OPTICAL DIAGNOSTIC TOOLS IN POTATO CROP TO ASSESS N STATUS

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Nitrogen management is an important ecological and economical challenge in the potato production. Despite soil variability, the standard fertilization recommendation is commonly applied resulting in side by side over and under supply (Babcock & Pautsch 1998). Adjusting fertilizer rates to the plant nitrogen status could optimize its utilization (Zebarth & Rosen 2007). Crop requirement should be evaluated locally to reduce the risk of nitrate leaching and optimize its uptake by the plant. Nitrogen concentration in tissues provides an adequate assessment of total N status (Lemaire 1997) but is time consuming. Real-time nitrogen status can be measured using optical diagnostic tools. This study aims to evaluate the sensitivity of the chlorophyll meter measurements and the leaf area index to different N sources and rates. A fertilization trial was established at Ste-Catherine-de-la-Jacques-Cartier on a sandy loam (Morin and Pont-rouge series) in a commercial potato field (Solanum tuberosum L. cultivar Russet Burbank). The experimental design was a factorial combination of three N sources and four N rates plus a control (no N applied), repeated four times. The three sources of fertilizer were ammonium sulfate, ammonium nitrate and controlled-release fertilizer and the N rates were 60, 120, 200, and 280 kg N ha^{-1}. Chlorophyll concentration was measured using a SPAD-502 (Konica Minolta Sensing, Osaka, Japan). Leaf area index was measured using LAI-2200 (LI-COR, Lincoln, NE). Measurements were taken weekly from flower bud stage to the beginning of senescence. Preliminary statistical analysis revealed significant differences among N rates at flower bud stage for SPAD while the only difference observed with leaf area index was between control and fertilized treatments. The SPAD-502 was more affordable, easier to use, and more sensitive to N additions at early stage of growth. Therefore the SPAD-502 proved to be a better diagnostic tool to assess the N status of potatoes compared to the plant canopy analyzer.

ÉVALUATION DU STOCK DE CARBONE ORGANIQUE DANS LES ILIÇAIES DU MOYEN ET HAUT MAROCAINS

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La présente étude a été réalisée dans la chênaie verte du Moyen et Haut Atlas marocain, avec pour objectif la détermination du stock de carbone organique dans les différentes composantes (sols, litière et biomasse) des écosystèmes étudiés. Les meilleurs corrélations ont été obtenues avec des régressions allométriques de type : Y(carbomasse) = aXb (X = C1,30) pour les différentes composantes épigée des iliçaies du Moyen et Haut Atlas. Les carbomasses totales de la partie épigée des peuplements d'iliçaies varient de 17 tC.ha^{-1} (Aït Aamar) à 40 tC.ha^{-1} (Ifghane) dans le Haut Atlas et de 55 tC.ha^{-1} (D. Hachlaf) à 91 tC.ha^{-1} (Ksiba) dans le Moyen Atlas. Ainsi, Il en ressort de cette étude que le stock de carbone du sol (SCOS) varie de 24,6 tC.ha^{-1} pour Aït Aamar à 141,4 tC.ha^{-1} pour Ajdir. Plus de 80 % du SCOS est emmagasiné dans les 30 premiers centimètres. L'approche corrélative montre que les SCOS sont fortement dépendants de la profondeur pour les différents sites d'études. Les SCOS diminuent avec la profondeur en suivant une courbe exponentielle à exposant négatif pour toutes les parcelles (Moyen et Haut Atlas). Le stock de carbone organique dans la litière au sol (SCL) varie de 1,4 tC.ha^{-1} pour Asloul à 14,3 tC.ha^{-1} pour Ajdir. Pour les différentes composantes étudiées, les écosystèmes du Moyen Atlas séquestrent plus de carbone. Les SCOS et SCBR représente plus de 50 % du SCOT. Le SCOS, SCL et SCB varient considérablement avec la surface terrière du peuplement. Le stock de carbone organique total dans les écosystèmes étudiés varie entre 53 tC.ha^{-1} pour Aït Aamar à 343 tC.ha^{-1} pour Ajdir.

FIVE-YEAR RESPONSE TO ASH FERTILIZATION IN A JACK PINE STAND: SOIL PROPERTIES AND STEM GROWTH

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Thousands of tons of ash from forest biomass combustion are being produced each year in Quebec. About half of the ash is recycled as fertilizer by the farming industry while most of the rest is buried in landfills. As environmental regulations for landfills are becoming more stringent, other means for ash disposal need to be developed. European trials showed that ash application can compensate for the base cations lost by forest harvesting. The potential of ash application for improving forest soil fertility under conditions prevailing in the Quebec Boreal Shield needs to be investigated. In 2005, a field trial was set up in a commercially thinned jack pine stand. The experiment was designed as completely random with four replications of five ash treatments (0, 1, 2, 4 and 8 dry tons ha^{-1}) with and without N fertilization (280 kg N ha^{-1}) for a total of 40 experimental units (EU). Prior to treatment application, all stems greater than 5.0 cm of diameter at breast height (dbh) were identified to species, tagged and measured (dbh) in three permanent circular sampling plots (200 m2) per EU. Stems were remeasured five years later. In each sampling plot, forest floor and 0 - 10 cm mineral soil were sampled and analyzed for pH, exchangeable base cations and acidity. Soil sampling took place one, two and five years following treatments. One year following treatments, soils were also analyzed for net potential N availability. Forest floor and mineral soil exchangeable Ca, Mg and K increased with ash application, resulting in increased soil pH and CEC and decreased exchangeable acidity. Significant differences were still observed five years after treatment with base saturation being twice as high in the 8-ton treatment compared with the control at both soil depths. Nitrogen fertilization had no significant effect on soil base status five years following fertilization. However, both ash and N fertilization increased forest floor net N mineralization in the year following application. Jack pine relative diameter growth increased following N fertilization while black spruce relative diameter growth decreased with ash application. The possibility that ash induces nutrient imbalances needs to be considered.

LAND SUITABILITY RATING SYSTEM - RECENT DEVELOPMENTS AND ACTIVITIES

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The national Land Suitaibility Rating System (LSRS), when initially released in 1995, was a systematic, consistent methodology that assessed climate, soils, and landscape attributes for growing spring-seeded small grains. Recently this methodology has been expanded to derive suitability ratings for corn, canola, soybean, alfalfa and brome grass. Some of the required modifications to the original methodology will be outlined. The LSRS methodology lends itself to be transformed into a series of algorithms within a Web Processing Service environment. An interactive, web based calculator now exists where LSRS crop specific ratings may be derived from climate, soil and landscape data for an individual polygon or in batch mode. The url for this initial version of the web application is: http://lsrs.landresources.ca/ With climate being a critical component of the LSRS methodology, this rating system may be used to assess the impact of climate change scenarios within Canada. The impact of different climate change models have been assessed in terms of the distribution of LSRS ratings within the agricultural region of Canada. The specific areas of interest are vulnerable landscapes due to limited precipitation or the potential expansion of the agricultural activities into those landscapes where frost-free period has been a limitation. In conjunction with present day and future assessments, a current project is attempting to link yield estimates to LSRS classes in order to predict the potential agricultural productivity in Canada for 2050.

PREDICTING SOIL DEVELOPMENT IN BRITISH COLUMBIA USING RANDOM FOREST

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Soil development reflects the role of the soil forming factors in mediating the processes that transform parent materials into soil. The specific role of topography, climate, parent material and vegetation in determining soil development can be evaluated and incorporated into predictions covering large areas by developing models based on training datasets from legacy soil surveys and other information. We developed or obtained gridded datasets for a variety of topographic indices, bedrock geology, climate derivatives, and vegetation characteristics , and then used the Random Forest procedure to generate a predictive function that was applied to the entire province of BC using a 9ha (300mx300m) grid. The resulting predictions were tested using individual point samples collected from field surveys for soil and ecosystem classification. These results will be valuable for landscape level evaluation of soil attributes as they affect resource management.

CHARACTERIZING SOIL PHOSPHORUS IN CANADIAN AGRICULTURAL SOILS WITH 31P-NMR SPECTROSCOPY

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In soils and other environmental samples, phosphorus (P) may be found in a range of inorganic and organic forms. Inorganic P forms include orthophosphate, which is readily available to plants, and complex inorganic P forms such as pyrophosphate and polyphosphate. Organic P forms can be divided into groups such as orthophosphate monoesters (e.g. sugar phosphates, phytic acid) and orthophosphate diesters (e.g. phospholipids, DNA) and phosphonates. These P forms or P compound classes vary in their bioavailability and in their chemical reactivity in the environment. As such, identifying P forms is important to enhance crop growth, with and without fertilization, and to minimize P loss to water, where it can cause harmful algal blooms. The best tool for characterizing P forms is solution 31P nuclear magnetic resonance (NMR) spectroscopy. In this talk, I will discuss how solution works and present results of studies using 31P-NMR to characterize P forms in a range of Canadian agricultural soils and samples, including manure.

NUTRIENT LOSS FROM SASKATCHEWAN CROPLAND AND PASTURE IN SPRING SNOW MELT RUNOFF

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In order to develop the most appropriate beneficial management practices (BMP) for a watershed, it is essential to quantify the nutrients lost from agricultural fields and to identify the primary mechanisms for this nutrient loss. It is also essential to understand nutrient loss from various agricultural practices, because annual cropping systems are expected to lose nutrients in different forms and by different mechanisms than animal production systems. In the Canadian prairies, the majority of nutrient loss from agricultural lands occurs as surface runoff during spring snowmelt events, while the ground is still frozen. As part of the Canadian-wide Watershed Evaluation of Beneficial Management Practices (WEBs) project, nutrient loss from cropland and pastures in southeastern Saskatchewan during a spring snowmelt event was measured. For both agricultural practices, the majority of nutrient loss was in dissolved form, rather than as particulates, and there were no significant differences in total particulate loss from cropland versus pasture. Significantly more nitrogen (N) was lost from pastures as dissolved ammonium and particulates than from cropland, while significantly more dissolved organic N was lost from croplands (note: nutrient concentrations were flow-weighted daily means, in mg L^{-1}). There were no differences in dissolved nitrate. Although there were no significant differences in total phosphorus (P) loss, there were significantly higher concentrations of dissolved reactive P in runoff from cropland, and significantly higher particulate P in runoff from pastures. Total carbon (C) in runoff was higher from cropland, due mainly to significantly higher dissolved organic C concentrations. There were no significant differences in dissolved calcium or magnesium, but runoff from cropland contained significantly higher concentrations of dissolved potassium and sulfur, reflecting the fertilization of cropland fields with these nutrients. Dissolved sodium was also significantly higher from the cropland, reflecting the sodic soils in portions of this field. These results clearly demonstrate that nutrients are lost from these agricultural practices by different mechanisms (e.g. in dissolved versus particulate forms), requiring the development of different types of BMPs to best control these nutrient losses.

PRECISION FARMING: LESSONS LEARNED FROM N MANAGEMENT

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Crop yields are highly influenced by the spatial variability of soil properties such as soil texture, drainage and organic matter content. Variable rate application (VRA) of fertilizers by management zone (MZ) or on a continuous basis can be helpful to managing this soil variability. Experiments were conducted in eastern Canada under rain-fed corn and potato production to evaluate different variable rate N application strategies using a precision farming approach. The results of two experiments dealing with the site specific nitrogen management will be summarized in this presentation: VRA of N using MZ delineated with soil electrical conductivity on a 13 ha commercial potato field or using MZ delineated with soil surface texture on a 15 ha commercial corn field, both located in Richelieu county, close to Montreal, Canada. Under potato production, the two MZ delineated with soil EC were significantly different in terms of yield potential and susceptibility to nitrate leaching. In some cases, crop response to N application strategy differed between MZ. Under corn production, the three MZ were significantly different in terms of grain yield, corn N uptake and N fertilizer response. Although, responses to VRA may be specific to the soil and climatic conditions, they suggest that MZ based on soil surface texture or soil electrical conductivity can be used in site-specific N management in corn and potato production by taking into account part of the spatial variability of soil N availability. In order to ensure the success of VRA approaches, part of the temporal variability of soil N must also be taken into account using dynamic models of soil N availability and N demand of crops according to soil texture zones.

EVALUATION OF STRUCTURAL CHANGES IN BRAZILIAN LATOSOL (OXISOL) UNDER INTENSIVELY-TILLED COFFEE, USING X-RAY COMPUTED TOMOGRAPHY

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Significant changes in soil structure usually occur during soil preparation, thus tillage systems that promote the preservation of soil structure are becoming popular. In recent years, a new system of soil management has been adopted by several coffee farmers in Brazil. This system is characterized by the application of high rates of gypsum (7 kg m-1), planting in November and the early establishment of Brachiaria sp. as a cover-crop. Coffee planting is done in 0.6 m deep furrows. The aim of this study was to evaluate, using X-ray computed tomography, structural changes associated with this management system, in Latosol (Oxisol) of clayey texture and gibbsitic mineralogy. This work was conducted on a coffee plantation in the municipality of São Roque de Minas, Minas Gerais, Brazil, belonging to the Piumhí Agricultural Company. Intact soil cores were collected, in triplicate, using acrylic tubes 14 cm high x 6.25 cm diameter, along the coffee rows, from three depths: 0.20, 0.80 and 1.50 m. The central 3.5 cm layer of each sample was scanned using an EVS MS8-130microCT Scanner (at 120 kV 170 mA), generating axial 2D imagery of 20 µm pixel size. Three-dimensional subvolume imagery (40 x 40 x 33 mm), with 60 µm voxel size, was modeled by filtered back-projection. Semi-variance analysis was conducted, on the three orthogonal image directions (X, Y, Z), using an algorithm in NIH ImageJ. Multiple regression analysis was used to fit an exponential model to the semi-variograms, and calculate 95% prediction intervals. The range of spatial dependence for samples from the 0.20 m depth was 49.59µm in the X (horizontal), 50.40 in the Y (horizontal) and 58.59 in the Z (vertical) directions. At 0.80 m depth, the corresponding ranges were 43.41, 43.95 and 43.86 µm, and a1.50 m depth, they were 50.76, 50.64 and 55.38 µm. Greater variability was observed in all three orientations for the 0.20 m depth, but only in the Y direction for the 1.50 m depth; this is attributed to the uniformity of soil disturbance in the surface layer and the variability natural structure of the soil at depth.

AMÉLIORATION DE L'IRRIGATION DANS LA PRODUCTION DE CANNEBERGES : IRRIGATION DE DÉFICIT

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L'utilisation rationnelle de l'eau est une préoccupation croissante pour des raisons économiques et environnementales. La production de canneberges nécessite des quantités importantes d'eau d'irrigation, à la fois lors de la récolte mais également en cours de production. La plupart des producteurs basent leur décision d'irrigation sur des minuteries, des mesures de potentiel matriciel ou de teneur en eau ou sur une évaluation empirique. Les travaux antérieurs ont permis de définir une plage de valeurs cibles de potentiel matriciel pour optimiser l'utilisation de l'eau en canneberge. Cependant, il semblerait que des gains plus importants de productivité et d'utilisation d'eau pourraient être obtenus en créant un léger stress hydrique chez la canneberge sans risque de perte de rendements. Des essais faits au Wisconsin en 2011 ont comparé une régie sèche à une régie humide pour la gestion de l'irrigation de la canneberge. Ces essais ont démontré que par rapport à une régie humide (-4 à -6 kPa), des réductions substantielles (70%) de l'utilisation de l'eau peuvent être obtenues avec une régie plus sèche (-4 à -7.5 kPa), en créant une baisse significative de l'activité photosynthétique sans compromettre l'atteinte de rendement maximum et malgré l'existence de phénomènes d'hystérèse importants en sol grossier.

ÉMISSIONS DE N_2O ET DE NH_3 APRÈS APPORT DE LISIER DE PORC: INFLUENCE DU MODE D'APPLICATION ET D'UN INHIBITEUR DE NITRIFICATION

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En semis direct, l'application des lisiers à la surface du sol entraîne une forte volatilisation de l'ammoniac (NH_3). Leur incorporation au sol permet de réduire cette perte azotée mais est incompatible avec l'absence de travail du sol et accroit souvent les émissions d'oxyde nitreux (N_2O). La stratégie évaluée dans cette étude pour réduire les émissions de N_2O et de NH_3 sous semis direct est 1) d'incorporer le lisier de porc en bandes et 2) d'utiliser un inhibiteur de nitrification. L'expérience a été réalisée entre août 2011 et avril 2012 à l'Université Fédérale de Santa Maria, Brésil, sous un climat subtropical. Les lisiers ont été appliqués avant le semis d'avoine (40,3 m^{-3} ha^{-1} ou 101 kg N-NH_4+ ha^{-1}) et avant le semis du maïs (46,0 m^{-3} ha^{-1} ou 112 kg N-NH_4+ ha^{-1}). Deux modes d'application (surface et bande), avec et sans inhibiteur de nitrification (Agrotain Plus; 8,1 kg de dicianodiamide (DCD) ha^{-1}) ont été évalués. Les émissions ont été mesurées à l'aide des chambres et les concentrations ont été déterminées par chromatographie en phase gazeuse (N_2O) et par le piégeage dans l'acide phosphorique (NH3). L'application du lisier a augmenté les émissions de N2O, et les plus hautes émissions cumulées ont été observées dans le traitement avec le lisier sans DCD incorporé en bandes (0,90 kg N-N_2O ha^{-1} dans l'avoine et 4,45 kg N-N_2O ha^{-1} dans le maïs). Ces émissions ont été supérieures à celles où l'application du lisier était faite à la surface et sans DCD (117%, avoine; 458%, maïs). En combinant les deux cultures, l'application du DCD a réduit l'émission de N_2O de 76% pour l'application du lisier en bande incorporée et de 34% pour l'application en surface. Pour le NH_3, l'application du lisier en bandes a réduit la volatilisation de 49% dans le maïs et de 32% dans l'avoine, par rapport à une application à la surface, alors que le DCD n'a eu aucun effet. Ces résultats indiquent que l'incorporation en bandes du lisier réduit les émissions de NH_3 mais augmente celles de N_2O par rapport à l'application en surface. Néanmoins, quand cette stratégie est combinée à l'ajout de DCD, les émissions de N_2O sont proches de celles obtenues avec l'application du lisier en surface et sans DCD. Ainsi, l'incorporation en bandes du lisier combiné à l'ajout de DCD représente une option intéressante pour augmenter la disponibilité de l'azote des lisiers pour les cultures sous semis direct, sans toutefois augmenter les émissions de gaz dans l'atmosphère.

DISSOLUTION DES PHOSPHATES PAR DES CHAMPIGNONS ET DES LEVURES EN TANDEM AVEC LES CHAMPIGNONS MYCORHIZIENS ARBUSCULAIRES

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Le phosphore (P) est un élément majeur limitant la croissance végétale. Les réserves de phosphate de roche sont en voie d'épuisement. D'autre part, une proportion importante des engrais phosphatés solubles réagissent avec les cations et s'accumulent dans les sols sous forme de phosphates non disponibles aux plantes. Il a été démontré que les microorganismes telluriques dissolvant les phosphates (MDP) sont plus efficaces lorsqu'en synergie avec les mycorhizes. L'objectif général de ce projet est de développer un inoculum qui utilisera en tandem des champignons et des levures MDP avec les mycorhizes dans le but d'améliorer le rendement et la nutrition phosphatée du blé, en mettant en valeur les réserves du sol en P inorganique et organique, tout en diminuant l'intrant engrais chimique ou en améliorant l'efficacité du phosphate de roche appliqué directement en agriculture biologique. Les MDP ont été isolés à partir de sol prélevés des cinq érablières situées à proximité immédiate de champs agricoles dans les régions de St-Hilaire et St-Jean-sur-Richelieu au sud et de Mirabel au nord de Montréal. Le milieu NBRIP modifié (Nautiyal, 1999) contenant 5 g/l d'hydroxapatite (HA) comme seule source de P et additionné de 50 µg/ml de chloramphénicol et de 100 µg/ml de streptomycine (pour inhiber les bactéries) a été utilisé pour isoler les champignons et levures, Un total de 270 isolats fongiques ont été obtenu. Afin de caractériser la capacité de solubilisation du P, les isolats ont été cultivés en milieu NBRIP-HA liquide. Les isolats sont en cours d'identification par séquençage du gène de l'ARN-r 18S, et l'utilisation du phosphore organique par ces isolats sera aussi caractérisée. Nos travaux à venir analyseront l'interaction entre le mycélium des champignons mycorhiziens à arbuscules et les MDP sélectionnés, à l'aide d'un dispositif de culture in vitro à deux compartiments, ainsi que leur capacité à stimuler la croissance du blé

SIGNIFICANCE OF N LOSSES THROUGH GASEOUS EMISSIONS AND LEACHING IN THE NON-GROWING SEASON IN SNOW-COVERED AGRICULTURAL SOILS

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It is now accepted that biological activity still goes on in soils during the non-growing season (NGS) under northern climate, especially in snow-covered environments. We monitored N_2O emissions (static chambers) and N leaching losses (zero-tension plates; 35 cm depth) on a yearly basis for two consecutive years on sandy loam and silty clay soils cropped to wheat and corn, with and without manure application. Results indicate that N leaching occurs mainly in the fall, following ploughing, and during snow melt in the spring. As a result, up to 70% of total annual N leaching loss occurred in the NGS for both soil types. On average, total water and N leaching losses were higher with the silty clay than the sandy loam, possibly because of preferential flow through cracks (swelling) in the silty clay. The N_2O emissions were also stimulated during winter, especially during gradual freezing of top soil in late fall – early winter, and during spring thaw. As a result, 20 to 67% of total annual N_2O-N loss was measured in the NGS. Interestingly, while N_2O emissions were generally higher in the silty clay than in the sandy loam throughout the year, the proportion of emissions in the NGS was about twice as high in the sandy loam, suggesting that the NGS period may be critical to consider in calculating annual N_2O-N emission from sandy soils. The NGS N_2O-N emissions were increased 2- to 3-fold by fall application of pig slurry, with N_2O emission coefficients up to 3% in the sandy soil. These results are evidence that a major part of annual N losses from agricultural soils occurs in the NGS in snow-covered environments.

MANURE STORAGE STRATEGIES ALTERED NUTRIENT AVAILABILITY AND GREENHOUSE GAS EMISSIONS FOLLOWING APPLICATION TO SOILS

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Livestock manure is viewed as a good source of nutrients for agricultural crops. However, strategies used to store livestock manure may influence nutrient availability and greenhouse gas emissions once applied to the soil. Microcosm studies were carried out to assess fertilizer value and N_2O and CO_2 emissions from liquid dairy cattle manure stored (i) in the absence (totally emptied tank scenario) or in the presence of old manure (partially emptied tank scenario); (ii) in the absence or presence of beddings (wood chips, cereal straw, peat moss); (iii) with or without anaerobic digestion. All manure types were applied to clayey and sandy soils and either cropped to wheat (*Triticum aestivum* L.), in a pot experiment, or incubated in closed microcosms to measure N_2O and CO_2 emissions. Manure stored alone (totally emptied tank scenario) emitted more CO_2 and N_2O and was associated with lower crop N uptake and dry matter yield than manure stored in the presence of old manure. Adding beddings slightly increased N_2O emissions (cereal straw) and had little influence on CO_2 emission and crop growth. Anaerobic digestion of manure reduced CO_2 and N_2O emissions upon application to soils, and was associated with the highest crop performance. The large concentrations of volatile fatty acids (VFAs) in the manure stored in totally emptied tanks (with and without beddings) could explain higher GHG emissions and lower crop productivity. Because VFAs decompose readily in soils, they may boost soil respiration (CO_2 emission) and N_2O emission through denitrification in the hours following application, while inducing net soil N immobilization in the following days, thereby reducing N availability to plants. Storage in the presence of old manure, or carrying out anaerobic digestion eliminated most VFAs, partly through methanogenesis, resulting in more stable carbon forms (lower CO_2 emission), thereby lowering N_2O emissions and soil N immobilization at time of application, and enhancing manure N availability.

STOICHIOMETRY OF C:N RATIO IN EARTHWORM MUSCULAR TISSUE IS CONSTANT AND INDEPENDENT OF FOOD QUALITY

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Ecological stoichiometry theory makes predictions about the balance of energy and elements within organisms and how this affects their ecology. The degree to which organisms maintain a constant chemical composition, particularly when consuming organic substrates that vary in their chemical composition and availability, is referred to as "stoichiometric homeostasis". The “Redfield ratio” confirms stoichiometric homeostasis in marine organic matter – is this also occurring in the world’s soils? We start to address this question through examination of earthworms, which consume organic substrates with a wide range of C:N ratios ; however, it is unclear whether the earthworm muscular tissue adjusts its C:N ratio to match that of its food sources. The objectives of this study were to (1) quantify the C:N ratio of earthworm muscular tissue, considering earthworms of different functional groups and ages, and (2) to determine whether the C:N ratio of food consumed by earthworms would change the C:N ratio in their muscular tissue. Juveniles and adults of the endogeic Aporrectodea tuberculata and the anecic Lumbricus terrestris were fed individually with peat moss (C:N = 80), a soybean mixture (C:N = 9), or no food (control). After 7 days of contact with food sources, earthworms survival was determined, they were euthanized, and their muscular tissue was collected for total C and total N analysis. The C:N ratio in A. tuberculata juveniles and adults was 4.24 ± 0.27 and 3.67 ± 0.27, and that of L. terrestris juveniles and adults was 3.70 ± 0.44 and 3.94 ± 0.33. The C:N ratio in muscular tissue differed between the earthworm species x age classes (A. tuberculata juveniles > L. terrestris adult > A. tuberculata adult = L. terrestris juvenile). However, the C:N ratio of food sources had no effect on the C:N ratio of earthworm muscular tissue. We conclude that earthworms maintain a low C:N ratio in their muscular tissue regardless of the substrate consumed, which is consistent with the principles of stoichiometric homeostasis. Further research should focus on the underlying mechanisms of how earthworms are able to maintain their low C:N ratio.

IN SITU MEASUREMENT OF SNOWMELT INFILTRATION UNDER VARIOUS SNOW DEPTHS AND TOPSOIL CAP THICKNESSES ON A RECLAIMED SITE

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Partitioning snowmelt to runoff and infiltration during spring snow ablation is requisite for water resources management and environmental risks assessment in cold semi-arid regions. Soil freezing and thawing processes, snowmelt runoff and infiltration into seasonally frozen soils are generally documented for natural, agricultural or forested systems but barely studied in severely disturbed systems such as reclaimed lands. We are investigating the effects of the freeze-thaw cycles on snowmelt infiltration on phosphogypsum tailing piles capped with varying thicknesses of topsoil (0.15, 0.3, and 0.46m) under various boundary conditions (i.e., snow accumulation depths). Time domain reflectometry (TDR) probes, temperature sensors, and matric potential sensors were installed at various depths for continuous, simultaneous, and automated measurement of apparent permittivity (ε), soil temperature, and matric potential, respectively. An on-site weather station was used to record routine weather data. This paper will focus on estimating temporal and spatial changes of soil ice (ϑ_i) and liquid water (ϑ_l) content - using ε-ϑ_i/ ϑ_l relationships derived from composite dielectric mixing models – as affected by varying snowpack depth and topsoil cap thickness.

BACTERIAL GEOGRAPHY IN THE RHIZOSPHERE – PH GRADIENT AND RHIZODEPOSITION SHAPE BACTERIAL NICHES

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It has been shown that soil pH regulates the spatial distribution of bacteria at field to continental scales, soil carbon content being far less important (Fierer, 2006, *PNAS*, 103: 626). At the rhizosphere scale (sub-centimetre), the geography of bacteria has never been documented and organic rhizodeposition is considered, despite no direct evidences, to shape the distribution of bacterial communities in this microenvironement. Soil pH displays high spatial variability in the rhizosphere (Blossfeld, 2007, *Plant, Cell Env.*, 30: 176), yet possible links between pH and bacterial geography at the rhizosphere scale remain largely unexplored. The aim of this study was 1) to document the spatial distribution of bacterial communities in the rhizosphere and 2) to relate the microgeography of bacteria to rhizospheric soil pH. Maritime pine (*Pinus pinaster*) seedlings were cultivated in thin mini-rhizoboxes with and without ectomycorrhizal inoculation (*Rhizopogon roseolus*). After two months, subcentimetre scale measurements of the following parameters were performed on 18 cm2 zones to produce maps for presence of roots and ectomycorrhiza; for soil pH; for total bacteria, fungi and six taxonomic groups of bacteria contrasted with respect to ecological behavior (acidobacteria, α-proteobacteria, actinobacteria, bacteroidetes, β- proteobacteria, firmicutes). Soil pH (from 4.0 to 7.3) and microbial data (variation coefficient up to 113%) varied considerably in the mapped zones. The spatial variability was systematically higher in rhizosphere soil exposed to ectomycorrhizal roots. The patterns of bacterial phyla were mostly linked to the activity of ectomycorrhizal fungi. For example, the absolute abundance of total bacteria and of r-strategy bacteria (bacteroidetes, β-proteobacteria and firmicutes) were mainly related to ectomycorrhiza-induced pH changes. In contrast, the relative abundance of all bacterial phyla and the absolute abundance of k-strategy bacteria (acidobacteria, α-proteobacteria and actinobacteria) were apparently associated to other products of ectomycorrhizal activity, such as rhizodeposits. Our study is the first to document bacterial geography at the rhizosphere scale. It challenges the idea that only rhizodeposition is involved in structuring microbial communities in the rhizosphere, and suggests that soil pH also contributes to bacterial patterns, notably to the abundance of total and r strategy bacteria.

APPLICATION OF USED COOKING OIL TO MINIMIZE NITROGEN LOSSES AFTER BROCCOLI HARVEST: USING 15N TO CHARACTERIZE THE FATE OF CROP RESIDUE DERIVED NITROGEN OVER THE POST-HARVEST SEASON

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Cole crops, compared to many other crops, can pose a high risk of N losses after harvest due to substantial quantities of N in crop residues. Nitrogen can rapidly mineralize from above-ground cole crop residues, however little is known about the quantity of N in cole crop roots and rhizosphere soil. Previous field and laboratory studies have found a reduced potential for N losses, via N immobilization, by applying used cooking oil to soil with broccoli crop residue. However, the quantity of broccoli residue derived N must be separated from indigenous soil N or fertilizer to accurately assess reduction of N losses. Thus, a 15N tracer study was conducted in 2011-2012 to label broccoli plants from both early and late crop production, with the objectives to (1) quantify the N partitioning of fertilizer into broccoli plant parts, rhizosphere soil, and soil at harvest, and to (2) quantify amount of broccoli residue derived N immobilized via application of used cooking oil throughout the fall after broccoli harvest. In spring 2011, 5% atom excess enriched 15N urea fertilizer was applied in microplots prior to broccoli planting, and typical broccoli production was followed throughout the summer. At harvest broccoli plants parts, (head, stem, leaves, roots) rhizosphere soil, and soil samples (0-30, 30-60 cm depth) were collected and analyzed for N and 15N. After harvest, above-ground 15N broccoli residue was exchanged for non-labelled above-ground residue. Treatments included a control (no used cooking oil) and an amendment (used cooking oil) to both 15N labelled above-ground and below-ground crop residue. Soil was sampled throughout the 2011 fall and analyzed for N and 15N. Whole broccoli plants contained an average of 43 g N m^{-2} and recovered 54% of 15N fertilizer. The crop residue biomass contained an average of 31 g N m^{-2}, with 40% of the 15N recovered by plants returned to soil as crop residue. Preliminary results for 15N in plant parts, total soil N, mineral N, microbial biomass N for 2011 broccoli harvest and post-harvest season will be presented. Future research will follow the crop residue N into subsequent growing season with spring wheat production.

INFLUENCE ON MANURE TYPE AND TIMING OF APPLICATION ON CROP NITROGEN UTILIZATION

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Current protocols within the nutrient management legislation in Ontario indicate that spring applied manure results in greater manure nitrogen uptake, and reduced loss compared to than fall or late summer application. Previous research however, suggests that this may not be the case for manures with low ammonium content, like solid beef manure. A study was conducted using 3 types of manure (liquid hog, solid poultry and solid beef) applied to achieve 4 nitrogen rates at 3 application timings (late summer, late fall, and spring) and at 3 field sites of differing soil hydraulic properties. Subsequent corn yield and nitrogen uptake were used as measures of manure nitrogen availability. Unlike liquid hog and solid poultry, yield response and nitrogen uptake was greater from the late summer and fall applications of solid beef manure than spring applied. These results indicate that the relatively slow rate of net nitrogen mineralization from the beef manure, requires application well in advance of the growing crop to optimize crop nitrogen availability.

APPLICATION OF TWO PROBABILISTIC DATA-DRIVEN METHODS FOR DIGITAL SOIL MAPPING IN TROUT CREEK WATERSHED, BRITISH COLUMBIA, CANADA

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In this study two data-driven methods of weights of evidence and logistic regression were applied for digital soil mapping. Each of these methods is able to create a posterior probability map indicating the probability of having a certain soil for each pixel within the study area. In addition uncertainty of such prediction is also estimated as another map. In data-driven methods relationships between the target variable (soil classes) and predictor (covariate) variables are quantified by the method, based on the data and then applied in the prediction. Similar to other data-driven methods both of these methods need a reliable training dataset indicating where each target soil is observed at least at some locations. In addition to the training dataset, these methods need detailed enough predictor maps.

BIOCHAR MADE FROM PINEWOOD CHIPS MODIFIES DENITRIFICAION PROCESS IN A SANDY LOAM SOIL IN LABORATORY

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There is considerable interest in applying biochar to agricultural soils, but limited information on the mechanisms if biochar action under filed conditions. Biochar application modifies soil chemical and physical properties which affect soil biological function; Denitrification is one such function that is sensitive to biochar application as biochar-amended soils often have lower nitrous oxide (N_2O) emissions under field conditions. Since the mechanisms are not known, the aim of our study was to determine the influence of pinewood chip biochar on denitrification in a sandy loam soil under controlled conditions. The experimental unit was a flask containing 20 g of soil mixed with biochar, with the following treatments: 4 biochar rates (0, 0.2, 0.4 and 0.6 g), 2 nitrogen fertilizer rates (0 and 100 mg NO_3-N) and 2 acetylene levels (0 and 10% headspace), arranged as a full factorial with 5 replicates. Soil moisture content was adjusted to 84% water-filled pore space, headspace was flushed with argon and acetylene added (10% treatment only) and flasks were incubated at 25oC for 24 hours. Headspace gases were sampled from each flask at 0, 2, 4 and 6 hours after the incubation ended and the N_2O concentration was measured with a gas chromatograph. There was a significant reduction in N_2O emission with increasing rate of biochar in the unfertilized treatments. The N_2O emission is reducted by 30.2%; 73.7%; 93.2% with biochar treatment of 0.2g; 0.4g; 0.6g, respectively, at the end of the experiment. The result shows the efficiency of pinewood chip biochar in reducing N_2O emission in sandy loam soil. This also suggests biochar contribute to N_2O reduction by modifying denitrification.

PREDICTION OF SOIL N SUPPLY IN THE FIELD USING A SIMPLE KINETIC MODEL

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A first study evaluated different strategies for use of a simple first-order kinetic model (Nmin = $N_0[1- e^{-kt}]$ where N_0 is potentially mineralizable nitrogen and k is the mineralization rate constant) to predict growing season soil nitrogen supply (SNS) in potato (*Solanum tuberosum* L.) fields under cool humid climatic conditions. All strategies considered spring soil mineral nitrogen (SMN) and the labile mineralizable N pool (Pool I) for 0-15 cm depth, and correction of the value of k was evaluated based on temperature (T) only, or based on both T and water content (θ). Predicted SNS was compared with a field-based estimate of plant available soil nitrogen supply (PASNS) measured as plant (vine plus tuber) N uptake plus residual nitrate at harvest in unfertilized plots. Correction of k based on T only generally over-estimated soil N supply even in this region with humid soil moisture regimes. The most promising strategies used correction of k values for both T and θ and either had the depth increased to 0-20 cm or considered N_0 to be replenished during the growing season. As a result a second study was performed to examine the depth distribution and seasonal variation of SMN and mineralizable N pools (Pool I, N_0). While the labile Pool I was somewhat depleted during the growing season, the N_0 did not change significantly over time suggesting that this N pool is actively replenished during the growing season. This is in contrast with previous studies which assume N_0 to be depleted over time. In addition, the depth distribution of the mineralizable N pools appeared to be controlled by depth of tillage and was constant over 0-20 cm depth. Overall this study demonstrated that SNS can be adequately predicted using a simple kinetic model and identifies the need to better understand the size and the behavior of the soil mineralizable N pools in order to better predict the growing season N mineralization.

CHANGES IN SOIL AVAILABLE N AND WATER WITH INCREASED SOIL TEMPERATURE AND ATMOSPHERIC N INPUTS IN A BALSAM FIR FOREST

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Most recent simulations of the future climate from the Canadian Regional Climate (CRC) Model for the eastern boreal forest of Canada suggest an average increase in annual temperature of 3°C and in precipitation of 5 to 20% by 2050. A growing number of studies show that the response of plants to climate in such biomes could be strongly influenced by the availability of inorganic nitrogen. The main objective of this study was to determine the effect of increased soil temperature (+4°C) and increased inorganic N concentration in precipitation (3x natural levels) on some key soil parameters (water content, N flux and respiration) affecting balsam fir growth within a mature forest stand in Québec (Canada). The addition of artificial precipitation was carried out by means of water nozzles set up above the tree canopy. Soil warming was done using buried heating cables. Tree diameter growth was monitored with electronic dendrometers, soil N availability with buried exchange membranes and soil water content with TDR probes. Heterotrophic soil respiration was determined on soils sampled after three years of treatment and incubated in the laboratory at 5, 10, 15 and 20°C for 72 days. Tree stomatal conductance and photosynthetic capacity were also measured using leaf $\delta^{13}C$. In 2010 and 2011, soil heating increased available N by 36.7% in the forest floor, while higher N concentration in precipitation had no significant effect. Based on soil incubations, a 4°C increase in soil temperature was determined to correspond to a 62% increase in soil heterotrophic respiration. Soil water content fluctuated more in heated soils during the growing season while leaf $\delta^{13}C$ in trees growing on heated soils was higher (+0.30‰) suggesting a higher susceptibility to water stress. A 30 to 50% increase in radial growth was measured in the first year for trees growing on heated soil, but no difference was detected in subsequent years. Overall, the results show that increased soil temperature could have a positive effect on soil fertlity in mature balsam fir forests by increasing both C and N mineralization rates, while tree growth could be tempered by soil water availability.

UPGRADING STANDARDS AND PROCEDURES FOR THE DESIGN OF AGRICULTURAL LAND DEVELOPMENT PROJECTS

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A great number of land development projects are underway in Quebec as part of agroenvironmental initiatives targeting water quality. However, the criteria and methods currently used in the agricultural sector to predict peak watershed discharge date back to the 1980s and have not been upgraded since. Anticipated increases in summer rainfall intensities and winter mild spells due to climate change call for the updating of the design criteria for hydro-agricultural land development to ensure that they serve tomorrow's water regimes. The goal of this project is to produce a user-friendly tool to support the design of land development projects at field and small watershed scales in rural settings. This tool will take into account the recent evolution in rainfall intensity, duration, and frequency (IDF), as well as winter mild spells, resulting from climate change. This project will provide results and tools to help end-users in the planning of hydroagricultural land development. These will include: A user-friendly software tool for the estimation of hydrological design criteria, such as peak discharge and runoff volumes; Web publication of indices for current mild spells and rainfall intensity-duration-frequency (IDF) curves for current precipitations and projections of these under future climatic conditions; A hydro-pedological data set for the agricultural land in Quebec; Training sessions offered to the project's targeted end-users.

PRENDRE EN COMPTE DE LA VARIABILITÉ SPATIALE DES PROPRIÉTÉS DES SOLS DANS LA RÉGIE DES CHAMPS : LE PROJET ReZoTaGe

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Le projet ReZoTaGe a pour objectif le développement et la validation opérationnelle d'une approche de gestion intégrée et localisée des champs supportée par la télédétection, de façon à soutenir la compétitivité du secteur des grandes cultures, à assurer la productivité des sols à long terme et à prévenir la contamination diffuse des eaux de surface. Notre intention est ainsi d'outiller les conseillers et producteurs agricoles dans la prise en compte de la variabilité spatiale des propriétés des sols dans la régie des champs. L'approche proposée de reconnaissance des propriétés du sol s'inspire de la méthode proposée par Sylvain et coll. (2010) en combinant, au moyen de modèles statistiques, le pouvoir explicatif des données d'élévation et de l'imagerie satellitaire multispectrale. Suivant une classification des images et des entités topographiques, l'attribution des propriétés du parcellaire (texture, égouttement et taux de matière organique) s'appuie sur une procédure de calage mettant à profit les banques de données pédologiques géoroférencées disponibles pour les comtés de Richelieu, Napierville, Laprairie, Iberville et Rouville. La méthode de représentation spatiale des propriétés du sol sera validée dans trois régions agricoles québécoises par l'entremise d'un protocole expérimental au champ (échantillonnages spatiaux par zones de gestion). À terme, sur la base de zones de gestion bien établies, démontrant des propriétés contrastées des sols, le producteur pourra ainsi assurer de façon optimale la correction de l'acidité du sol, la fertilisation azotée, la richesse du sol en P et K, l'aménagement du drainage ou l'amélioration du profil cultural (propriétés physiques du sol). Au niveau environnemental, l'application des principes de la gestion intégrée et localisée est porteuse de bénéfices importants, notamment au niveau de la réduction de l'exportation diffuse des nutriments vers le réseau de surface. De concert avec les producteurs, le cadre du projet permet d'identifier les critères décisionnels et d'évaluer les coûts et les bénéfices associés à la mise en œuvre de l'approche de gestion intégrée et localisée du parcellaire, appuyée par la télédétection. Lors de cette présentation, les traitements des données, les résultats préliminaires de

prédiction et de cartographie des propriétés des sols et le protocole terrain de validation seront présentés.

CONTRASTING CULTIVATION PRACTICES EFFECT ON SOIL BACTERIA POPULATION DIVERSITY IN A MULTI-YEAR EXPERIENCE

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Cultivation practices have a direct impact on soil quality and sustainable agricultural processes performed on farms. Producers need to consider different options for their enterprise in order to optimized yield from their field. International economy, market dynamic and price fluctuation of fertilizers and pesticides directly affect farm incomes and long-term modification of soil protection practices. Soil cultivation technics could contribute to sustainability of the production in relation to a more integrated approach to the control of weeds and rotation management. A long-term trial was established in La Pocatière, Québec in 1987. Until spring 2011, every plot of the experimental site was subjected to only one of the three tillage techniques (plough, chisel, direct), but received different input treatments (inorganic fertilizers, transgenic, no herbicide application, organic) and all parcels were sowed by the same plant on a specific year. A multidisciplinary approach allowed testing the effect of the three ploughing technics on the yield of the different culture in rotation, presence and type of weeds -including seeds amount, earthworms diversity and amount, ground beetle (Carabidae) amount and diversity, rhizobium and mycorrhiza diversity. 2011 was the last year of this multi-year project and one half of each plot was plough in spring in order to observe residual effect of the different treatments on the different factors. Glyphosate resistant corn was sow (LibertyLink) throughout the site and N fertilization was reduced to maximize expression of residual effects. Sampling was performed for the different measured factors, including soil (0-15 cm) for bacteria diversity from the 48 experimental plots. PCR amplification was performed (primers 357F-520R) followed by DGGE (8% acrylamide gels, 20-80 formamide concentration) diversity study. A computation of the diversity is currently under way as well as a clones library, sequencing and analysis with blast algorithm. Comparisons between treatments are performed in relation with treatments and basic soil parameters (pH, organic matters).

LONG-TERM EFFECTS OF FERTILIZATION AND CROP ROTATION ON NITROUS OXIDE EMISSIONS FROM SOILS

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A field study was established in 1959 on a Brookston clay loam soil in SW Ontario to evaluate the effects of fertilization and crop rotation on crop yields, soil and environmental quality. There were two fertilizer treatments (fertilized and not-fertilized) and six cropping treatments which have been maintained for 51 years. The crop rotation treatments included continuous corn, continuous Kentucky bluegrass sod and a 4-yr rotation of corn-oat-alfalfa-alfalfa with each phase present each year. We measured N_2O emissions, inorganic N and plant N uptake over 3 growing seasons (2007-2009) in the corn phase (i.e. fertilized and not fertilized continuous corn and rotation corn). Nitrous oxide emissions varied over the 3 years as a result of the seasonal variation in precipitation quantity, intensity and timing in addition to the differences in crop growth and N uptake. The fertilized continuous corn lost, on average, 7.00 kg N/ha from N_2O emissions whereas the unfertilized continuous corn lost only 0.36 kg N/ha. When corn followed plow-down of alfalfa, the fertilized rotation corn lost 5.49 kg N/ha which was 22 % lower than fertilized continuous corn. The not-fertilized rotation corn, on the other hand, emitted about half as much N_2O (2.50 kg N/ha) as the fertilized rotation corn. The dramatic differences in N_2O emissions between fertilized and unfertilized treatments were somewhat reduced when yield specific N_2O emissions were determined. The fertilized rotation corn treatment had corn grain yields that averaged 9.85 t/ha over the 3 years followed by fertilized continuous corn at 5.51 t/ha. The unfertilized rotation corn treatment had yields that were 60 % lower (3.96 t ha-1) than fertilized rotation corn, whereas the unfertilized continuous corn had yields that were 74% lower (1.44 t/ha) than fertilized continuous corn treatment and 85% lower that fertilized

rotation corn. This study demonstrated that N_2O emissions could be dramatically affected by long-term management practices and that crop rotation treatments had lower emissions in the corn phase of the rotation even though the N input was greater due to fertilizer addition and legume N fixation. These N_2O emission and yield results were due to the differences in N uptake and soil quality between the treatments.

NITROGEN AVAILABILITY AFFECTS TREE GROWTH ON RECLAIMED LANDSCAPES IN THE ATHABASCA OIL SANDS REGION IN ALBERTA, CANADA

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Peat-mineral mix over tailings sand or overburden commonly used for oil sands reclamation often has unfavorable properties such as salinity, soil compaction and low nutrient and water availabilities. The objective of this study was to identify limiting factors for tree growth in reclaimed sites in the Athabasca oil sands region, Alberta. Six lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.) sites on peat-mineral mix over tailings sand and six white spruce (*Picea glauca* (Moench) Voss) sites on peat-mineral mix over overburden were selected in the Suncor lease in Fort McMurray to form a gradient of site productivity; visual symptoms of nutrient deficiencies were observed in some of those reclaimed sites. There was no significant difference of pH among the pine or spruce sites. The pine sites with the lowest productivity had greater soil strength in the main rooting zone than the intermediate and best performing sites. Foliar nitrogen (N) concentration was higher in best performing spruce sites than in the poor and intermediate sites, consistent with the trends of total and inorganic N availability in the peat-mineral mix among the productivity gradient. Foliar $\delta^{15}N$ values ranged from -9.9 to -5.0‰, and were positively correlated with foliar N and total and inorganic N concentrations in the peat-mineral mix in spruce sites but not in pine sites. In conclusion, nitrogen availability was identified as one of the factors affecting white spruce growth in the studied reclaimed sites, while lodgepole pine trees may be limited by other factors, such as soil compaction, salinity and phosphorous availability.

SOIL CARBON CYCLING BY COLLEMBOLA: POSSIBLE IMPACT OF DIET SWITCHING AND LOW SEASONAL TEMPERATURES

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Collembola make up a large subset of the decomposer community in the soil ecosystem. They are believed to influence carbon cycling either by directly feeding on microbial community or by comminuting the larger plant residues. However, one species was recently shown to have the ability to switch to a plant root diet and act as herbivore. The feeding behavior of Collembola is also influenced by temperature. To determine if the diet switch to herbivory applies to other springtail species and could impact the role of Collembola in soil carbon cycling, the feeding behavior of Folsomia candida Willem at low temperature is being investigated by employing stable isotope technique. Early results suggest that the switch to herbivory is also possible for F. candida but no firm conclusion is possible until more tests have been completed. Tests on the impact of low temperatures have been initiated.

CHARACTERIZING ORGANIC CARBON IN AGGREGATE INNER- AND OUTER-CORE FRACTIONS OF SOILS UNDER DIFFERENT LAND USE SYSTEMS

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Soil organic carbon (SOC) concentrations and stability are found to differ within individual aggregates; however, there is a lack of knowledge about the SOC stability, decomposition patterns, and structural features in aggregate surfaces and inner-core fractions. In this study, aggregates from surface soil (Brookston clay loam) of a native woodlot, a grassland, and an arable soil were fractionated into inner and outer-core fractions using peeling methods. The fractions were ground to pass a 0.25 mm sieve and then aerobically incubated (120 d). The CO_2 evolved during the incubation was described using a two-pool model. Structural features and relative proportions of labile- and stable-C in these fractions before and after incubation were also investigated using Fourier transform mid-infrared spectroscopic technique. SOC concentrations were 11.1% and 6.8% higher in the aggregate inner-core than the outer-core fractions in woodlot and grassland systems, respectively. However, no differences were observed between the two fractions in arable soils. The CO_2-C evolved was significantly greater from the outer-core than from the inner-core fraction, with 19.5%, 13.0% and 11.7% more in woodlot, grassland and arable soils, respectively. The SOC in the inner core of the aggregate had a longer half-life than the SOC in the outer-core fraction. Spectroscopic analysis revealed that the aliphatic-C content was significantly higher in the outer-core than in the inner-core fractions under all land use systems ($P < 0.05$) and this C decreased dramatically after incubation. The aromatic-C was significantly higher in the inner-core than the outer-core fractions in woodlot and grassland systems and showed a slight decrease after incubation. However, there was no significant difference of aromatic-C between the two fractions ($P = 0.29$) and no notable decrease was observed for inner-core ($P = 0.25$) or outer-core ($P = 0.18$) fractions after incubation in the arable land. The ratio of aromatic-C to aliphatic-C in both aggregate fractions showed a trend of woodlot < grassland < arable soil. These results suggest that the SOC in the aggregate inner-core fraction is more stable than in the outer-core fraction, and it is better protected by aggregates in the woodlot and grassland systems than in arable soils.

RAPID DETERMINATION OF SOIL TEXTURE AND ORGANIC MATTER WITH A PORTABLE ATTENUATED TOTAL REFLECTANCE FOURIER TRANSFORM INFRARED (ATR-FTIR) SPECTROMETER

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Soil texture, determined by the percentages of sand, silt and clay in mineral soil, is a general indicator of soil-water relations, crop production, and field management. Soil texture controls physical processes like the drainage rate, water holding capacity and porosity, which affect root development and crop yields. Together, soil texture and organic matter content control key chemical reactions like the cation exchange capacity and the pH buffering capacity (both increase with percent clay and organic matter), which govern nutrient availability for crop uptake and fertilizer use efficiency. The development of quick and inexpensive methods for analysis of soil texture and organic matter would be highly advantageous. In this regard, infrared (IR) spectroscopy is one of the most promising techniques because research has shown that multiple soil properties can be simultaneously determined from a single spectral measurement completed in <1 min. However, the implementation of IR soil analysis methodology requires that calibration models be developed using multivariate analysis to relate the spectral characteristics of the soils to soil property values determined by conventional soil analysis methods. Although most work in this area has focused on near-IR spectroscopy, the mid-IR spectral range contains more detailed and specific spectral information and hence may offer the possibility of developing more readily generalized calibration models. In the present study, mid-IR

spectra of approximately 300 soil samples collected from farms across eastern Canada were recorded on a portable Fourier transform mid-IR (FTIR) spectrometer equipped with a single-reflection diamond attenuated total reflectance (ATR) module. Subsequently, these spectra were employed to develop individual calibration models for the prediction of the percentages of sand, clay, and silt and the total carbon and total nitrogen content, as determined by conventional laboratory methods, through the application of partial-least-squares (PLS) regression. Preliminary validation of these models by the leave-one-out cross-validation approach yielded R2 values in the range of 0.70-0.89 for the five soil parameters determined. Further steps will be taken to refine and validate these and additional calibration models for in-field soil analysis that can be exploited to rapidly assess soil fertility without resorting to the use of laboratory techniques.

DEVELOPING AN OPERATIONAL-SCALE RULEBASE IN ArcSIE FOR DIGITAL SOIL MAPPING

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We describe a method for creating and updating an operational-scale rulebase for the ArcGIS Soil Inference Engine extension (ArcSIE). ArcSIE uses 'fuzzy logic' to predict soils across a landscape based on a set of environmental predictors and user input rules that define the soil's relationship to the predictors. The use of fuzzy logic inference is beginning to move from research applications toward operational mapping exercises. However, this can require inputs and rulebases for multiple soils that may each require many instances. Creating and changing a complex rulebase with the ArcSIE interface can be technically problematic, causing the interface to falter or crash, and it can also be cumbersome for the user. Another way of working with the ArcSIE rulebase is to directly manipulate the rulebase .dbf file. Rather than using the ArcSIE interface, by directly editing the .dbf file, environmental predictors can be turned on and off; new soil types can be added; multiple instances of a soil type can be created; and the rule curve parameters can be modified. Using this method, an ArcSIE rulebase was developed to predict 23 soils across a 75,000 ha sub-watershed of the Okanagan Basin, using a variety of 14 different environmental predictors. We demonstrate how the rulebase of the Trout Creek DSM was developed and diagram the ArcSIE rulebase .dbf file and illustrate which fields correspond to which rule parameters in the ArcSIE interface.

WARMING OF CRYOSOLS AND THAWING OF PERMAFROST: ONE OF THE MOST SIGNIFICANT FEEDBACKS TO CLIMATE CHANGE FROM TERRESTRIAL ECOSYSTEMS?

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Permafrost-affected soils, or Cryosols, are directly dependant of high latitudes and high altitudes climates and represent 16% of global soils. In cold regions, air and soil warming is already in progress at a rate that is expected to increase. When we consider the first 3m of soil, Cryosols contain 1672 Pg C of organic carbon, which is approximately 50% of the global belowground C and twice the atmospheric C pool. This organic matter has accumulated as peat, deep cryoturbic layers or yedoma formations because of the limited decomposition of organic matter due to wet, cold conditions and to rapid incorporation in permafrost. Northern ecosystems actually play a significant role in the global C cycle, being a sink of atmospheric CO_2 but a source of CH_4. The thawing of permafrost with warming induces important changes in the northern ecosystems, changes in water balance and deep organic matter exposed to microbial decay can enhance CO_2 or CH_4 release. Fires in subarctic regions release large amount of carbon by combustion and subsequent thaw of permafrost. However, warming also increases plant uptake by extending the length of the growing season and enhancing plant primary productivity. Therefore, the most recent estimates confirm that carbon released from Cryosols will probably lead to net carbon loss to atmosphere. In order to illustrate these related processes, results from field experiments carried on in Salluit (Nunavik; 62°14'N, 75°38'W) will be presented. Two sites under tussock tundra vegetation were set up to monitor respiration of Cryosols under current and warmer conditions: one is a Histic Cryosol in a polygonal peatland (H); the other one is a Turbic Cryosol reductaquic (M) on post-glacial marine clays. During summer 2010, in ambient conditions, average respiration in H (1.27 µmolCO2.m^{-2}.s^{-1}) was lower than in M (1.97

µmolCO2.m^{-2}.s^{-1}). A provoked warming of 2.5°C led to a respiration enhancement of 65% and 32% in H and M respectively. In the Histic Cryosol, this increase in CO_2 fluxes could not be offset by gross primary production. Respiration rates during summer depend mainly on soil surface temperature and to a lesser extend on soil moisture and wind velocity.

FREEZE-THAW CYCLES AND SOIL WATER CONTENT EFFECTS ON INFILTRATION RATE AND BULK DENSITY OF THREE SASKATCHEWAN SOILS

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Many soils at high latitudes freeze and thaw seasonally. Predictions of frequent freeze-thaw cycles (FTC) imply tremendous impact on ecosystem diversity and productivity. Freeze-thaw cycles provoque changes in soil physical properties and affect water movement in the landscape. This study examined the effect of FTCs (0, 1, 5, and 10) and antecedent soil moisture (at matric potentials 15, 0.33 and 0.2 bars) on infiltration rate and bulk density of three Saskatchewan soils (a clay, a loam and a loamy sand). A tension infiltrometer was used at tensions 5, 10 and 15 cm. Infiltration rates were higher at lower matric potentials (more negative) than at higher matric potentials. Infiltration rates for clay were higher than for loam or loamy sand, but FTCs did not affect clay infiltration rates. Freeze-thaw cycles decreased infiltration rates for the loam and loamy sand soils at 15 bar and for the loamy sand at 0.33 bar compared to no FTCs. Bulk densities were higher at 0.33 than at 15 bar, and were higher for loam followed by clay and loamy sand soils. However, FTCs did not affect soil bulk densities.

SOIL PHYSICAL AND HYDROLOGICAL PROPERTIES OF SLOPING PERENNIAL PASTURE AND ANNUAL CROPLAND OF THE PRAIRIE POTHOLE REGION OF SOUTHEASTERN SASKATCHEWAN, CANADA

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Soil physical properties and hydrological processes are important when assessing agricultural best management practices (BMPs) and their effect on soil and water quality. As part of the Saskatchewan (SK) WEBs (Watershed Evaluation of BMPs) project, this study characterized subsurface water movement at various landscape positions for two common practices: perennial tame pasture (grass/alfalfa) and annual cropland (canola/wheat). Located within the Pipestone Creek watershed in Southeastern SK, the sites are formed by glacial loess deposits of black Chernozemic loam on hummocky rolling topography. Using two sites for each management practice, in-situ tension and double ring infiltration rates were measured in fall 2010 and 2011 at three landscape positions (upslope, midslope and toeslope) on two transects. Gravimetric soil water content, soil texture, and bulk density were also measured. Landscape position did not affect double ring infiltration rates, and these were higher for pasture compared to cropland practices. In 2010, tension infiltrometer results showed a significant ($p<0.05$) interaction between landscape position and management practice. Upslope and midslope, tension infiltration rates were higher for pasture than cropland. However, at the toeslope position, tension infiltration rates were higher for cropland than pasture. In cropland, tension infiltration rates were higher at the toeslope than at mid and upslope positions. However, in pasture, tension infiltration rates were higher at the up and midslope than at toeslope positions. In contrast, in 2011, tension infiltration rates for pasture and cropland were no different.

IMPACT OF LAND MANAGEMENT PRACTICES, SOIL PROPERTIES AND WEATHER CONDITIONS ON DENITRIFICATION LOSSES IN MANURE-AMENDED PERMANENT FORAGE AND CORN-SOYBEAN-WHEAT ROTATIONS IN ATLANTIC CANADA

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Losses of nitrogen (N) from agricultural fields via denitrification contribute to Canada's greenhouse gas emissions. These losses have the potential to be significantly higher when organic amendments such as liquid dairy manure are substituted for inorganic N sources for crop production. A six year study was undertaken to compare the effect of land management practices on growing season (GS) denitrification losses in a permanent forage (PF) and a corn-soybean-wheat (CSW) rotation with or without tillage (T v NT). Results are presented for the first five years. Denitrification rates (g N ha^{-1} d^{-1}) were measured using the acetylene blockage technique with soil cores taken at biweekly sampling intervals, while cumulative N losses (kg N ha^{-1} GS^{-1}) were estimated using linear interpolation of daily rates. Spring-applied liquid dairy manure (LDM) was used as an N source for crop production at rates equivalent to 150 - 195 kg N ha^{-1} in corn or wheat years (2007, 2009 and 2010). In soybean years (2008 and 2011) no manure was applied at the site. In these years, the PF rotation received inorganic N fertilizer at 55 kg N ha^{-1}, while the soybeans received no N fertility in 2008 and a nominal 20 kg N ha^{-1} as inorganic fertilizer in 2011. Denitrification losses ranged between 0.3 and 27.4 kg N ha^{-1} GS^{-1} across all treatments and growing seasons. Cumulative losses over the five year study period were 38.2, 41.0 and 49.1 kg N ha^{-1} for the PF, CSW-NT and CSW-T treatments respectively. There were no consistent differences between treatments over the five year study period. Higher availability of carbon from incorporated organics in CSW-T and greater NH3 volatilization losses in CSW-NT are potential reasons for the higher cumulative denitrification losses in the former treatment. Large differences (~ 27 kg N ha^{-1} GS^{-1}) in average denitrification rates between growing seasons, point towards non-treatment soil factors and climatic conditions as being the major drivers for denitrification.

IMPACT OF LAND MANAGEMENT PRACTICES ON NITRATE LOADS IN TILE DRAINAGE WATERS FROM MANURE-AMENDED PERMANENT FORAGE AND CORN-SOYBEAN-WHEAT ROTATIONS IN ATLANTIC CANADA

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This long term study examined the effect of tillage practices in manured permanent forage (PF) and corn-soybean-spring wheat (CSW) rotations on growing season (GS) and non-growing season (NGS) nitrate (NO_3-N) loading of tile drainage waters over a 14 year period. Treatments included (i) PF rotation established and re-established with tillage (T) practices; (ii) CSW-T rotation; (iii) CSW-NT (no-till). NGS drainage was significantly higher and flow-weighted NO3-N concentrations significantly lower in all years when compared with GS. Across all treatments, loads ranged between 1.7 and 32.3 kg N ha^{-1} and 9.7 and 77.0 kg N ha^{-1} for GS and NGS, respectively. Consistent differences in GS or NGS NO_3-N concentrations and loads between the two tillage regimes of the CSW rotation were not observed, although CSW-NT loading may have been offset by greater NH_3 volatilization losses in the period following spring manure applications. In non re-establishment years, the PF rotation was significantly more efficient in N utilization when compared with a CSW rotation, resulting in significantly lower loads. Differences in the amount of N removed by corn, soybean and spring wheat in the CSW rotation were observed, but these were not significant in determining the magnitude of NO3-N loads. The correlation between LDM application rate and NO_3-N drainage losses in a particular season proved difficult to define.

DISPONIBILITÉ DES MÉTAUX SUITE À NEUF ANNÉES D'ÉPANDAGE DE BIOSOLIDES PAPETIERS ET RÉSIDUS ALCALINS EN GRANDES CULTURES

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Les résidus provenant de l'industrie forestière peuvent améliorer de façon tangible et durable la fertilité et la qualité des sols, mais leur impact sur la disponibilité des métaux a été peu étudié. Une expérience s'est déroulée pendant neuf ans (2000-2008) sur un sol loameux à Yamachiche près de Trois-Rivières, où des biosolides mixtes papetiers, appliqués seuls ou en mélange avec différents produits chaulants, ont été évalués pour leur effet sur la disponibilité du Cu, Zn et Cd dans le sol. Les biosolides papetiers ont été apportés annuellement en post-levée à des taux de 0, 30, 60 et 90 t hum. ha-1. Les produits chaulants (chaux calcique commerciale, boues de chaux et cendre de bois) ont été appliqués séparément à un taux de 3 t hum. ha-1 dans les parcelles recevant 30 t ha-1 de résidus papetiers. Les sols ont été échantillonnés à l'automne 2008, après la récolte du maïs, à des profondeurs de 0-30 cm, 30-60 cm et 60-90 cm. L'analyse de la disponibilité des métaux s'est faite en utilisant la procédure de fractionnement séquentiel de Tessier. Les résultats indiquent que la grande majorité du Cu, Zn et Cd apportée par les matériaux se retrouve dans la couche de surface (0-30 cm) et qu'il y a peu d'effets perceptibles plus en profondeur. Le Cd est présent en large quantité dans la fraction échangeable (42%), à l'opposé du Cu et du Zn (< 3%). Le Zn et le Cd ont été les métaux les plus affectés par les différents traitements. Les doses de biosolides ont augmenté de façon linéaire la fraction échangeable, la fraction liée aux oxydes Fe-Mn et la fraction liée à la matière organique (Zn seulement). Les produits chaulants ont réduit la fraction échangeable mais augmenté celle liée aux carbonates. Une relation très étroite a été établie entre le prélèvement en Zn et Cd des plants de maïs et la fraction échangeable de ces métaux dans le sol. Le Cu a été moins affecté mais la fraction liée à la matière organique a été augmentée par les biosolides papetiers alors que celle liée aux oxydes Fe-Mn a été réduite.

EVALUATION OF SOIL AMENDMENTS AND COVER CROPS FOR WINE GRAPE PRODUCTION

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Increased costs of fertilizers and emphasis on sustainable production systems have prompted the management practices that can make use of local waste products and utilize cover crops. The effects of these practices on vine growth and grape quality have not been explored under Nova Scotia climate and soil conditions. A two year study on using soil amendments and cover crops is being conducted at Petite Riviere Vineyards in Nova Scotia. Soil at this site was low in organic matter as well as available nitrogen (N) and potassium (K). Amendment treatments of interest include woodash (6 t/ha), municipal solid food waste compost (MSFW); (13 t/ha), mussel sediments (42,000L/ha), inorganic fertilizer (40-0-83-40S-24Mg-2.4B) and a nitrogen deficient control treatment (0-0-83-40S-24Mg-2.4B). Cover crops include an oats/pea/hairy vetch mixture (O/P/V), oats underseeded with red clover (O/RC), triple mix(TM) and a bare soil treatment (BS). Preliminary results showed amendments had no significant effect on yield ($\alpha \leq 0.10$) although there was a trend toward higher yield production in MSFW and mussel sediments compared with other treatments. Cover crops treatments resulted in a significant ($\alpha \leq 0.10$) yield difference between treatments. The O/RC treatment resulted in the highest yield followed by O/P/V, TM and BS treatments. The O/RC produced 58% higher grape yields compared with BS treatment. Other yield and quality parameters such as trunk diameter, numbers of clusters, average cluster weight, leaf tissue nitrogen content at blooming stage, sugar content, phenolic content, antioxidant capacity, and yeast assumable nitrogen will be determined. After the second growing season, the amendment and cover crop combination with the best yield and quality of wine grapes while maintaining a high soil quality will be determined.

BETTER QUALITY DIGITAL ELEVATION MODELS FROM GLOBAL ELEVATION PRODUCTS

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Australia and Canada are both countries with large areas of low population density and limited resources, requiring innovative approaches to national challenges including the management and mapping of land and water resources. Digital elevation models (DEMs) are one of the fundamental data sets for land resource mapping, and Australia has recently produced a series of 1 second (about 30 m) resolution DEM from the NASA Shuttle Radar Topographic Mission (SRTM) data. These products represent two orders of magnitude improvement in information density compared to our previous 9 second DEM and are publicly available from the Geoscience Australia National Elevation Data Framework (NEDF) portal (http://nedf.ga.gov.au). A number of methods were developed to process the raw SRTM data to treat the voids, striping, height offsets due to trees and random noise, yielding products suitable for routine terrain analysis. Canada has now obtained permission to release a DEM product derived from 1 second SRTM and the methods developed in Australia are likely to be useful in Canada as well. Enhanced methods will probably be required due to the different landforms and vegetation cover patterns, and methods could be explored to draw together the various high resolution elevation sources over Canada to produce a consistent high quality product.

GLOBAL DATA, NATIONAL DEMS AND LOCAL SOIL MAPPING: AN AUSTRALIAN PERSPECTIVE

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With the advent of global digital elevation models (DEMs) such as the SRTM and ASTER GDEM, elevation data is now available with more or less global coverage but at a resolution that is relevant at the local scale. In Australia, the 1 second SRTM data has been used as the basis for a continental DEM. The raw SRTM data was processed to remove artefacts and provide the smoothness and drainage connectivity needed for most analytical applications. A consistent, fine scale continental DEM allows similarly consistent terrain attributes to be produced and these are now being produced for all of Australia and will be freely available. Deriving and distributing the most widely used terrain attributes means that people needing to use those layers, for any purpose, do not have to go to the trouble of deriving them from the DEM. It also means that all users can work with exactly the same terrain attributes, and that the attributes are derived using robust methods and with suitable corrections for the non-uniform geographic projection in which the DEM is stored. Being based on a near-global data set, this approach could be exploited in other countries and even across most of the world. A consistent DEM and attributes derived from it could play an important role in the collaborative development of digital soil mapping techniques.

IMPACT OF DIFFERENT RESOLUTION CLIMATIC DATA ON CORN SUITABILITY RATINGS IN THE LOWER FRASER VALLEY, BRITISH COLUMBIA

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The Land Suitability Rating System (LSRS) is an algorithm-based model that spatially incorporates climate, soil and landscape information to assign a suitability rating (class) to a soil map polygon for a specific crop type. To derive LSRS ratings for Canada, a national 10km gridded climate database supplied by the Agriculture and Agri-Food Canada (National Agro-climate Information Service) is employed. However, in mountainous terrain, especially in British Columbia, the spatial resolution of the gridded climate data is inappropriate, since the valleys between mountain ranges are overshadowed due to the elevation extremes and the limited extent of the lowland areas. In the Lower Fraser Valley, corn suitability ratings derived from the 10km gridded climate database were compared to ratings derived from the higher resolution, 400 m grid PRISM climate data set. The results of the comparison study will be presented in this presentation. As expected, within the current agricultural portion of the Lower Fraser Valley corn suitability ratings are generally similar, with some abnormalities, which will be discussed. Also the more detailed climate database did capture more moderate temperatures associated with the valleys within the neighbouring Coastal mountains.

ANALYSE DE LA VARIABILITÉ SPATIALE DES TENEURS EN CARBONE ORGANIQUE DES SOLS ALLUVIAUX SOUMIS À CRUES FRÉQUENTES EN LIEN AVEC LES CHANGEMENTS CLIMATIQUES

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Cette étude examine la répartition spatiale du carbone organique dans des sols alluviaux soumis à des crues successives, lesquelles résultent des variations hydroclimatiques associées au réchauffement climatique. Les sites sélectionnés sont situés dans des plaines inondables sous couverts forestiers et agro-forestiers, dominés par l'érable argenté (Acer saccharinum L.) et le frêne rouge (Fraxinus pennsylvanica Marsh.). Ces plaines d'inondation sont affectées de plus en plus par des crues fréquentes, surtout depuis les deux dernières décennies, lesquelles ont une incidence directe sur les processus pédogénétiques et l'appauvrissement des sols riverains, notamment au niveau de la biomasse et de la matière organique in situ. Les analyses des échantillons de sols (total n =109) prélevés en zone inondable indiquent des teneurs généralement plus faibles en carbone organique (C.O.), soit des taux qui varient entre 0,53% à 5,39%. On note que c'est dans les zones soumises à des crues successives avec des récurrences élevées (0-20 ans) que les taux de carbone organique sont les plus faibles, soit des valeurs situées entre 0,53% à 5,14%, avec des valeurs moyenne et médiane 1,97% et 1,73% respectivement. Ceci confirme les tendances observées dans nos travaux antérieurs sur l'appauvrissement des sols en zone inondable active. Par ailleurs, la perte de biomasse (litière) lors de la décrue entraîne une perte nette en matière organique pour les sols. Dans les zones non affectées par les crues, les teneurs en C.O. (%) sont généralement plus élevées, soit des valeurs qui varient entre 0,84% et 30.67%, avec des valeurs moyenne et médiane de 4,71% et 4,13%. Les crues successives ont une incidence sur le maintien de la biomasse au sol et sur le potentiel de régénération des peuplements, ce qui pourra avoir un effet sur la vitalité de ces peuplements et des écosystèmes riverains en général.

EFFECT OF AN ALKALINE-TREATED BIOSOLID ON SOIL PH, CO_2 EVOLUTION, NH_4, AND NO_3

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The effect of increasing rates of an alkaline-treated biosolid (ATB) on several soil chemical properties was investigated in an aerobic soil incubation. Amendment rates of ATB equivalent to 0, 7, 14, 28, and 42 t/ha were monitored over a four month period. Soil pH, NH4, and NO3, were measured on days 0, 3, 6, 9, 12, 15, 22, 29, 55, 88, and 121. CO_2 evolution had three additional samplings on days 45, 71, and 103. The soil pH was significantly increased by the addition of ATB and a rate effect was observed, although the increase in soil pH with higher ATB amendment rates was not linear. In the unamended soil and the lowest ATB rate, pH dropped within the first two weeks whereas in the two highest ATB treatments, pH generally increased over the first two weeks. However, this effect was not maintained over time, as the final pH in all ATB rates was actually lower than the pH on day 0. CO_2 evolution was most rapid at the beginning, which was mirrored by a rapid depletion of NH4 indicating immobilization of nitrogen. During the same time period, a NO_3 deficit relative to the control was also seen, particularly in the two highest amendment rates. Taken together, these results show that the carbon sources in this particular ATB are quite labile, which led to immobilization rather than mineralization of nitrogen during the initial stages of decomposition. The high microbial activity and rapid decomposition of the material may have contributed to the decline in soil pH over time. These results indicate that using ATB as a fertility source could actually lead to less available N for plant growth within the first few weeks after application, and supplemental nitrogen fertilizer may be necessary to meet fertility requirements for a particular crop.

NITROUS OXIDE EMISSIONS FROM AN ANNUAL CROP ROTATION IN THE RED RIVER VALLEY, MANITOBA

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Agricultural soils are the most significant anthropogenic source of nitrous oxide to the atmosphere. In the present study, the micrometeorological flux of nitrous oxide was measured over three years (2006 -2008) in a maize (Zea mays L.)/faba (Vicia faba minor L.)/spring-wheat (Triticum aestivum L.) rotation in the Red River Valley, Manitoba on Gleyed and Gleysolic Humic Vertisols. Comparison of newly established reduced and intensive tillage treatments showed high variability between duplicated plots and no difference in net nitrous oxide flux. The annual gap-filled cumulative nitrous oxide emissions across tillage treatments was 5.5, 1.4, and 4.3 kg N/ha in the maize, faba and spring-wheat crop years, respectively. Emissions from fertilizer N addition and soil thaw the following spring were responsible for the greater cropland-atmosphere flux of nitrous oxide in the maize and spring-wheat years. Using four approaches to approximate background emissions at the site resulted in estimates of 3.5 - 3.8% and 1.4 -1.8% of applied fertilizer N emitted as nitrous oxide for the maize and spring-wheat crops, respectively. The global warming potential equivalent over the three study years was an emission of 5.4 Mg CO2-eq. / ha for the site.

SIMULATION OF SOIL NO_3 CONTENT AND SOIL TO PLANT N FLUX UNDER POTATO CROPPING SYSTEMS IN EASTERN CANADA

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As a nitrogen (N) fertilization management tool, models should reliably simulate both temporal and spatial variability of soil nitrate (NO_3) content (SNOC) due to non-linear soil heterogeneity. Non-linear processes can be difficult to model by the classical deterministic approach. Alternatively, neural networks (NN) can better take into account indicators of sub-field soil heterogeneity and plant growth pattern such as the leaf area index (LAI). The goal of this study was to evaluate NN and hybrid models to simulate soil to plant N fluxes and SNOC in the 0-40 cm soil layer considering inter-annual variations, spatial soil heterogeneity, and differential N application rates for three potato cultivars. To this aim, the driving meteorological variables as well as functions of LAI and the state variables of deterministic models have been fed to several multilayer perceptrons. The hydraulic process was monitored by the CLASS model, soil temperature calculated from air temperature and LAI with a semi-empirical approach and N plant uptake was empirically estimated from LAI. Results were compared to field data collected between 2004 and 2006 at several experimental plots under potato cropping systems in Québec, Eastern Canada. Analysis of variance showed that N concentration in plants tissues did not increase significantly with added N. Even though soil temperature was the most performing single variable accounting for SNOC, the most performing model was obtained using a 4-input hybrid model composed of 1) cumulative air temperature, 2) cumulative LAI, 3) cumulative drainage and 4) day of year . The mean absolute error was 12.6% on training and 25.2% on testing. High sensitivity to LAI suggests that the model may take into account sub-field spatial variability and support N management.

WHAT ARE THE EFFECTS OF COLD AND FREEZING SOILS ON NITROUS OXIDE EMISSIONS, DENITRIFICATION AND DENITRIFIER AND NITRIFIER COMMUNITIES?

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Climate warming may lead to a decrease in soil temperatures over winter due to a reduction in snow cover in Canada. We examined the effects of cold and freezing soils on nitrous oxide (N2O) emissions, denitrification, and soil nitrifier and denitrifier abundance and structure under controlled and field conditions. Soil microcosms with red clover residues were incubated at -4°C, -1°C, +2°C or +5°C, representing soil temperatures encountered during winter. N2O emissions and/or denitrification increased with increasing temperature at the start of the incubation however N2O emissions and cumulative denitrification losses over 120 days were greater at -2°C probably due to the presence of more free water compared with -4°C and more anoxic microsites compared with +2°C and +5°C. Abundance of denitrifiers and nitrifiers were lower in soils at -4°C compared to other soil temperatures with the exception of Nitrobacter-like bacteria and nirS denitrifiers that did not vary among temperatures. Community structures of nirK and nirS denitrifiers and Nitrobacter-like bacteria shifted between below-zero and above-zero temperatures. Ammonia oxidizer bacteria (AOB) structure also changed but not systematically among frozen and unfrozen temperatures, whereas ammonia oxidizer archaea (AOA) structure was globally not affected by temperatures. An agricultural field was sampled five times from November to April in the winters of 2009/2010 and 2010/2011. N2O emissions and denitrification increased when soils were frozen in January and March in both winters. Abundance of nitrifiers and denitrifiers did not change in general over the winter 2009/2010 however these communities were the most abundant in March and April compared to other sampling dates in the following winter. Structure of the nitrifier and denitrifier communities was different at each sampling date in both winters. The results showed that N2O emissions and denitrification were stimulated in frozen soils both under controlled and field conditions. Freezing soils had either no effect or decreased abundance of nitrifiers and denitrifiers however the community structures constantly changed over time

indicating that the communities were active in frozen soils. These studies demonstrate that the environmental factors controlling N2O emissions and denitrification are different from those controlling nitrifier and denitrifier abundance and community structure in cold or freezing soils.

IMPROVING PHOSPHORUS MANAGEMENT

Cynthia Grant
AAFC Brandon Research Centre

An adequate phosphorus supply is critical for plant growth and either inorganic or organic P forms are commonly applied in agricultural systems to optimize crop production and avoid soil depletion. It is estimated that P use efficiency in the year of application is generally less than 30%, although long-term efficiency of P use may be higher when considered over a cropping cycle. Movement of P fertilizers from the plant-soil system to water bodies is a major cause of eutrophication, particularly in fresh-water systems, while accumulation of trace elements such as Cd in the soil from P fertilization can lead to long-term soil degradation and decreases in crop quality. Negative environmental effect may occur from nutrient losses that are not large enough to be economically important, so in some cases adoption of management practices for environmental purpose may be necessary that would not be considered essential for agronomic purposes. Adoption of management practices to more closely match nutrient supply to crop demand, both in terms to rate and timing of supply can improve nutrient use by the crop and reduce potential environmental impacts. Various methods and products have been proposed over the years to improve the efficiency of P fertilizer use. These include novel formulations, improved application methods and microbial treatments. The effectiveness of different products and management practices and the fate of P applications will be affected by P dynamics in the soil and by soil characteristics, cropping systems, and environmental conditions. Selection of nutrient rate, source, timing and placement suited to the soil type, environment and production system is critical to optimise nutrient use efficiency and minimise nutrient loss.

LES SOLS DE MISSISQUOI : UNE APPROCHE CARTOGRAPHIQUE PAR ZONES PHYSIOGRAPHIQUES, PÉDOPAYSAGES ET CLASSES DE PENTE

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Dans le cadre du projet d'évaluation du potentiel viticole de Brome-Missisquoi réalisé par le Dura-Club en partenariat avec l'IRDA, AAC et le MAPAQ, il y a eu près de 500 descriptions de profils de sols réalisés en 2010 et 2011, en majeure partie dans le comté de Missisquoi. Celles-ci se sont ajoutées à près de 500 autres réalisées antérieurement pour le projet GRISE. Ces 960 profils de sols ont été géoréférencés et caractérisés en séries de sols. Afin de faire une mise à jour de l'étude des sols de Missisquoi (1948) et de les cartographier malgré une couverture de faible densité (environ 1 observation par 100 ha), trois types de données ont été couplés à ces 960 sites: les zones physiographiques, les paysages ainsi que les pentes. L'élévation de la région à l'étude varie entre 30 et 950 m et elle a été divisée en 4 zones : 1) de 30 à 60m (plaine étale de la vallée du Saint-Laurent); 2) 60 à 90 (plaine ondulée); 3) 90 à 180 m (plaine ondulée à vallonnée); et 4) 180 m et plus (plateau et hautes-terres des Appalaches). Les paysages ont été réalisés à l'aide du logiciel LandMapR© en y intégrant un modèle numérique d'élévation (MNE) au 1 : 50 000. Le logiciel LandMapR© permet, à partir du principe de la logique floue, de caractériser le territoire en 15 classes de paysages représentant la position dans le relief. Ces classes sont notamment les crêtes, les revers de pente, les bas de pente, les dépressions de milieu et de haut de pente, etc. Ces 15 classes ont été regroupées afin de faire ressortir l'impact de la position dans le relief sur le drainage et les matériaux du sol. Les trois nouveaux paysages sont les terrains en pente, les terrains plats et les terrains bas ou en dépression. Enfin, les pentes ont été dérivées du MNE et regroupées en deux classes soit : les pentes de 2,5% et moins et les pentes de plus de 2,5 %. Les trois couches d'information produites ont par la suite été superposées l'une à l'autre afin de délimiter des polygones, lesquels sont associés aux matériaux originels de sols et aux classes de drainage les composant et ultimement décrits par des séries de sols.

INFLUENCE DU TRAVAIL DE SOL, DE LA JACHÈRE D'ÉTÉ ET DU TYPE DE CULTURE EN ROTATION SUR LES ÉMISSIONS D'OXYDES NITREUX D'UN SOL DE TYPE UDIC BOROLL DES PRAIRIES CANADIENNES

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Les activités agricoles peuvent générer de grandes quantités d'oxyde nitreux (N_2O), un puissant gaz à effet de serre (GES) dérivé de l'N du sol et des fertilisants. Une meilleure compréhension des décisions de gestion des pratiques culturales qui influencent les émissions de N_2O, telles que l'intensité du travail de sol, l'utilisation de jachère d'été et la sélection du type culture, est nécessaire pour raffiner les inventaires nationaux de GES et les stratégies pour minimiser les pertes. Les émissions de N_2O ont été mesurées dans un système de rotation à long terme situé à proximité de Three Hills, AB, Canada. Les objectifs de recherche étaient de quantifier les émissions de N_2O sous plusieurs cultures typiques de la région et d'étudier les interactions possibles entre la rotation de cultures et le travail de sol. Les flux gazeux ont été mesurés à l'aide de chambres statiques sur une période de 6 ans, du dégel printanier au gel de l'automne. Les rotations étaient : 1) blé de printemps en continu; 2) blé de printemps - jachère d'été; 3-4) les phases de blé de printemps et de pois d'une rotation canola-orge-pois-blé de printemps. Chaque rotation a été maintenue sous régime de travail de sol conventionnel (travail de sol secondaire pour préparation du lit de semence) et de semis-direct (sans travail de sol). La perte moyenne annuelle de N_2O estimée en termes de superficie variait de 91 à 8 045 g N_2O-N ha^{-1}, alors que les pertes exprimées par unité de rendement ont varié de 0,6 à 148 g N_2O-N kg d'N prélevé-1. Ceci représente environ 0,1 à 12 % de l'N appliqué. Les émissions ont été systématiquement inférieures sous semis-direct et dans les parcelles de pois en rotation. Bien que très variables, les émissions provenant de parcelles en jachère d'été (2 318 g N_2O-N ha^{-1}) étaient comparables aux émissions provenant de parcelles ensemencées en blé de printemps et fertilisées (2 140 g N_2O-N ha^{-1}). Réduire l'intensité du travail de sol, éliminer les jachères d'été et inclure une légumineuse dans la rotation pourraient être employés comme stratégie pour mitiger les pertes d'N sous forme gazeuse dans les Prairies canadiennes.

MODÉLISATION DE L'IMPACT D'UNE COUCHE COMPACTE SUR L'EFFICACITÉ DU SYSTÈME DE DRAINAGE EN CULTURE DE CANNEBERGES

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En production de canneberges, les champs sont dotés de systèmes de drainage souterrain qui ont pour but d'évacuer l'excédent des eaux infiltrées et accumulées dans le sol. Le système de drainage possède trois objectifs spécifiques. Premièrement, il doit accélérer le transfert de l'eau accumulée lors de fortes précipitations en permettant un rabattement adéquat de la nappe. Deuxièmement, le rabattement rapide de la nappe permettra de garantir une bonne oxygénation de la zone racinaire afin de maintenir sa croissance optimale. Finalement, le système d'assainissement en eau doit favoriser le maintien de la tension dans la gamme idéal pour conserver un confort hydrique adéquat pour la plante. Le design et le bon fonctionnement du système de drainage reposent, entre autres, sur des hypothèses d'homogénéité et d'isotropie du milieu poreux. Néanmoins, ces hypothèses théoriques ne sont pas toujours respectées dans le monde réel. En effet, diverses expériences de terrain réalisées dans la région de Québec ont révélé l'existence d'une couche compacte, d'origine encore méconnue, qui entraverait la circulation adéquate de l'eau vers les drains. Dans cette étude, le modèle HYDRUS-3D a été utilisé afin de comprendre l'impact qu'aurait cette couche restrictive sur l'efficacité du système de drainage. En premier lieu, le modèle HYDRUS a été calé avec des données prises au court de l'été 2008. Des suivis de l'élévation de la nappe et de la tension de l'eau dans le sol au niveau des racines ont été effectués en dix-huit points d'observation différents également répartis entre deux champs d'étude. Les résultats démontrent d'une bonne concordance entre les tensions mesurées et simulées avec un coefficient de Nash-Sutcliffe et un R2 supérieur à 0.60 et 0.70. Le calage du modèle a été également appuyé par une caractérisation des propriétés hydrodynamiques des sols des deux champs. Une foi le modèle calé, la deuxième étape a été de simuler des scénarios de couches de restriction dans le sol. Pour ce faire, trois paramètres de cette couche ont été choisis; sa profondeur, son épaisseur et sa conductivité hydraulique à saturation. Les résultats des simulations des scénarios démontrent un fort impact de la couche restrictive sur l'efficacité du drainage.

THE IMPACT OF THE DEGREE OF SOIL WETTING AND DRYING ON NITROUS OXIDE EMISSIONS

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Soil wetting and drying play an important role on the microbially mediated N transformations in soils including N mineralization and denitrification. However, the extent of the wetting and drying cycle is dependent on soil properties, climate and the availability and extent of irrigation. In this laboratory incubation study, the impacts of different ranges in soil drying (drying to 45, 30, 20 or 10% water-filled pore space, WFPS) and wetting (75 or 90% WFPS) on soil N_2O emission were investigated using repacked soil cores of a clay loam soil. We found that the highest N_2O emissions occurred when the soils were dried to 10% WFPS followed by a wetting event whereas the lowest emissions occurred when the soil was dried to 45% WFPS before the wetting event. When the soil moisture varied between 10 and 90% WFPS, the cumulative N_2O emissions were 7.4 times greater than when the soil moisture varied between 10 and 75% WFPS. N_2O emissions from soil after a wetting process increased proportionally with the extent of drying. Soil denitrification enzyme activity was also found to increase over the incubation period. The ratio of N_2O:(N_2O+N2) generally increased when the soils underwent more extensive drying. Soil wetting to 75% WFPS had significantly greater N_2O:(N_2O+N2) ratio than when soil wetting to 90% for all drying treatments except the 45% WFPS. In general, the greater the range of drying and rewetting stimulated N_2O emissions and total denitrification losses.

EXAMINING STUDENT EXPERIENCES IN A MODIFIED PROBLEM BASED LEARNING APPROACH TO TEACHING SUSTAINABLE SOIL MANAGEMENT

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Soils sustain life on Earth and their capacity to do so is dependent on the sustainable management of this limited resource. However, enrollment in soil science undergraduate programs has steadily declined over the past 30 years across North America. To ensure an adequate supply of soil scientists to meet current and future environmental challenges, some post-secondary institutions are restructuring their soil science programs. Innovative teaching methods like problem based learning (PBL) may help prepare soil scientists for the rigorous demands of the workforce. At the University of British Columbia (UBC), a combined upper-level undergraduate/graduate-level course titled Sustainable Soil Management employs a modified PBL approach to teaching applications of fundamental chemical, physical and biological soil science principles to forested, agricultural, and constructed ecosystems. Groups of 4-6 students collaborate on three separate four-week interactive cases aided by guiding questions and weekly tasks. At the conclusion of each case, groups share their findings with their peers in oral presentations, while individual students also submit case reports detailing their learning, including cross case comparisons. The objective of this study is to examine how student experiences in this Sustainable Soil Management course contribute to the development of critically thinking soil science professionals. This case study converges evidence from classroom observations, student interviews, and document analysis obtained between January and May 2012. Data analysis is being conducted through pattern matching for trends and anomalies. Preliminary results from the first case suggest that while students feel the lecture/group-work balance is supportive to learning about sustainable soil management for their own area of interest, transfer of knowledge between contexts is only weakly exhibited in students' written assignments. Two more sets of interviews will be completed before April 30, 2012 to observe changes in student approaches and behaviors over the duration of the course. Final results will be presented as key transferable

elements for utilizing PBL in teaching Sustainable Soils Management. It is hoped that the outcomes of this study will not only lead to improvements in this specific course at UBC, but will also contribute to the enhancement of soils education in North America.

CHARACTERIZING THE SPATIAL STRUCTURE OF FOREST FLOOR PH, NITRATE, AND AMMONIUM ASSOCIATED WITH BIGLEAF MAPLE AND WESTERN HEMLOCK AT MULTIPLE SCALES

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Novel analytical techniques are needed to enhance our understanding of species-specific influence on soil properties. Four analytical techniques were used to detect the spatial structure of forest floor properties associated with bigleaf maple (Acer macrophyllum Pursh), at multiple scales, within a conifer forest. Two 140 yr-old and two 75 yr-old bigleaf maple and western hemlock (Tsugaheterophylla (Raf.) Sarg.) 20 x 20 m plots, centered on individual dominant stems, were sampled at 100 systematic locations and tested for forest floor pH, nitrate, and ammonium. Kriged maps showed that forest floor pH had higher and lower values in locations adjacent to bigleaf maple and western hemlock stems respectively. Local indicators of spatial association analysis showed the presence of positive clusters and negative clusters associated with bigleaf maple and western hemlock stems respectively, up to a distance of 3 m from the stems. Polynomial RDA variance partitioning revealed that the spatial component has a higher contribution to overall variability on bigleaf maple plots and PCNM RDA analysis revealed that broad (large) and fine (small) scale spatial patterns of forest floor pH, NO_3, and NH_4 are related to topography, canopy cover, canopy density and moisture content. This study provides an understanding of the multi-scale spatial patterns of forest floor properties due to species-specific impacts on soil properties.

A RAPID TECHNIQUE FOR SEPARATING WILLOW ROOTS FROM CLAY SOIL BASED ON SODIUM-INDUCED DISPERSION

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Numerous studies have examined the root dynamics of willow biomass energy crops growing on medium to light-textured soils, using either soil coring, minirhizotron techniques, or a combination thereof. However, neither approach is well suited for studying roots in expansive high clay content soil. Solonetzic or sodic soils occur worldwide and their genesis results from the presence of abundant sodium salts within the soil profile; either inherent within the parent material or supplied by groundwater discharge. The high exchangeable-Na content causes soil alkalization, with the Na-saturated clay minerals having thicker diffuse double layers, causing repulsion and deflocculation of clay particles, which eluviate from the A to the B horizon to form a dense hardpan layer. The objective of this study was to apply these first principles of Na-induced dispersion of soil colloids to develop an improved method of separating willow roots from an Orthic Vertisol by using a $NaHCO_3$ pre-treatment before washing. We hypothesized that shaking soil core samples in a solution with abundant Na, would saturate the clay surfaces with Na, disperse clay aggregates and liberate the bound roots (especially the fine roots), resulting in more efficient root-soil separation and increased fine-root recovery compared to conventional washing. Soil cores collected from a willow variety trial plot were either conventionally washed (i.e., no pre-treatment) or washed following a pre-treatment consisting of shaking the sample for 15 min with either deionized water or 1.2*M* $NaHCO_3$. Measurement variables included washing duration, water usage, and recovery of fine (< 2 mm) and coarse roots. The ranking of washing duration and water usage was 1.2*M* $NaHCO_3$ pre-treatment < deionized water pre-treatment < conventional washing. Compared to conventional washing, the 1.2*M* $NaHCO_3$ pre-treatment reduced the washing duration and water usage by 45 and 61%, respectively, while increasing the fine-root recovery by 29%. There was no significant difference (P > 0.05) in coarse root recovery among the three washing methods. Developing a quicker technique of separating willow roots from high clay content soil, which conserves water and increases fine root recovery, should promote further investigations of root growth dynamics within this traditionally difficult soil type.

FIRST ROTATION NUTRIENT BUDGETS OF WILLOW BIOMASS PLANTATIONS IN SASKATCHEWAN

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Natural Resources Canada, along with a number of Canadian provinces, considers bioenergy to be a legitimate and sustainable source of energy that will constitute a significant portion of future energy production. Shrub willow (Salix spp.) is a proven viable purpose-grown bioenergy feedstock. The objective of this four-year study was to examine the cycling of nitrogen, phosphorus, potassium, and sulphur within several high density willow stands during the first rotation, in order to forecast the long-term sustainability of these woody crop plantations grown on numerous soil types in Saskatchewan. Soil and plant samples were collected throughout the rotation and analyzed for their nutrient content. The results of this study indicate that sites with relatively fertile soils are more capable of sustaining willow productivity for multiple rotations compared to sites with marginal soils, where supplemental fertility will be required to sustain long-term production levels. Ensuring optimal soil fertility will help promote the sustainability of these purpose-grown biomass energy plantations.

SOIL NITROGEN SUPPLY AND GREENHOUSE GAS EMISSIONS OF SHORT-TERM AND LONG-TERM NO-TILL FERTILIZED FIELDS COMPARED TO AN ADJACENT NATIVE PRAIRIE

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With a world population now greater than seven billion, it is imperative to conserve the arable land base, which is increasingly being leveraged by global demands for producing food, feed, fibre, fuel, and infra-structure needs. The objective was to determine the effect of varying fertilizer nitrogen (N) rates on soil N availability, mineralization, and CO_2 and N_2O emissions of soils collected at adjacent locations with contrasting management histories: native prairie, short-term (10 years), and long-term (32 years) no-till continuous cropping systems receiving five fertilizer N rates (0, 30, 60, 90, and 120 kg N ha^{-1}) for the previous nine years. Intact soil cores were collected from each site after spring thaw, maintained at field capacity, and incubated at 22 ^{o}C for six weeks. Weekly assessments of soil nutrient availability along with CO_2 and N_2O emissions were completed. There was no difference in cumulative soil N supply between the unfertilized long-term no-till and native prairie soils, while annual fertilizer N additions of 120 kg N ha^{-1} were required to restore the N supplying power of the short-term no-till soil to that of the undisturbed native soil. Highest CO_2 fluxes from the native prairie soil are consistent with its high organic matter content, elevated microbial activity, and contributions from root respiration. Repeated applications of ≥ 60 kg N ha^{-1} resulted in greater residual inorganic N levels in the long-term no-till soil, which supported larger N_2O fluxes compared to the unfertilized control. The native soil N_2O emissions were equal to those from both short- and long-term no-till soils receiving repeated fertilizer N applications at typical agronomic rates (e.g., 90 kg N ha^{-1}). Eighty-eight percent of the native soil N_2O flux was emitted during the first two weeks and is probably characteristic of rapid denitrification rates during the dormant vegetative period after snow melt within temperate native grasslands. The use of modern no-till continuous diversified cropping systems, along with fertilizer N application, enhances the soil N supplying power over the long-term through the build-up of mineralizable N and appears to be an effective management strategy for improving degraded soils.

CALIBRATION OF TDR FOR SIMULTANEOUS MEASUREMENT OF LIQUID WATER AND ICE CONTENT IN FROZEN SOILS USING COMPOSITE DIELECTRIC MIXING MODELS

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Calibration curve for the TDR method to accurately estimate unfrozen liquid water content (θ_l) and ice content (θ_i) in freezing/frozen soils are required to characterize the freezing-thawing processes. Previous studies have calibrated TDR to measure θ_l in frozen soils, but we present and assess a method to accurately estimate both θ_l and θ_i in frozen soils simultaneously. Four multi-phase, composite permittivity models (Birchak model, spherical model, genreralized de Loor model and simplified de Loor model) were investigated to estimate θ_l and θ_i of frozen soils. These models were tested with published datasets that consisting of TDR-measured permittivity and independently measured θ_l on frozen soil samples with at least two unique initial water contents prior to freezing. The results showed that spherical model and simplified de Loor model have limited use in frozen soils. The geometric parameter (α) of Birchak model is dependent on temperature and initial total water content and is soil specific. Furthermore, the de Loor model can be parameterized in unfrozen soil conditions and then used to estimate θ_l and θ_i in frozen conditions.

EVALUATION OF THE IMPACT OF FALL COVER CROPS ON SOIL STRUCTURE IN HORTICULTURAL PRODUCTION SYSTEMS USING X-RAY COMPUTED TOMOGRAPHY

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Horticulture producers often plant cover crops to improve soil quality, but our understanding of the impact of such crops on soil parameters remains limited. This study is part of a broader field experiment, designed to evaluate the effect of four years of fall cover cropping on soil quality. The trial is a randomized complete block design, with cover crops seeded after the harvest of processing tomato (Solanum lycopersicum L.) in late September 2010. Treatments include: no cover crop control, oats (Avena sativa L.), fall rye (Secale cereale L.), oilseed radish (OSR) (Raphanus sativus L. var. oleiferus Metzg Stokes), and mix of OSR and rye (OSR+Rye) drilled at 80, 67, 16, and 9+34 kg ha^{-1}, respectively. In spring 2011, the trial was dised twice and commercial corn was seeded in late April. Intact cores of topsoil (64 mm diameter x 150 mm high) were collected in late October, just prior to harvesting corn in early November 2011; special care was taken to preserve the surface structure. Yield analysis has indicated that cover crop treatment had no effect on commercial corn production ($p=0.5133$). The soil cores were scanned twice, using a high-resolution EVS MS8x-130 X-ray microCT scanner, to capture digital imagery of the soil surface, as well as of the middle 3.5 cm tier (to represent the middle of the plow layer). The reconstructed 3D imagery represented real volumes of 33.6 mm x 33.6 mm x 24 mm (height), with a voxel size of 40 micrometres. Computerized image processing and analysis was done using GE Microview and NIH ImageJ software. Following standard Gaussian filtering of the 16-bit greyscale imagery, 3D semivariance analysis and vertical (Z-axis) profiling was conducted to quantify the spatial structure of X-ray attenuation (as a proxy for soil density). The greyscale imagery was then segmentated into void and solid phases; the resulting binary imagery was analyzed to quantify void morphology and variability of aggregation. Results are interpreted to evaluate the impact of treatment on both the bulk structure of the plow layer, as well as the nature of the surface crust - from the perspective of structural resilience.

SOIL FUNCTIONING IN A CHANGING CLIMATE: TOO WARM, TOO DRY OR TOO FROZEN?

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While global climate change research has focused heavily on projected changes in air temperature, the responses of soils will likely be complicated by interactions between temperature and precipitation. In particular, soil moisture is influenced by both warming and changes in the timing, frequency and size of precipitation events, and soil freezing dynamics are determined by interactions between air temperature and snow cover. Furthermore, soil functioning may respond strongly to climate-induced changes in plant cover, and other ecosystem-level factors. I examined soil responses to warming and altered precipitation in field studies, with an emphasis on soil functional responses, as revealed through changes in extracellular enzyme activity. I also explored how changes in air temperature and precipitation may alter snow cover and the frequency and intensity of soil freeze thaw cycles, along with soil responses to these changes. In general, soil moisture manipulations in field studies have had a much greater influence on soil processes than warming, but these results may reflect to some extent the low magnitude of soil warming achieved in many field experiments. In addition, soil functional measures that quantify potential activity in the laboratory often overlook likely soil responses to climate change in situ. With respect to changes in soil freezing dynamics, despite a general pattern of a decreased numbers of days of frozen soil and decreased numbers of days with snow on the ground, projected changes in the number of soil freeze-thaw cycles have been regional in nature. Changes to the intensity, duration and depth of soil freezing may also prove more influential for soil functioning than changes in the number of soil freeze-thaw cycles. Future challenges are to improve the mechanistic understanding of soil responses to climate change, and in particular linking changes in soil microbial communities to functional changes. Predicting the outcomes of plant-soil feedbacks to climate change also remains a priority.

PREDICTIVE PARENT MATERIAL MAPPING USING TOPOGRAPHIC INDICES: A RANDOM FOREST APPROACH

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Soil parent material is the material from which soils are derived. In the field of digital soil mapping, information about parent material plays an important role for predicting soils; yet, the number of methods for predictive parent material mapping remains few. In British Columbia, digital parent material data can be obtained from legacy soil surveys, surficial material maps, and terrestrial ecosystem maps; however, conventional mapping approaches can be expensive and time consuming. With advances in GIS and computing capabilities, numerous predictive approaches have been developed and applied in fields such as digital soil mapping, predictive ecosystem mapping, and ecological modeling. One such predictive approach uses Random Forest. Similar to decision trees, Random Forest is well suited for handling non-parametric data; it is not sensitive to the number of predictors; and is able to handle numerical, ordinal, and categorical datasets equally well. However, Random Forest has the additional advantage of incorporating 'randomness' into its prediction through reiterative bootstrap sampling and randomized variable selection when generating multiple decision trees. In this study, a parent material map is developed using Random Forest for the Lower Fraser Valley region of BC. Conventional soil survey maps are used to generate randomized training points for each parent material class. Values of topographic indices such as slope, curvature, wetness index, and slope position are extracted for each point. The point data is used for training Random Forest and parent material predictions are made at a spatial resolution of 100 m. This study provides an approach for efficient parent material mapping, which can be validated through fieldwork and can assist in future digital soil mapping, predictive ecosystem mapping, and geomorphic modeling.

ASSESSING THE CAPABILITY OF SOIL PROCESSES TO REDUCE THE POTENTIAL HEALTH HAZARDS OF NATURALLY OCCURRING ASBESTOS (NOA)

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Asbestos refers to a group of fibrous minerals that are considered to pose a severe health risk when inhaled. Naturally occurring asbestos (NOA) forms in the geology of a region. There have been few studies conducted on NOA, as opposed to commercial asbestos, and the health risks remain unclear. Asbestos fibers appear to become less toxic when 1) the surface layer that contains oxidizing metals is leached from the fibers surface and 2) the surface charge changes from positive to negative. Weathering in the natural environment may alter the surface chemistry of asbestos fibers, making them less hazardous. A landslide on Swift Creek, a tributary to the lower Fraser Valley Sumas River system, is dumping asbestos rock into the Sumas River. The asbestos material is deposited on the floodplain during flood events, where the sediment becomes airborne and poses a potential inhalation risk to local residents. We examined the surface chemistry of asbestos: [1] after treatment with naturally occurring organic acids and [2] as it moved through the Sumas River, to determine if naturally occurring organic acids in soil and stream environments are altering the surface chemistry of asbestos fibers and thus reducing their toxicity. Chrysotile fibers exposed to oxalic acid had a negative surface charge and a surface layer that did not contain heavy metals. Chrysotile samples taken from sampling sites along the Sumas River had a negative surface charge, but still contained some oxidizing metals in their surface layer. Time spent in the stream and soil environment alters the surface charge and surface composition of the fibers, likely making them less hazardous when inhaled. We may be able to speed up the rate the asbestos surface composition is altered, and thus detoxified, by stimulating natural weathering processes. Covering the deposited sediment with organic matter will generate organic acids that will, over time, change the surface charge of the fibers from positive to negative and dissolve and leach the oxidizing trace elements contained within the surface layer. The organic matter would act as a barrier, preventing the asbestos material from becoming airborne and subsequently posing an inhalation risk.

WATER AVAILABILITY WAS RELATED TO FOREST PRODUCTIVITY ON RECLAIMED UPLAND SITES IN THE ATHABASCA OIL SANDS REGION

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Reclaiming disturbed upland forest sites to equivalent land capability is a requirement for all mining companies in the Athabasca oil sands region. Peat-mineral mix over tailings sand or overburden is commonly used in oil sands reclamation. Water availability is a potential limiting factor affecting tree growth on these reconstructed soils. The purpose of this study was to examine water availability on sites that form a gradient of stand productivity. Stands of white spruce (Picea glauca (Moench) Voss) on peat-mineral mix over overburden, and lodgepole pine (Pinus contorta Dougl. ex Loud. var. latifolia Engelm.) on peat-mineral mix over tailings sand were selected on Suncor lease 86-17, which is 20 km north of Fort McMurray, Alberta. The 2011 growing season was drier and warmer than normal. Preliminary results indicate that on pine sites, diameter at breast height (DBH) increment and soil strength in the peat-mineral mix horizon, were negatively related through a regression analysis (r^2 =0.90 p=0.003). DBH and predawn shoot water potential were positively related (r^2 =0.73 p=0.03). Our results indicate that pine sites with low productivity were experiencing greater water stress, however white spruce sites did not show similar trends. Ongoing work includes the construction of soil moisture retention curves and the calculation of plant available water for each site; those data will be used to further evaluate the relationship between soil water availability and forest productivity.

SOIL ENZYME ACTIVITIES AND NITROGEN AVAILABILITY IN OIL SANDS RECLAIMED SOILS: INFLUENCE OF AMENDMENT TYPE, SOIL DEPTH AND SAMPLING TIME

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Soil enzyme activities and nutrient cycling are important indicators of biological functions in reclaimed soils. We studied the effects of amendment type, depth and sampling time on enzyme activities and nutrient release in oil sands reclaimed soils. Monthly field sampling was conducted in reclaimed sites at Suncor Energy Inc. in Fort McMurray, Canada during June to October 2011. Four random quadrats of 1 x 1 m in each10 x 30 m plot were used for soil sampling at 0-10 and 10-20 cm depth intervals in established plots with peat-mineral mix (PM) and LFH amendments. Four pairs of plant root stimulator probes were installed in each plot in June and removed in September for analysis of nitrogen supply rate. The results indicated that microbial biomass carbon (MBC) and nitrogen (MBN), NO_3-N and glucoaminidase activities were significantly higher in LFH than in PM whileNH_4-N and urease activities were not different between the two substrates throughout the sampling period. Significantly higher nitrogen supply rate was found in LFH than PM ($p<0.05$), suggesting greater organic matter decomposition in LFH than in PM. All parameters were higher in the 0-10 than in the 10-20 cm depth ($p<0.05$). This may be related to more decomposed organic matter in the 0-10 cm than in the 10-20 cm soil depth. The time of sampling had a large influence on analyzed parameters at both soil depths and on both organic amendments, indicating the environmental variability during sampling time. Overall results indicate that amendment type has the dominant control on biological functions and nitrogen availability in newly developed soil ecosystems in the oil sands reclaimed landscape.

EVALUATING MICROSCALE VARIABILITY PATTERNS OF CANADIAN TOPSOIL FROM X-RAY µCT IMAGERY

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The application of X-ray computed micro-tomography (µCT) in soil micromorphology has allowed researchers to quantify soil structure, particularly void space. Soil structure, including void space is reflective of soil developmental processes and management, and a major control on functionality through its influences on many physical, chemical and biological processes. The high resolution X-ray µCT imaging technology in conjunction with computerized image processing and analysis provides an objective evaluation of the 3D nature of soil structure, impartial to the operator. By employing the use of the X-ray µCT technique it has allowed for the examination of the variability in soil structure of top soils in Canada. Intact samples of topsoil from the Canadian Soil Thin Section Collection, archived at the University of Guelph were investigated. Attention was given to evaluate variability within the grey-scale imagery to allow for an improved understanding of the variability of soil structure, fundamental to refining criteria for distinguishing 'A' horizons in both natural and managed systems. The objectives of this study were to: (i) Classify a sampling of soils from across Canada using µCT and associated semivariogram parameters; (ii) Identify the distinctness and relationships of the created clusters to classification given with traditional defining constructs; (iii) Determine µCT variability parameters which distinguish soils of different clusters; (iv) Determine µCT variability parameters which distinguish soils of different horizon classification, specifically Ah and Ap. Six parameters each in the three orthogonal directions (X, Y, Z) of the x-ray images were determined from semivariogram functions of X-ray attenuation variability within samples. Cluster analysis identified three distinct groups that were partially related to soil taxonomy classifications identified in the field. Further, distinctions between parameters in Ah and Ap horizons were found. Cluster analysis of X-ray attenuation variability appears useful for revealing patterns of homogeneity and for identifying relationships among soil texture and structure. As technology to identify smaller forms of variability within the soil environment becomes available, numerical analysis may be a helpful method for correlating soil survey classifications with a large amount of data collected within the field and laboratory.

X-RAY COMPUTED TOMOGRAPHY OF THE MICROSTRUCTURE OF TOPSOILS FROM THE STATE OF RIO GRANDE DO SUL, BRAZIL

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This study is part of a multi-institutional initiative entitled "Quantification of the Micromorphology of Brazilian Soils", the primary objective of which is establish a reference database of structural parameters of major soils in the various bioclimatic regions of Brazil, using high-resolution X-ray CT imaging. The soils of this work are located within the state of Rio Grande do Sul, located in the subtropical, southern region of Brazil and have all been developed from basalts. Specifically, Chernossolos, Neossolos Regolíticos and Nitossolos comprise a toposequence in the area of Encosta Superior da Serra; the moderately deep Chernossolos occur on the lower slopes, the shallow Neossolos on the steeper slopes and the deep Nitossolos on the upper plateaus. Organic-rich Cambissolos are found in the higher altitude Campos de Cima da Serra, which has a colder and more humid climate. The deeper Latossolos are located on the lower elevation interfluves, characterized with higher temperatures. Intact cores (64 mm diameter x 150 mm length) were obtained from the surface A horizons of representative profiles of each soil order. These samples were then scanned, using a high-resolution EVS MS8-130 microCT scanner (at 120 Kv 170 mA), generating axial 2D imagery of 20 µm pixel sizes. Three-dimensional subvolumes (33.6 mm x 33.6 mm x 25 mm) were subsequently reconstructed at 40 µm voxel size, using filter back-projection; this imagery represented the middle tier (3.5 cm) of the sampled cores. The 16-bit grey scale imagery was analyzed (using NIH ImageJ) for both 3D semi-variance, run on the orthogonal axes of the imagery, to quantify the spatial variability of the soil structure, as well as for vertical profiling to evaluate relative apparent density (using X-ray attenuation as a proxy). Subsequently, the imagery was binarized to distinguish voids from solids, and the morphometric analysis of the detectable voids was conducted. Masking of the void network permitted more detailed analysis of the nature of the aggregated material. Ultimately, the goal of this research is to identify structure-based parameters, which can be used to quantify the state of these soils.

EFFECT OF CROPPING SYSTEMS ON NITRATE-NITROGEN AND PHOSPHORUS LOST BY LEACHING ON A SANDY LOAM SOIL INFLUENCED BY SWINE MANURE APPLICATION

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In Canada and Manitoba, hog manure is widely applied as an amendment to agricultural land. Hog manure provides nutrients and organic matter to the soil, so it may be an excellent agricultural resource. However, concerns about loss of nutrients to groundwater and streams are growing. The chemical characteristics of nitrate (NO_3^-)–N make it susceptible to leaching through the soil system and into water bodies. NO_3^-–N concentrations in excess of 10 mg L^{-1} in drinking water can cause significant risk to human health. Also phosphorus (P) is considered a pollutant due to its effects on promoting algal growth and eutrophication of surface waters. Elevated concentrations of NO_3^- and P in water bodies increase the costs of water treatment. Additionally, loss of nutrients from fields reduces the nutrients available to growing plants and may adversely affect yields, reducing returns to the producer. A field study was conducted at Carman (Ian N. Morrison Research Farm) on a loam soil to directly measure NO_3^- and P leaching from the root zone. A split-plot treatment structure was adopted with cropping system (annual and perennial) as the main plot and manure treatment (N-based liquid hog manure, P-based liquid hog manure, N-based solid hog manure, P-based solid hog manure) as the sub-plot in a randomized complete block design with 4 replications. The objectives of this study are to determine the influence of liquid and solid swine manure, cropping system and nutrient management system on the loss of water, as well as NO_3^- and P below the root zone. Leachate was collected from lysimeters (one per 10 m by 10 m plot) at intervals dependent on observed precipitation during 2011 growing seasons. The total volume of leachate from each lysimeter was recorded and the NO_3^- and P concentrations were measured. Soil samples were collected during spring, mid-season and harvest and analyzed for inorganic N and P concentrations. Total N and P uptake by crops were determined on oven-dry samples. Results on the effects of the various swine manure management strategies and cropping systems on the loss of water, NO_3^--N and P will be presented.

LONG-TERM EFFECTS OF AGRICULTURAL MANAGEMENT ON CROP YIELDS AND SOIL PROPERTIES – HIGHLIGHTS FROM SWEDISH LONG-TERM FIELD EXPERIMENTS

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Long-term field experiments (LTEs) are valuable for quantifying changes in soil fertility due to different agricultural management practices. Sweden has a rich tradition with several LTEs initiated in the 1950s. Here we present results from soil fertility LTEs with a focus on the effect of crop rations, crop residue management, fertilization and addition of organic materials on crop yields and soil properties. We also discuss the importance of LTEs for calibration and validation of a simple dynamic soil C model that is used within the Swedish national greenhouse gas reporting system. Crop residues and organic amendments applied to soil affected crop yields depending on nutrient concentrations in these materials. However, short-term effects differed from long-term effects due to feedbacks on soil fertility. Continuous applications of high-N organic materials such as farmyard manure, sewage sludge, household compost and green manure caused a yield increase whereas application of low-N organic materials such as straw, peat and sawdust in combination caused a two-phase yield response with initially declining crop yields that were converted to increasing yields exceeding those in the control after about three decades. Combinations of low-N amendments and N fertilizer resulted in higher yields than only N fertilization. The crop rotations also significantly affected soil C stocks. The higher soil organic matter contents induced by combining organic amendments and N fertilization were mainly explained by a higher root input, and the carbon sequestration increased with frequency of perennial forage crops in the rotations. Roots were found to contribute more than twice as much to refractory soil organic matter than a corresponding amount of aboveground crop residues. Thus, farming practices that lead to increased crop yields also resulted in increasing soil organic matter stocks. Averaged over ten LTEs, one kilogram of carbon was sequestered for each kilogram of nitrogen applied during 50 years. This positive feedback due to N fertilization can probably also explain why soil organic matter content could be maintained on many Swedish farms during recent decades even without applying manure or other organic materials. We emphasize that in addition to the short-term fertilizer value of organic amendments, the long-term effects on soil fertility should be considered including changes in bulk density and hydraulic properties. These LTEs also revealed that the crop responses to N fertilization were shown to be dependent on soil P status. Furthermore, it is also highlighted that management effects on subsoil C are not negligible, and that changes in soil structure following changes in soil C had a significant effect on crop yield potentials.

NITRATE PRODUCTION IN A SANDY SOIL AMENDED WITH CATTLE MANURE COMPOSTS TREATED WITH CHLORTETRACYCLINE

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Composted manures are widely used as soil amendments to increase ammonia oxidizing bacteria and nitrifying bacteria (Maeda et al., 2011) and consequently nitrate (NO3) level in soils through the process of nitrification (Chu et al., 2007). However, some compost made from animal manures may contain antibiotic growth promoters. There is little information on the nitrification process in coarse textured soils amended with manure composts containing veterinary antibiotics. An incubation experiment was conducted to monitor NO3-N evolution in an agricultural sandy soil amended with two composts receiving chlortetracycline (CTC) at seven incubation periods (0, 10, 20, 40, 80, 120, and 160 days) under triplicated controlled laboratory conditions. The soil had 20.1 g C/kg, 1.0 g N/kg, and a pH (H2O) of 6.3. The two composts were made from cattle manures and wood ships (CW) or straw (CS) and have received three rates of CTC (0, 450 and 2250 µg CTC/kg wet compost). The compost treatments were prepared by adding 0, 15.45 and 30.9 g CS/kg soil or 0, 12.5 and 25.0 g CW/kg soil in order to provide 0, 2.75 and 5.50 g total N/ kg soil. Results indicated that the percentage of NO3-N produced in sandy soil during the incubation period ranged from 0.5% to 7.0% and 1.5% to 7.5% in the soil amended with the highest rate of CW and CS without CTC, respectively. In general, soil amended with CTC-treated CS has produced larger amounts of NO3-N compared to soil amended with CTC-treated CW. The amount of NO3-N

produced in soil amended with CTC-treated composts was less than that in soil amended with composts without CTC (control). Overall, it can be concluded that applying 2250 µg CTC/kg wet compost did not affect markedly nitrification process in sandy soil amended with cattle manure compost.

PHOSPHORUS MANAGEMENT FOR VEGETABLE PRODUCTION IN ONTARIO HISTOSOLS

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This study was conducted in a significant Ontario histosol landscape in the Bradford, Holland, Colbar and Keswick marshes. Due to their physical characteristics, these organic soils are ideal for vegetable production and generate approximately $ 100 million annually in farm revenue. When first cropped, these soils had relatively low phosphorus (P) availability, however, fertilization over the years has increased soil P levels and potential for P loss. It is currently estimated that the polders contribute about 2 tonnes/year of P into Lake Simcoe. To address this issue, the study objectives were to evaluate improved phosphorus (P) management in vegetables produced on histosol soils through evaluating reduced phosphorus applications rates and phosphorus fertilizer placement. Both replicated small plot and large field sampling of yields, harvest storage quality, lysimeter for soil solution P, subsurface drainage water and P dynamics (sorption/desorption) was conducted over three years. The results of the P rate trials indicated Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) recommendations are a good guide to manage soil applied P for onions and carrots in histosols. Reduced phosphorus application rates showed no yield response and no reduction in post-harvest storage quality. Soil water collected from lysimeters and sub surface drainage demonstrated that the majority of the phosphorus was in a soluble form, and prone to leaching. Soil test P results of different P sources (soluble and particulate), indicated that phosphorus applied as fertilizer is leaching through the soil profile. The first step in mitigating P contributions from the marsh is to apply according to provincial recommendations based on the sodium bicarbonate extraction method. This project was funded by the Lake Simcoe Clean Up Fund, Environment Canada, and by the Nutrient Management Beneficial Management Practices (BMP) Demonstration Grant, Ontario Soil and Crop Improvement Association.

DIAGNOSTIC FOLIAIRE DE PRÉCISION D'UN CHAMP DE POMME DE TERRE AU QUÉBEC

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La pomme de terre est l'une des cultures qui consomment le plus d'engrais et se cultive dans des sols légers de faibles réserves en N, P, K, Ca et Mg. Ces cinq éléments sont les plus indispensables à la croissance des plants, à l'atteinte des bons rendements et l'obtention de bonne qualité des tubercules de pomme de terre à la récolte et à l'entreposage. La recherche d'un équilibre entre ces 5 proportions est l'un des défis de pratiques agricoles de précision. La collecte de 168 échantillons de feuilles de pomme de terre selon une grille de 40 X 60m dans un champ de pomme de terre de 54 ha au Lac-St-Jean et leur analyse en N, P, K, Ca et Mg au stade début floraison, jumelée à une lecture chlorophyllienne au SPAD502, nous a permis de constater les faits suivants : Parmi tous les indicateurs de diagnostic foliaire selon les 3 approches connues VMC, DRIS et CND, le contraste logarithmique entre les 2 éléments nutritifs type anioniques (N et P) vs les 3 éléments type cationiques (K, Ca et Mg), noté ilr (log ratio isométrique) du coda (compositional data analysis) est l'indicateur le plus fortement relié à la lecture SPAD (r=0,77). L'étude géostatique spatiale appliquée au Coda a montré une grande similitude entre l'ilr (anions vs cations) et la lecture SPAD. Cet ilr devrait être interprété en termes de fertilisation de démarrage (N+P), en lien avec les apports des cations sous forme d'engrais (K, Ca et Mg) ou d'amendement (Ca et Mg).

USE OF NITRIFICATION INHIBITOR 3,5-DIMETHYLPYRAZOLE IN ESTIMATING NET MINERALIZATION AND DENITRIFICATION RATES IN SOIL

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Mineralization and denitrification processes play important roles in nitrogen (N) cycling and occur at varying rates depending on soil aeration status. However, it is often difficult to estimate the rate at which these processes occur in soil. The objective of this study was to develop an experimental system which would allow measurement of the rates of net N mineralization and denitrification without the use of stable isotopes or acetylene. The approach evaluated was to use a nitrification inhibitor such that mineralization rate could be measured as the increase in soil ammonium concentration and denitrification rate as the decrease in nitrate concentration. Therefore, incubation experiments were conducted on a loamy soil to assess the efficiency of nitrification inhibitors. Experiment 1 compared Nitrapyrin, 3,5-dimethylpyrazole (DMP) and phenylacetylene to inhibit the oxidation of added NH_4^+ (50 mg N kg^{-1}) by incubating soil at 50% water-filled pore space (WFPS) and 25°C for 6 weeks. Only DMP (50 mg kg^{-1}) maintained the concentration of added NH4+ in soil. Experiment 2 assessed different concentrations of DMP (0, 5, 10, 25, 50 and 100 mg kg^{-1}) to test for inhibition of nitrification in soil amended with 50 mg NH_4^+-N kg^{-1} and denitrification of added NO_3- (100 mg N kg^{-1}) under aerobic (50%WFPS) and anaerobic (95%WFPS) conditions. In soil amended with NH4+, the percent inhibition of nitrification increased from 73 to 100% with increase in concentration of DMP from 5 to 100 mg kg^{-1} under both aerobic and anaerobic conditions. Essentially complete inhibition of nitrification was observed for DMP added at 50 and 100 mg kg^{-1} under both aerobic and anaerobic conditions. In soil amended with 100 mg NO_3^--N kg^{-1}, NO_3^- concentration remained almost constant throughout the incubation in soil treated with 50 and 100 mg DMP kg^{-1} under aerobic conditions, whereas under anaerobic conditions about 80% of added nitrate was lost in 2 weeks. Results of this study suggest that treatment of soil with 50 or 100 mg DMP kg^{-1} can be used to inhibit nitrification, and allow measurement of net mineralization and denitrification rates in soil under a range of soil water contents.

GEOSPATIAL MODELLING OF A-HORIZON THICKNESS AND SOIL C REDISTRIBUTION IN ERODED AGRICULTURAL LANDSCAPES

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This study is part of a larger investigation to characterize and determine the quality, quantity, distribution and the relative and absolute age of buried soil organic matter (SOM) under varying climatic and management conditions at various sites in Canada. The first part of the study characterized and reconstructed the history of Soil Organic Carbon (SOC) redistribution and burial over the past 60 years at five locations across Canada. Buried profiles varied in thickness from 45 cm to over 90 cm. The second component of this study included measurements every 2 m of the A-horizon thickness along 10 m transects established parallel, perpendicular and diagonally (45o and 325o) upslope and downslope of each soil pit along the slope. Comparison of SOC stocks to the thickness of the A-horizons from the sample pits has yielded very high R2 values. The A-horizon thickness (and subsequently the SOC) across the landscape was modeled using a derived down-slope index of a hill-slope (soil horizon depth distribution across the hill-slope) with the algorithm similar with the one for gravimetric water movement model developed by Beven and Kirkby (1979). An open source multi-scale or resolution feature landscape analysis toolkit was used in determining the desired scale or resolution for predictive soil mapping sensitivity analysis and feature selection at the process scale of interest. The predicted soil thickness distribution on hill-slopes was significantly correlated with measured field data. The SOC stock was derived for the study site near Middleton, P.E.I.

VIRTUAL SOIL SCIENCE LEARNING RESOURCES

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The Virtual Soil Science Learning Resources (VSSLR) Consortium (http://soilweb.landfood.ubc.ca/promo/) was established in 2004 with a goal to enhance soil science education through cooperative and innovative approaches to teaching and learning. The VSSLR has become the focal point for collaborative educational efforts among scientists, students, and multimedia experts from 7 universities and 3 research institutions in Canada. To date, the VSSLR Consortium has developed a total of 11 web-based educational tools, 2 distance education courses, 1 multi-institutional soil identification and classification field course, and 1 cross-disciplinary graduate program. The online, multimedia educational resources featured at the VSSLR website focus on (1) description of key concepts in soil science, (2) explanation of soil classification, (3) illustration of the land-use impacts on soil quality, and (4) raising awareness about importance of soil. By taking advantage of a great diversity of Canadian soil types and landscapes, the VSSLR website exposes learners to different soil types and ecosystems and a variety of soil management and sustainability issues. Learners are able to access information from various geographic regions, interact with other learners and professionals in the field and generally to broaden their learning perspectives. The VSSLR website is accessible through broadband internet, which is available at most public and private institutions, and even with the video content it is reasonably accessible to users on slower bandwidths. These resources are often applied in blended learning situations where they are used not only by distance education students but by on-campus students as well. To our knowledge, these educational tools are currently used by at least 2,000 students/year. Overall, the student response has been excellent and currently we are collecting student feedback to help us refine existing resources. The VSSLR marks the beginning of a process to create a suite of knowledge-rich, accessible online educational resources for the study of soil science and the development of a distributed community of practice in soil science in Canada and beyond. An interactive overview of the VSSLR website will be given during the presentation.

RELATIONSHIP BETWEEN LOWBUSH BLUEBERRY LEAF NITROGEN, CHLOROPHYLL AND POLYPHENOL CONTENTS

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A non-destructive measurement with optical instruments have been succesfully used in other crops to evaluate N status with leaf chlorophyll (Chl) and polyphenol(Phen) contents. The objective of this project was to determine the relationship between blueberry (Vaccinium augustifolium Ait.) leaf N concentration, leaf Chl and Phen contents at different times during the sprout year. The experiemental sites were located in Saguenay-Lac-St-Jean area on two blueberrry fields. Leaf samples were collected twice in July and in August during the sprout year to determine leaf N concentration. At the same sampling time, a non-destructive leaf sampling to estimate Chl and Phen contents was performed with SPAQ-502 (Minolta Camera Co., Ltd, Japan) and Dualex (Force-A, Orsay, France). Leaf N concentration was the highest at the beginning of July (2.34 %) and decreased as the season advanced (1.57 %). Leaf Chl content was the highest at the end of July (40.74 SPAD unit) and at the beginning of August (40.40 SPAD unit). Leaf Phen content increased as season advanced. However, leaf Phen content was the highest at the beginning of August (3.46 Dualex unit). Leaf N concentration was significantly correlated with Chl (R = 0.21 to 0.62), Phen (R = -0.39 to -0.76) and Chl/Phen ratio (R =0.24 to 0.80) at the different sampling dates. These preliminary results indicated that optical measurements of Chl and Phen content estimated correctly leaf N concentration but field calibration is still needed.

FERTILISATION EN CALCIUM ET EN MAGNÉSIUM DANS LA PRODUCTION DU BLEUET SAUVAGE

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L'accroissement de la productivité du bleuet nain sauvage (Vaccinium angustifolium Ait.) a eu comme conséquence de diminuer les concentrations foliaires en calcium (Ca) et en magnésium (Mg) sous les seuils minimaux des concentrations optimales établies. Ainsi, l'objectif de l'étude a été de déterminer l'impact de l'apport de Ca et de Mg sur la culture du bleuet et sur le sol. Quatre doses de sulfate de Ca (0, 540, 1080 et 2160 kg ha^{-1}) et de sulfate de Mg (0, 31,5, 63 et 94,5 kg ha^{-1}) ont été appliquées au printemps de l'année de végétation. L'expérience a été réalisée à six sites situés dans quatre bleuetières commerciales localisées au Saguenay-Lac-Saint-Jean de 2006 à 2010. Une fertilisation en azote (N), en phosphore (P) et en potassium (K) a été appliquée selon les recommandations au même moment. Le pH du sol a été mesuré dans l'eau. Les éléments nutritifs du sol ont été extraits avec la solution Mehlich 3. Le pH du sol a augmenté significativement avec les apports de Ca dans les couches de sol 0-5 et 5-20 cm. La teneur en Ca du sol a augmenté significativement avec les apports de Ca dans les trois couches de sol tandis que les apports de Mg ont augmenté la teneur en Mg dans les deux premières couches de sol de surface. Les concentrations en N, P, K et Ca des feuilles ont augmenté significativement avec les apports de Ca. Les apports de Mg ont augmenté la concentration en Mg des feuilles. Les rendements en fruits n'ont pas été significativement influencés par les apports de Ca et de Mg.

DRAINAGE OF CULTIVATED ORGANIC SOILS, EVOLUTION OF THE SOIL PROFILE

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Peatlands in southern Quebec have been drained at the beginning of the 20th century for vegetable agriculture. Drainage is known to enhance degradation of organic soils. However, agriculture on organic soils has also been highly productive, and increasingly intensive, causing problems of soil water infiltration and redistribution. Growers have to irrigate crops, while at critical locations water perched in the surface layer probably due to a textural discontinuity in the soil profile. The objectives of this study are to identify mechanisms conducting to bad drainage efficiency, and to analyze a simple solution to reestablish a textural continuity. Two drains were installed in a field characterized by a hard pan layer. Parts of these drains were installed by fulfilling with surface soil from drain to surface creating a textural continuity (treatment 1), and other parts were installed as growers do usually; by letting reinstate the soil stratification profile over the drain after the drainage mole passage (treatment 2). This experimental set-up was monitored two times in 2011, during dry and wet conditions in July and October, respectively. Water table level was recorded at 16 observation wells; 8 beside drains and 8 between drains. Soil water tension was monitored at 24 sampling points and 3 depths. Comparisons of infiltration velocities and hydraulic gradients were performed in R software. Results showed that drainage was effective in both treatments. Comparisons between treatments showed similar infiltration velocities. This result was supported by tension measurements, but these have also allowed the identification of a perched water table around 30-cm depth in a major part of October 2011. Results may be explained by the short delay between drains installation and measurements. Preferential flow could have occurred, rendering both drainage treatments equally efficient. Our hypothesis is that treatments will evolve differently overtime; therefore, differences in drainage efficiency should be expected in the second year. In order to optimize irrigation performances in organic soils, an efficient subsurface drainage system is required. This kind of optimization may signify important water and money savings

for growers. This study is part of a larger project for precision irrigation in organic soils.

ELEMENTAL AND ISOTOPIC COMPOSITION OF BOREAL FOREST SOM RESERVOIRS ALONG A CLIMATE TRANSECT: INDICATORS OF ENHANCED SOM DECAY RATES WITH WARMING

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Boreal soils store large amounts of C in the form of soil organic matter (SOM), most of it being resistant to microbial release through decomposition. According to thermodynamic laws, warming should increase the rate of C release to the atmosphere with relatively greater increases from the more resistant pools. The complex nature of the soil matrix and intrinsic environmental factors, however, make the realization of this theory difficult to assess empirically. In this study, we used the newly established Newfoundland and Labrador Boreal Ecosystem Latitudinal Transect (NL-BELT) to investigate the impact of climate warming on the degradation state of boreal forest SOM reservoirs. The use of a climate transect offers an opportunity to isolate the long-term impact of warming on intact boreal forests that are similar in several aspects except for temperature regime. We used the C:N ratio and C and N isotopic signatures of SOM as indicators of SOM degradation within different horizons of the soil profile: L, F and H horizons of the organic layer and podzolic B horizon of the mineral soil. In all three regions of the transect, the C:N decreased from the L horizon down to the mineral soil while $\delta^{13}C$ and $\delta^{15}N$ values increased, consistent with the expected increase in the state of SOM degradation with depth. The C:N of SOM in all soil horizons was generally lower in the warmest region of the transect while SOM was more enriched in ^{15}N, congruent with the idea that SOM in warmer regions experience relatively more degradation per unit time. Furthermore, the more extensive change in elemental and isotopic composition with depth in the warmest region suggests a potential increase in the capacity of microbes to decompose more resistant SOM in a warmer climate. In conjunction with estimates of organic matter inputs to these profiles, which are similar in elemental and isotopic composition, our results provide in situ evidence that boreal SOM reservoirs are likely to be destabilized by climate warming. More significantly these results suggest that an increase in the capacity of microbes to decompose more resistant SOM may persist with future climate warming.

EFFECTS OF DAIRY MANURE APPLICATION ON CO_2 FLUX AND $\delta^{13}C$ OF SOIL RESPIRATION FROM A SOIL WITH CARBONATE

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Applying dairy slurry on agricultural soils is a common practice. Previous research at our site has indicated that carbonates may be contributing to CO_2 fluxes. Application of manure may promote the inorganic dissolution of carbonates. The objective of this study was to investigate the effect of fall dairy manure application on CO_2 fluxes by using $\delta^{13}C$ to identify the sources of CO_2. The experiment was conducted at the Elora research station, Elora, Ontario, in November and December 2011, as part of larger study were CO_2 fluxes were measured using a micrometeorological technique. Two 4-ha plots subjected to conventional tillage practices were studied, with one of them receiving liquid dairy manure at a rate of 150 kg total N/ha at the middle of November. Two sets of gas samples for CO_2 analysis (one for stable isotope and one for CO_2 concentration measurement) were taken from closed non-flow through non-steady state chambers, using gas-tight syringes at times 0, 15, and 30 min. Four chambers per plot were inserted to a soil depth of 10 cm. To minimize effects of diurnal variation in emissions, samples were taken at the same time of day (10:30–12:00 eastern time) on each occasion. Soil gas chambers were sampled seven times at 1, 3, 5, 7, 15, 21, and 33 days after manure application. The results show that the highest CO_2 flux was at day 1 after manure application with 21 $\mu g\ m^{-2}s^{-1}$, and for the plot without manure application it was on day 5 with 14 $\mu g\ m^{-2}s^{-1}$ after soil disking. Preliminary results show that $\delta^{13}C$ of respired CO_2 (-20.8‰; obtained with the Miller Tans approach) is similar to soil organic matter $\delta^{13}C$ (-20.8‰) in the plot without manure application, and in the plot with manure application a more enriched value of -13.75‰ was

obtained compared to soil organic matter and manure carbon (-23.0‰). This suggests inorganic dissolution of carbonates due to manure application is contributing to CO_2 flux at this site.

N_2O ET CO_2 PRODUCTION IN FROZEN SOILS/ N_2O ET CO_2 DANS LES SOLS GÉLIFS

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Les mouvements de gaz dans les sols influence les échanges sol/atmosphère, jouant un rôle majeur dans la gestion de sites contaminés et dans la fertilité des sols. Ces mouvements de gaz ont été peu étudiés dans les sols gelés, malgré qu'ils soient présents partout au Canada. Un sol argileux, utilisé en pâturage pendant la saison estivale, a été instrumenté avec 49 points d'échantillonnage pour évaluer la formation de N_2O et CO_2 durant la saison froide. Les concentrations de CO_2 et N_2O dans le sol ainsi que celles émises à la surface du sol ont été mesurées à différentes reprises durant la saison hivernale. En parallèle, des propriétés physico-chimiques du sol, telles que la température et la concentration en O_2, nitrate et N ont également été mesurées. La variabilité spatiale et temporelle de concentrations en N_2O et CO_2 sera discutée en lien avec les propriétés physico-chimiques du sol.

Soil gas movement influences soil/atmosphere gas exchanges, playing a major role in various environmental and agricultural domains. Gas movement is ill known in frozen soils although most Canadian soils freeze part of the year. A soil under pasture management was installed with several instruments at 49 measuring points during the cold season. CO_2 and N_2O soil gas concentrations and gas emissions were measured several times during the season. Additional soil physical and chemical properties were also measured as temperature, humidity, nitrate and N content. Spatial and temporal variability of CO_2 and N_2O soil concentrations are discussed along with other soil properties.

WHAT CAN WE LEARN ABOUT SOIL RESPONSE TO CLIMATE CHANGE BY COMPARING OLD AND NEW SOIL SAMPLES?

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This presentation will focus on application of soil archives for studies of native soil responses to recent climate and environmental changes. I will talk about results obtained in two large projects: 1) study of Historic Russian Soil Collection (HRSC) and 2) studies of more recent soil archives encompassed by members of Northeastern Soil Monitoring Cooperative. The core of HRSC collection is represented by more than 60 soil profiles collected in late 19th, -early 20th century by Vasily Dokuchaev (1846 - 1903) and his collaborators in Russia, Poland, Kazakhstan and some other countries. The concept of HRSC as representative collection of native Eurasian soils was enhanced by approximately 1000 new soil profiles collected mostly in 1920-1970 period by researches from the Central Docuchaev's Soil Museum (Petersburg, Russia). Studies of subsamples from HRSC revealed trends in chemical properties of forest and grassland soils. More detail analysis of these trends showed signals from climate change as well as from atmospheric pollution. Native Step soils from southern Russia, for example, demonstrate visible loss of pedogenic carbonates. This particular trend must be solely attributed to fundamental changes in moisture regime of Russian plain during second part of 20th century. Previously unleached soils where precipitation was less than potential evapotranspiration are now being leached due to increased precipitation. At the same time, forest Podzols from Northwestern Russia showed acidification and changes in concentration of organic carbon which coincided in time with 20th century climate warming as well as increase in atmospheric acidic deposits. Our more short-term studies of forest soils archives from Northeastern US demonstrate changes in soil acidity as well as soil organic matter after the period of intensive acidification. More specifically, we observed a loss of soil organic matter which overlaps in time with very rapid soil warming and decline in acidic deposits. Overall our work demonstrates clear trends in soil chemical properties while the interpretation of these trends often is not unequivocal because of overlap in air pollution and climatic trends.

ÉVOLUTION ACTUELLE DE QUELQUES CARACTÈRES PÉDOLOGIQUES DES SOLS STEPPIQUES ARIDES DE L'ALGÉRIE OCCIDENTALE

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Au niveau des steppes arides du sud-ouest de l'Algérie (zones de Ras el ma et El aricha), zone de transition entre les paysages méditerranéens du nord et les paysages désertiques du sud, zone très affectée par la désertisation et la désertification, on a voulu observer quelques caractères pédologiques tels la texture des sols et les taux de la matière organique incorporées comme étant des indicateurs au niveau des sols dans des environnements touchés par des rigueurs climatiques souvent très sévères. La texture des différents sols analysés représentatifs de grandes surfaces arides est dominée par les sables, jusqu'à 70%. Elle est grossière notamment au niveau de l'horizon de surface. Ceci est relevé et confirmé par d'autres travaux traduisant ainsi in situ une évolution des sols steppiques vers une couverture pédologique de type désertique. Les taux de matière organique incorporée aux sols, et pour tous les échantillons relevés n'excédent point 2.03 % au sein des profils analysés. On assiste à des variations du taux de la matière organique qui individualisent des profils organiques, caractéristiques des profils de sols steppiques pauvres en matière organique. Le caractère essentiel de la matière organique des steppes est sa concentration superficielle. On constate aussi que ces concentrations diminuent selon un gradient nord- sud en relation avec une accentuation de l'aridité du climat. Aussi, on observe que la teneur en matière organique décroît avec la dégradation du couvert végétal. Mots clés : texture, matière organique, sols steppe aride, Algérie occidentale.

BASES DE DONNÉES PÉDOLOGIQUES ET DE QUALITÉ DES SOLS CULTIVÉS DU QUÉBEC

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La qualité des sols est une extension de la science pédologique (Norfleet et al. 2003). Les indices de qualité sont influencés par les pratiques agronomiques, mais l'étendue de leur variabilité est liée aux propriétés de nature génétique. L'appréciation quantitative de la qualité des sols cultivés nécessite donc la combinaison de bases de données sur les propriétés dynamiques des sols et sur les propriétés pédologiques. Au Québec, la quasi-totalité des sols cultivés a fait l'objet d'une couverture pédologique et 689 séries de sols ont été caractérisées et cartographiées. Un inventaire sur les problèmes de dégradation des sols agricoles du Québec a été réalisé afin de comparer, sur la base de la série de sols, l'effet des systèmes culturaux (prairie versus culture en continu [maïs, céréales, pommes de terre]) sur la qualité des sols (Tabi et al. 1990). La base de données de cette étude comprend des caractéristiques physico-chimiques comme la granulométrie, le carbone organique, la masse volumique apparente, la porosité et la stabilité des agrégats ([8-5] [5-2] [2-1] [1-0.2 mm]) de 16 405 couches associés à 164 séries de sols. De nombreuses propriétés de sols comme la texture ou l'agrégation constituent des données compositionnelles contraintes à une somme constante (1 ou 100 %). Afin d'éviter les biais de calculs occasionnés par la redondance et la résonnance entre les composantes (*D*), l'intégration des données compositionnelles à des équations de pédotransfert ou à des modèles agronomiques peut nécessiter l'utilisation de transformations log ratio isométriques (*ilr*). Ces balances *ilr* permettent le transfert de l'information brute de l'espace compositionnelle avec *D* composantes à l'espace des nombres réels selon *D*-1 partitions binaires séquentielles avec base orthogonale. Les analyses statistiques conventionnelles peuvent alors être réalisées sans biais (Egozcue et al. 2003). Des équations de pédotransfert élaborées à partir de balances *ilr* pour prédire la qualité physique des sols seront comparées aux équations établies avec les variables brutes. La synthèse de propriétés de sols dans des indices globaux de qualité pourrait être réalisée avec les balances *ilr*. Le degré de dégradation d'un sol donné (zone de gestion) par rapport à une référence (système prairie) serait alors quantifié par le calcul d'une distance Euclidienne entre les coordonnées *ilr* sélectionnées (Parent et al. 2012). Par ailleurs, la construction d'indices globaux à partir de données non compositionnelles pourrait être réalisée par indice compensatoire. Les indices globaux de qualité pourront notamment être utilisés comme

variables explicatives pour la méta-analyse des données reliées aux recommandations en fertilisation.

PRODUCING GRIDDED RASTER SOIL ATTRIBUTE PROPERTY MAPS FOR THE CANADIAN CONTRIBUTION TO THE GLOBALSOILMAP.NET PROJECT

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Agriculture and Agri-Food Canada is developing raster data products for the North American Node of the GlobalSoilMap.net initiative. Canada has a wide range of legacy soil data at a variety of scales collected over multiple decades. Current spatial soil information is provided as polygon maps that range in scales from the coarser Soil Landscapes of Canada – SLC - 1:1,000,000 to the finer scaled regional/provincial Detailed Soil Surveys that are portrayed through various scales between 1:10,000-1:250,000. Due to the diverse soil information related to these different spatial and temporal scales several scale specific versions of raster property maps have been developed that follow the techniques and meet the standards and specifications of the GlobalSoilMap.net project. Each version will successively utilize data of increased detail with the final product being a fully modeled continuous digital soil map. The versioning concept will allow for the raster data to be produced and validated in a time efficient manner.

PRELIMINARY RESULTS OF A SNOW SURVEY IN THE BLACK BROOK WATERSHED USING MANUAL METHOD AND A GROUND PENETRATING RADAR

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Studies on watershed hydrology and water quality have focused on rainfall events and rainfall induced runoff. In cold climate regions, such as in most of Canada, a large portion of the annual precipitation is in the form of snow fall. Snowmelt runoff has reported to consist more than 30% of the total runoff in several sites in Canada. However, our knowledge on snowmelt hydrology is limited, which has been identified as a major restriction on the modeling and interpretation of water quality at the watershed scale. One of the limitations is due to the lack of input information on snow depth, which is normally not uniform in a watershed and is affected by many factors such as climate, topography and land use. To better understand the snowmelt hydrology, Agriculture and Agri-Food Canada (AAFC) carried out a snow survey in the Black Brook Watershed (BBW) in March 2012. Thirty three snow cores were sampled from predetermined locations, which covers different land uses and slope positions. The snow depth ranged from 0.17 m to 0.74 m and averaged at 0.36 m. The water equivalent depth of the snow ranged from 0.06 m to 0.23 m and averaged at 0.10 m. Forested area had significantly deeper snow than cultivated area. Points on the edge of the forested area had the deepest snow. The variability within cultivated area is high and the variation is related to the slope position. Slope aspect did not show a significant impact on snow depth. A Ground Penetrating Radar (GPR) was used to measure the snow depth along transects. The GPR was effective in detecting the soil surface under the snow. The GPR data also demonstrated the strong effect of local topography on snow depth. Future studies are required to examine the use of these data for snow depth predictions.

IDENTIFICATION OF CRITICAL FACTORS AFFECTING N AND P LOSSES BY SPRING SNOWMELT RUNOFF UNDER LONG-TERM CONVENTIONAL TILLAGE

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Exports of nitrogen (N) and phosphorus (P) from agricultural land have drawn increasing attention because of the potential to degrade downstream water quality. A long-term microwatershed study was initiated in 1993 in southern Manitoba to identify the critical factors controlling N and P transport by snowmelt runoff. Flow over a v-notched weir on the downstream edge of the watershed was continuously monitored and step changes in discharge triggered automated water sample collection. Total and dissolved N and P were determined for water samples and nutrient loadings were calculated by interpolating concentrations between water samples. The flow-weighted mean concentrations and loads of N and P for the first half, second half, and yearly snowmelt runoff were calculated and regarded as response variables. A complex dataset consisting of management practices, climatic variables, and hydrologic variables were collected as predictor variables. The exports of N and P varied more than the respective concentrations due mainly to variation in volume of runoff (VR). Partial least square regression analysis indicated that critical factors affecting the water chemistry of snowmelt runoff varied depending on specific water quality variables and stages of runoff. Management practices such as fertilizer application rate, number of tillage passes, and residue burial ratio were critical factors for flow-weighted mean concentration of N but not for P concentration or nutrient loads. For all studied water chemistry variables at all stages of runoff, VR was the most important factor controlling N and P in runoff followed by snow water equivalent. The identified critical factors provide the basis for regional modeling of nutrient losses driven by snowmelt runoff, and will aid in the design of effective practices to reduce agricultural non-point nutrient pollution in downstream waters.

EVALUATION OF DSSAT CROP AND SOIL MODELS USING MAIZE-SOYBEAN ROTATION DATA WITH DIFFERENT TILLAGE IN NORTHEAST CHINA

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The DSSAT cropping systems model (CERES-Maize and CROPGRO-Soybean) and the CENTURY-soil model were employed to simulate soybean-maize rotations under no-till (NT), reduced tillage (RT) and conventional tillage (CT) systems from 2004 to 2011 in Black soil (*Mollisols*) in Northeast China. Measured crop yields at harvest and time-series soil water content and soil temperature were collected from the field experiment for model evaluation. Maize (*Zea mays*) and soybean (*Glycine max*) cultivars were calibrated under CT treatment and cultivar coefficients were evaluated using the measured yields under RT and NT. The result showed good agreements between the simulated and measured yields of soybean and maize in both calibration and evaluation (i.e., normalized Residual Mean Square Error (*n-RMSE*) 10-21%). The measured soil water content by soil sample method during 2004-2007 was accurately simulated in the 0-5 cm layer, but it was slightly over-estimated by the model in the 5-15 and 15-30 cm layers. However, the measured soil water content by the Time Domain Reflectometry (TDR) during 2009-2011 was well matched by the simulated data in the 0-20 cm layer with *d* (degree of agreement) values of 0.75 to 0.87; *E* (mean error) values of ±0.06 and *n-RMSE* values of 13% to 34%, respectively. Both the measured and the simulated results confirmed that NT enhanced soil water content compared with RT and CT, and there was no difference between the RT and CT. The simulated soil temperature showed reasonable agreement during growing season with the measured data in the 0-5, 5-15 and 15-30 cm layers in 2009, 2010 and 2011 with *d* values of 0.91 to 0.96 and *n-RMSE* values of 13% to 34%. However, the model under-estimated soil temperature in non-growing season in three years perhaps due to greater complexity of soil temperature changes with soil properties during the soil free and free-thaw process. The measured soil temperature under NT and RT was lower than CT by about 1 ^{o}C in the 0-30 cm layers, but no difference was found from the simulated soil temperature under NT, RT and CT.

EVOLUTION AND HISTORY OF DIGITAL SOIL MAPPING

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This presentation attempts to provide a summary description of the history and evolution of digital soil mapping (DSM) in 45 minutes. The description uses the universal model of soil variation as an overarching framework. This model is expressed as $Z(s) = Z^*(s) + \varepsilon(s) + \varepsilon$, where $Z^*(s)$ is the deterministic component of any prediction - which is the part of the variation that is predictable by means of some process-based soil-landscape model, $\varepsilon(s)$ is the stochastic component of any prediction - which is the part of the variation that shows spatial structure and can be modelled with e.g. a variogram and ε is pure noise - which is the part of the variation that cannot be predicted at the current scale with the currently available data and models. At any given scale ε itself has components for error in the deterministic part, the stochastic part and the remaining pure noise. Within this as an overarching framework, I propose to talk about the history and development of DSM in 3 stages of past, recent-present and future. Under each of these headings I propose to talk briefly about Theory, Concepts, Inputs, Models and Software. I will highlight major developments and improvements in DSM at each stage and provide a few examples of the main kinds of outputs. We will see how initially many DSM applications focussed principally on either the deterministic component or the stochastic component but rarely addressed both components in an integrated fashion. A key development in DSM has been the increasing number of approaches that fully integrate all elements of the universal model of soil variation. Looking into the future, we can anticipate DSM moving from diverse and scattered, single-scale, local efforts to map static soil classes or semi-permanent soil properties towards more integrated global and national multi-scale models for mapping both static and dynamic soil attributes in space and time and for continuously updating and improving all predictions in a systematic and optimised manner. I think it is important, especially for new DSM practitioners or ones who favor only one approach (e.g. deterministic soil-landscape type models versus kriging type models) to see the complementary nature of $Z^*(s) + \varepsilon(s)$ and to realise that it is not a contest between 2 competing approaches but rather a complementary situation in which both components are needed to contribute to an overall whole.

PHYSICAL PROPERTIES OF A BRAZILIAN LATOSOL (OXISOL) UNDER INTENSIVELY-MANAGED COFFEE

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In the coffee growing areas of Brazil, soil tillage normally negatively influences soil quality, by changing porosity, bulk density, as well as resistance to penetration, and hence the development of plants. Considering the normal development of most crops, 2 MPa is typically a critical limit of resistance, 0.10 m^3 m-3 of macroporosity, and bulk density ranging from 0.80 to 1.7 Mg m-3, depending on texture. The purpose of this study was to evaluate the physical properties of gibbsitic Latosols (Oxisols) subjected to an innovative system of coffee (Coffea arabica L.) production using intensive tillage. This study was conducted in an experimental area (1.05 ha) within a 3.5 year-old coffee plantation, belonging to the Piumhi Agricultural Company, located in the city of São Roque de Minas, Minas Gerais, Brazil. Crop establishment is usually done in November, and involves preparing planting furrows 0.60 m deep, the application of high rates of gypsum (28 Mg ha-1) and an initial correction of fertility; Brachiaria sp. is then planted between coffee rows, and a rigorous program of monitoring the nutrition of plants, based on leaf analysis, is followed for subsequent fertilizer recommendations. Three contrasting treatments were used for this study: G0 - no application of gypsum within the rows (0 Mg ha-1 of gypsum), G7 (7 Mg ha-1), and G28 (28 Mg ha-1). Intact soil samples were collected, in triplicate, using volumetric rings (2.54 cm high x 6.34 cm diameter), from depths of 0.20, 0.80 and 1.50 m along the coffee rows. These samples were analyzed for resistance to penetration (RP), bulk density (BD) and total pore volume (VTP); macro and microporosity were characterized according by Embrapa (1997). In general, high values of VTP and low values of BD and RP were observed. These results were attributed to deep soil tillage and maintaining Brachiaria sp between rows. No definitive influence of gypsum application rate could be determined.

ANALYSE GLOBALE DES IMPACTS DES EFFLUENTS D'ÉLEVAGE SUR LES STOCKS DE CARBONE DU SOL

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Les effluents d'élevage sont utilisés couramment par les agriculteurs en tant qu'engrais. Les fumiers et composts de ferme sont également appliqués dans l'objectif d'entretenir le niveau de matière organique du sol, améliorant ainsi la fertilité et la qualité du sol. Mais les changements des stocks de carbone (C) du sol suite à l'application d'effluents d'élevage sont variables dans le sens et dans l'amplitude. Les caractéristiques de l'effluent d'élevage et les facteurs environnementaux (propriétés du sol, climat, etc.) pouvant contrôler la réponse des stocks de C à l'application d'effluents d'élevage ne sont pas encore bien définis dans les recommandations du Groupe d'experts Intergouvernemental sur l'Évolution du Climat (GIEC). Il est nécessaire de mieux quantifier et de mieux comprendre la variabilité de cette réponse afin de contribuer à l'amélioration des inventaires nationaux des stocks de C organique du sol et à la validation de modèles de C organique du sol. Cette étude intègre les impacts de l'application d'effluents d'élevage sur les changements de stocks de C du sol mesurés sur une soixantaine de dispositifs expérimentaux à travers le monde (201 observations). La méta-analyse indique que le type d'effluent (solide/liquide), le climat, la texture du sol et l'origine animale de l'effluent dans une moindre mesure influencent l'augmentation de C organique du sol suite à l'application d'effluent. Plus précisément, le pourcentage d'accumulation de C suite à l'application d'effluent solide par rapport à une situation référence serait plus élevé que suite à l'application d'effluent liquide. La proportion de C de l'effluent retenue dans le sol serait plus élevée dans les régions tempérées froides que dans les régions tropicales. Cette proportion diminuerait avec la teneur en sables du sol. Enfin, cette proportion tend à être plus élevée pour l'effluent d'origine bovine que pour l'effluent d'origine porcine. Cette étude raffine l'estimation des facteurs de changements de stocks de C proposé par le GIEC pour les inventaires nationaux de gaz à effet de serre et contribue à la connaissance des facteurs contrôlant la proportion de C de l'effluent retenue dans le sol.

INTERACTING CONTROLS ON CH_4 AND N_2O EMISSIONS IN RESTORED VS. CULTIVATED WETLAND SOILS

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Both methane (CH_4) and nitrous oxide (N_2O) are important greenhouse gases with global warming potential values (CO_2 equivalency) of approximately 20 and 300 respectively. Their emissions are highly variable, both temporally and spatially. Methane production is strongly affected by the presence of alternative electron acceptors such as sulphate whereas high N_2O production is strongly correlated with an elevated, but not completely saturated, water filled pore space (WFPS) (≈80%). This study investigated the interacting effects of land use (restored grassland and cultivated grassland) and environmental variables (sulphate concentration for CH_4 and WFPS for N_2O) on the production of CH_4 and N_2O through two separate laboratory soil core incubations. Soil cores were collected from cultivated and restored ephemeral ponds in the St Denis National Wildlife Area, Saskatchewan. The CH_4 soil core incubation was a continuous anaerobic incubation with a 2-way factorial design using land use (cultivated or restored grassland cores) and sulphate treatments (control, low, medium and high rates). Methane concentrations from the soil cores were measured 10 times over the course of a 14 day incubation. The restored grassland cores had significantly higher rates of CH_4 emissions compared with their cultivated counterparts. Within the cultivated soil cores, sulphate-treated soils had net negative CH_4 fluxes beyond day 10 of the incubation, whereas the restored soil cores had little to no negative net flux taking place, regardless of sulphate treatment. The N_2O soil core incubation was an aerobic incubation using a 3-way factorial design, similar to the CH_4 incubation; however, WFPS levels (60%, 80%, and 120%) and nitrate additions (control and added nitrate) replaced the sulphate addition treatments. The N_2O flux rates were consistently higher in the restored land use cores. Under the nitrate addition treatments, both the restored and cultivated cores had the highest emissions at 80% WFPS whereas in the ambient nitrate cores, soils at 60% WFPS had the highest emissions rates. Additional results and conclusions will be presented.

COMPARING POINT-BASED AND EXPERT KNOWLEDGE-BASED APPROACHES TO PREDICTIVE SOIL MAPPING

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The presentation explores different methods for mapping soil properties in areas with limited soil information. The work was part of a larger project funded by the Joint Research Centre of the European Commission to investigate the potential for Digital Soil Assessment as a technique to improve the soil database for Europe. Two different approaches for generating detailed soil property maps were evaluated, a direct approach using existing representative profiles with measured soil properties and an indirect approach making use of a large number of augers bore points with only descriptive information. For the *first approach*, there were only 334 representative profiles available for the study area providing only a very limited representation of the feature space. An area with the highest density of representative profiles was chosen for analysis. The results clearly demonstrated that the available data did only cover about half of the feature space and consequently were not sufficient to be used for soil property mapping. For the *second approach*, there were about 20000 auger bore observations available with a completed soil series field. The data were used to generate a soil class (series) map in the first instance followed by soil property maps based on fuzzy membership values and generic database values. The project demonstrated the feasibility of mapping soil properties across large areas using this approach. However, the method is less reliant in areas were equal combinations of very diverse soils exist.

DIGITAL SOIL MAPPING IN SUPPORT OF THE IRISH SOIL INFORMATION SYSTEM

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The demise of the former national Soil Survey in Ireland left a serious data deficit in the Irish soils thematic area, needed to support and underpin a raft of policy and operational environmental decision making. The ISIS project has been funded by the Irish Environmental Protection Agency (EPA) to seek to address this issue through the application of modern digital soil mapping techniques deployed in tandem with traditional field survey techniques for sampling and validation. The project is led by Teagasc, the Irish agriculture and food development authority, with Cranfield University staff acting as technical consultants. The work involves a range of activities to develop a national Irish soils information base. The development of a national spatial data infrastructure for soil contributes to the European Commission's need for a unified European soil map and further facilitates member state legislative requirements under INSPIRE (Infrastructure for Spatial Information in the European Community) and the proposed Soil Framework Directive. The current national map, the Generalised Soil Map of Ireland, exists at 1:575,000 scale and is often applied inappropriately for the level of information required for many national applications. More detailed county soil maps cover 44% of the country with associated information on soil series, but there is no information on the remaining un-surveyed counties. The main project objective is to construct a soil map at 1:250 000 scale with a harmonised national legend, linked to associated soil data within a soil information system. Key components of the project are 1) rationalisation, harmonisation and correlation of Irish soil types; 2) digital soil mapping and predictive mapping techniques; 3) field survey for validation and sampling; 4) final national map development and publication preparation and 5) development of a Soil Information System and associated dissemination tools. The project relies primarily on DSM to generate soil maps, which has led to considerable efficiencies in guiding field survey effort. Four major components have been addressed in order to generate predictive soil maps; these are a) data compilation, b) inference development, c) model deployment and d) soil map validation. The final data products will provide for a strengthened Irish national

response to emergent policy and legislative developments in the area of environmental resource management.

ENVIRONMENTAL FACTORS INFLUENCING THE IMMIGRATION BEHAVIOUR AND DISPERSAL OF THE INVASIVE EARTHWORM LUMBRICUS TERRESTRIS

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Despite the ecological threats posed to North American forests by the invasive earthworm Lumbricus terrestris, the dispersal behaviour of this organism is poorly understood. This study investigated how environmental conditions influence the immigration behaviour of L. terrestris. Experimental mesocosms were used to control for leaf litter type (sugar maple or white pine) and the background population density of conspecifics (0 m-2, 25 m-2, or 100 m-2). Video recording was used to measure the latency between introduction and establishment. Choice chambers were used to test for selection between habitat conditions. A significantly greater proportion of individuals established in the presence of maple over pine litter ($p = 0.035$) although this preference did not result in a significant difference in latency. The time since establishment of the background population of conspecifics had a significant effect on earthworm habitat selection ($p = 0.038$), with an increasing preference for the high density habitat which became significant 6 weeks post background establishment ($p = 0.022$). Population density was found to have a significant effect on latency, with greater latency under the low density condition ($p = 0.016$). Additionally, potential methodological limitations of laboratory-based mesocosm studies were identified that should be considered when interpreting the results of this and similar studies. These results suggest that L. terrestris can detect differences in litter type and conspecific population density and can modify its immigration behaviour accordingly. These findings may be useful in predicting and responding to future dispersal patterns of this destructive invader.

SOIL TEST P DISTRIBUTION AS AFFECTED BY LONG TERM P AND N FERTILIZATION OF A GRASSLAND

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Soil testing for grassland fertilizer P recommendations in eastern Canada relies on soils sampled to a 15-cm depth whereas evidence from other countries suggests the use of a 5-cm depth. Our objective was to examine soil P concentrations in two layers (0-5 and 5-15 cm) in a long term timothy-based grassland established in 1998 on a gravely-sandy loam soil in Quebec. The experimental design was a split-plot with four P additions (0, 15, 30, and 45 kg P/ha [triple super phosphate]) as main plots and four N additions (0, 60, 120, and 180 kg N/ha [calcic ammonium nitrate]) as subplots with four replicates. Fertilizers were applied annually in the spring (1999-2006) and timothy was harvested twice a year. Soil samples for this study were collected in spring 2010; no fertilizers were applied from 2007 to 2010. In P-fertilized plots, Mehlich-3 P (PM3) concentrations were approximately three times greater in the 0-5 cm (63 to 128 mg/kg) than in the 5-15 cm soil layer (23 to 33 mg/kg). The PM3 concentrations increased with increasing P additions in the 0-5 cm soil layer. In the 5-15 cm soil layer, however, PM3 concentrations with all P additions were similar but were greater than with no applied P. This P accumulation in the 0-5 cm soil layer of P-fertilized plots appears to be caused by a lack of mixing of applied fertilizer in the soil through tillage because similar accumulations were observed for total N and P. Soil NH_4-N in the 0-5 cm soil layer was 1.4 times greater than in the 5-15 cm soil layer. In contrast, soil NO_3-N in the 0-5 cm soil layer was 2.5 times lower than in the 5-15 cm soil layer. The distribution of N with soil depth appeared to be mostly dominated by the mobility of N forms. As a consequence, Soil pH was significantly decreased by N additions but the decrease was much greater in the 0-5 cm than in the 5-15 cm soil layer. Our results suggest that the depth of soil sampling for grassland fertilizer P recommendations in eastern Canada should be re-examined.

SOIL P MODELING IN AGRO-ECOSYSTEMS USING A PROCESS-BASED MASS-BALANCE APPROACH

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Modeling changes in soil-available P in relation to P budgets should integrate the isotopic kinetic approach, which describes the dynamics of P ion transfer at the solid-to-solution interface. We tested a process-based mass-balance model that uses the quantity of P ions in solution, the diffusive P ions (Pr) in the solid phase, and the annual P budget to describe the soil P availability of a timothy (Phleum pratense L.) grassland and a corn (Zea mays L.) monoculture. Timothy was established on a gravely-sandy loam soil in 1998, with combinations of P (0, 15, 30, and 45 kg ha^{-1}) and N (0, 60, 120, and 180 kg ha-1) applied annually from 1999 to 2006. Corn was cropped between 1975 and 1992, with four P additions (0, 27, 79 kg P ha^{-1} every year and 52 kg P ha^{-1} every 2 years). An isotopic dilution analysis was performed on soils sampled in both cropping systems to calibrate the Freundlich kinetic equation that describes the dynamics of Pr transfer at the solid-to-solution interface as a function of time (t) and concentration of P ions in solution (Cp). Model simulations were performed over the duration of the cropping systems. Measurements of Cp were compared with simulated values to evaluate the model performance. The Freundlich kinetic equation was defined as: Pr = 7.78Cp0.41 t0.36 (with Pr < PrLIMIT, 192 observations, Adj. R^2 = 1.0, P < 0.001) for timothy and Pr = 5.72Cp0.69 t0.24 (with Pr < PrLIMIT, 144 observations, Adj. R^2 = 0.95, P < 0.001) for corn. For these two crops, simulations accurately reflected the long-term effects of fertilization on the trends of measured Cp and reproduced the most important patterns of the fate of soil P for the fertilization practices. This approach needs to be tested in various soil types and diverse cropping systems because the estimation of Pr can be quite sensitive to the transfer periods because of the variable extent of rapid and slow reactions. The proposed approach accurately describes the functioning of P cycling and confirms the agronomic importance of solution and solid phase P ions in managed grasslands and corn production.

PHOSPHORUS APPLICATION IN NO-TILL AFFECTS THE RELATIONSHIP BETWEEN SOIL TEST P AND P BUDGET

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More information is needed about the agronomic effects of conservation tillage in temperate and humid regions. Our objective was to determine whether No-till management affects the relationship between P budgets and soil test P in a corn-soybean rotation. The study site was established in 1992 on a clay loam soil (Dark Grey Gleysol). The experimental design is a split plot with no-till (NT) and mouldboard plough (MP) treatments assigned to main plots and nine combinations of 3 N (0, 80, and 160 kg N ha^{-1}) and 3 P (0, 17.5, and 35 kg P ha^{-1}) additions to subplots. Soil samples (0-15 cm) collected in all plots between 2001 and 2008 were analyzed for Mehlich-3 P (PM3). Soil tests PM3 concentrations in unfertilized P treatment were similar in the NT and MP. In contrast, NT maintained greater PM3 concentrations than MP in the fertilized P treatments. Under MP, we calculated that a P budget change of 100 kg P ha^{-1} would change PM3 by 12 kg ha^{-1} Under NT, a linear relationship was not obtained across P treatments, but for the unfertilized P treatment the rate of decrease of PM3 was similar to those obtained under MP. For fertilized NT treatments, however, the change in PM3 was more than proportional to the P budget. We concluded from this study that the P budget approach was not appropriate to monitor the soil P status in the rooting zone of fertilized NT soils due particularly to challenges in sample collection. We therefore suggest a more detailed sampling that integrates the variability caused by the absence of mixing the fertilizer with soil.

DIGITAL SOIL MAPPING TO SUPPORT FIELD WATER MANAGEMENT

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This presentation summarizes a decade of geospatial R&D applied to soil and water management at the farm and watershed scale supported by IRDA's team, as part of several cooperative rural watershed initiative's in southern Quebec. These projects took advantage of LIDAR technology, multi-spectral imagery, soil morphological data, soil erosion surveys as well as hydrometric/water quality monitoring data in developing and validating a set of field-scale diagnostic and management tools for farming collectives involved in the sustainable development of their watersheds. Digital maps and atlases were made available to the several region's farmers and agronomists in order to: (i) support field-scale drainage diagnostics and custom design in land development, (ii) predict runoff, erosion and phosphorus yields from alternate cropping systems (iii) detect and manage soil properties variability according to a soil zone management approach. From a water management perspective, management tools first integrated soil reflectance indices to detect poor drainage, together with LiDAR derived DEM's to precisely picture spatial patterns in runoff and drainage capacity and design structural runoff controls. Fields' vulnerability to runoff, erosion and phosphorous exports were also quantified and mapped according to their soil properties, topography, land management and cropping practices, using a P-EDiT management tool. Drawing additionally on LIDAR data, Land MapR© software (MacMillan et al., 2000) served to delineate the territory under study according to a host of topographic attributes and classify it into distinct hydro-pedological zones. Building from relationships derived between soil surface reflectance and inherent soil properties, a method to delineate digital cartography of the variability in soil properties across the watershed was further developed and validated. The approach is currently under on-farm operational testing within three watersheds from the Montérégie region.

LANDSCAPE AND MANAGEMENT DRIVERS OF HYDROLOGIC REGIME AND WATER QUALITY FROM AGRICULTURAL WATERSHEDS

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A network of twin micro-watersheds weas established within five rural communities of Estrie, Témiscouata, Mauricie, Missisquoi and lower Yamaska, Québec. The objectives of the research-action network are to (i) develop of a better understanding of non-point source sediment and nutrient transport dynamics in varying landscapes and agricultural production sytems of rural Quebec, (ii) document the water quality response to best management practices of local stakeholders initiatives and (iii) develop and validate field and farm scale management tools dedicated to soil and water management. The stream stage-velocity-discharge relationships of the micro-watershed were derived from continuous bubler and acoustic doppler data. Continuous sediment flux and hydrogaph separation for surface runoff and subsurface/drain flow were derived from turbidity and electrical conductivity signals using multi-parameter probes moving vertically within the water columns. Nutrient fluxes were determined from event sampling, analytical determination of nutrient concentrations and flow:concencentration modeling considering distinct seasonal and flow strata. Total water yields (260-840 mm/yr) and surface runoff (68-267 mm/yr) during the 2009-2011 monitoring period reflected the effects and interactions of climatic (snowmelt) > soil properties > land use gradients. Sediment yields (88-1,236 kg TSS/ha-yr) were best explained by the interaction of soil properies (drainage classes) and cropping systems (annual crops), with significant influence of natural wetlands. Total phosphorus yields (0,62-5,82 kg P/ha-yr) were shown correlated to sediment yields, with particulate P varying from 50 to 91% of total P yields. However, P speciation amongst watersheds largely differed from sediment and total P gradients. Bioavaibility indices (5 to near 100%) reflected contrasting P sources (manure, field and stream bank/bed sediments) and hydrologic pathways (surface, subsurface). These observations recall the preeminent importance of two main lines of agroecosystem defence: the control of nutrient sources and their transport. The first calls for manure application timing and incorporation methods which minimize runoff-driven P

losses, as well as long term management of soil P enrichment. The second calls for the control surface runoff through cropping systems improving soil quality and crop residue cover, as well as riparian zone management including structural runoff controls.

DETERMINING CRITICAL SOURCE AREAS AND BMP PLACEMENT AT CATCHMENT SCALE: BRAS D'HENRI AND FOURCHETTE WATERSHEDS WEB'S CASE STUDY

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Bras D'Henri and Fourchette's basins, Québec, provides a better comprehension of the non point sediment and nutrient transfers from the landscape to the stream, as well as evaluations of the effectiveness of best management practices in reducing the sediment and nutrient loadings to the stream. A specific component of the research program aims at developing tactical tools to locate critical source areas (CSAs) within the watersheds and recommend site-specific BMP suites. The project is fundamentally based on the overarching conclusion drawn from the results obtained in the first WEBs study that the performance of a specific best management practice (BMP) may significantly vary when implemented in different agri-ecosystems as function of their cropping practices, landscape and soil properties. The translation of WEB's I and II principal findings into operational tools designed to locate and propose optimal, site-specific BMP's is conducted under an approach relying on remote sensing, aquatic monitoring and hydrologic modeling: 1) The hydrological responses of both experimental basins are spatially described and classified based on the analysis and integration of airborne and satellite multispectral images, topographic and flow path indices derived from LiDAR data, as well as soil survey data; 2) runoff, sediment and nutrient yields monitored at micro-watershed's outlets are upscaled at basin scale, considering typologies developed from terrestrial spatial data. The timing as well as the spectral and spatial resolution of different satellite images (Landsat TM-T, Quickbird, Ikonos and SPOT IV) were compared in their ability to discriminate soil wetness across the area of study. Results stress the avantage of relying on a multi-dates approach in developing wetness indices, as well as the best predictive power of bands 4 (INB4) and 7 (IBN7). Low resolution images (Landsat) proved to be efficient in expressing the natural pattern in drainage, while the other high resolution images captured the drainage artefacts, at intra-field scale. The LiDAR-derived indices complement the image-derived inherent sol wetness by providing some interpretation of landscape influence in land drainage. It is anticipated that the development of catchment scale diagnostic and planning tools will favour the concerted action of rural stakeholders by providing a global perspective on triggers of contaminant transfers and means to prevent them.

WATERSHED EVALUATION OF BENEFICIAL MANAGEMENT PRACTICES (WEBS) IN THE LOWER LITTLE BOW RIVER WATERSHED: STREAMBANK FENCING

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The WEBs (Watershed Evaluation of BMPs) program is a national program funded by Agriculture and Agri-Food Canada and administered by AESB (Agri-Environmental Services Branch), and was initiated in 2004. Various BMPs are being evaluated at nine watersheds across Canada, including the Lower Little Bow (LLB) River watershed in southern Alberta. Streambank fencing is one of the BMPs that has been evaluated since 2004. A 800-m reach of the LLB River was fenced in 2001 and off-stream watering installed. We have evaluted water quality and aquatic insects at upstream and downstream sites along this reach, streambank erosion, fish communities, soil properties in the riparian zone, as well as soil, vegetation, and runoff properties in the ungrazed and grazed pastures associated with streambank fencing. Fencing was found to prevent pollution of the river by cattle, aquatic insects were greater at the downstream than upstream site on certain sampling dates but not for majority of dates, and streambank erosion was lower for the fenced than unfenced reaches downstream. The findings from this BMP evaluation will be discussed.

LONG-TERM EFFECT OF FRESH AND COMPOSTED CATTLE MANURE ON THE SIZE AND NUTRIENT COMPOSITION OF DRY-SIEVED SOIL AGGREGATES

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Application of feedlot manure to cropland may impact the size distribution and nutrient content of soil aggregates. The objective of this study was to determine the effects of fresh or composted feedlot manure containing straw or wood-chip bedding on dry-sieved aggregate size distribution and nutrient contents. Surface (0-15 cm) soil samples were obtained from a long-term field experiment where treatments were fresh (FM) or composted manure (CM) containing straw or wood-chips applied annually at 0 (control) or 77 Mg/ha/yr for 11 yr. Air-dried soil samples were separated using a rotary sieve into six aggregate size fractions ranging from <0.47 mm to >12.7 mm. Total C, total N, C:N ratio, soil mineralizable N (41-day incubation), total P, soil test P, and P saturation index were determined on the six aggregate fractions. The amendments significantly ($p \leq 0.05$) increased the proportion of smaller (<0.47 mm) aggregates and decreased the proportion of the larger (>12.7 mm) aggregates relative to the unamended control. The geometric mean diameter (GMD) was also lower and wind erodible fraction (WEF) was greater for the amended treatments than unamended control. We attributed this manure effect to increased organic matter content in the soil making the aggregates more friable and susceptible to breakdown by tillage. Carbon, N, and P concentrations were not shifted to smaller aggregate sizes where root growth and nutrient uptake are generally greater. The exception was mineralizable N which tended to be greater in the finer < 0.47 mm fraction. Mineralizable soil N in all aggregate sizes ≥ 0.47 mm was reduced for wood-chip compared to straw bedding, and resulted in net N immobilization in aggregate sizes ≥ 1.2 mm.Phosphorus sorption was lower in soil amended with wood-chips compared to straw bedding for aggregates ≥0.47 mm. Long-term manure application may shift soil aggregates from larger to finer fractions because of greater friability and suggests that these soils should be managed to avoid the greater risk of wind erosion.

LIMING: AN EFFECTIVE TREATMENT TO MAINTAIN REPRESENTATION AND HEALTH OF SUGAR MAPLE IN ACIDIC AND BASE-POOR SOILS

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Dolomitic lime ($CaMg(CO_3)_2$) was applied in 1994 at rates of 0 to 50 t·ha^{-1} to sugar maples (SM) (*Acer saccharum* Marsh.) in a base-poor and declining northern hardwood stand subjected to a high level of acid deposition in Quebec. The soil chemistry and the SM nutrition, growth, crown vigor, and regeneration status were evaluated 15 years after treatment. The soil chemical properties still responded strongly to lime after 15 years. Similarly, the foliar Ca and Mg concentrations were still higher for treated trees relative to the control trees. After 15 years, the mean crown dieback of trees decreased quadratically with the lime rate, from 39% for the control trees to a value of 1 to 3% for the lime rates of 5 t ha^{-1} and higher. Additionally, the stem basal area increment for the limed trees was nearly double that of the unlimed trees in 2009. The lime application was also beneficial to the SM regeneration. The overall SM seedling density increased with the lime rate, being nearly twice as much in the 50 t ha^{-1} (32 seedlings m^{-2}) compared with the controls (16 seedlings m^{-2}). The proportion of the SM seedlings to all of the other species increased quadratically from 22% in controls to more than 55% in the 5 to 50 t ha^{-1} treatments. In contrast, the proportion of the competitive species decreased quadratically with the lime rate including American beech (*Fagus grandifolia* Ehrh.) for which the proportion in the treated plots (24%) was nearly half the proportion observed in the controls (46%). These results show that a single lime addition has long-term beneficial effects on the soil chemistry and the SM nutrition, vigor, growth, and regeneration in base-poor and declining northern hardwood stands. Moreover, the results confirm that liming is an essential tool to restore the SM representation and health in acidic and base-poor soils.

PREMIÈRES MENTIONS DE VERS DE TERRE DANS TROIS ÉCOSYSTÈMES FORESTIERS DU BOUCLIER CANADIEN

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Dix espèces de vers de terre furent dénombrées lors de travaux effectués à Duchesnay, à la Forêt Montmorency et dans le parc des Grands-Jardins, trois écosystèmes forestiers du Bouclier canadien dont les conditions de pH du sol et de climat étaient, en apparence, inadéquates pour la survie de ces organismes. La présence de vers de terre dans les deux écosystèmes boréaux visités s'ajoute aux rares mentions de vers de terre en forêt boréale nord-américaine. Les résultats de nos travaux laissent supposer que le territoire propice à leur présence ou à leur colonisation au Québec est plus étendu que ce que l'on croyait antérieurement. La présence de vers de terre dans ces trois écosystèmes forestiers semble reliée à leur utilisation comme appât pour la pêche sportive. Aussi, nos résultats démontrent que la tolérance à l'acidité de certaines espèces de vers de terre est encore mal connue. Compte tenu de l'effet probable de la colonisation des écosystèmes forestiers par les vers de terre sur certains processus (p. ex. : recyclage des éléments nutritifs, cycle du carbone) et composantes (p. ex. : diversité faunique et floristique), il appert qu'une meilleure connaissance de la répartition des vers de terre pourra nous aider à mieux expliquer les changements susceptibles de survenir dans les écosystèmes colonisés.

USE OF HYPERSPECTRAL VEGETATION INDICES TO ASSESS POTATO CROP NITROGEN STATUS

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In a context of sustainable agriculture, the amount and timing of nitrogen (N) fertilization represents a leading issue, especially for potato (Solanum tuberosum L.) crop since N is an essential element for plant growth and tuber yield. Therefore, the ability to assess in-season crop N status from non-destructive methods such as proximal sensing is a promising alternative to improve N fertilization management as well as uptake efficiency and minimizing environmental losses. The objective of this study was to evaluate the effectiveness of hyperspectral vegetation indices (VI) to reveal N status of a Russet Burbank potato crop throughout the 2011 growing season in Ste-Catherine-de-la-Jacques-Cartier, Québec. The crop was established on a Morin sandy loam. A randomized complete block design consisting in four N fertilization rates (i.e. 60, 120, 200 and 280 kg N ha^{-1}; N source: ammonium sulfate applied 40% at-planting and 60% at-hilling) plus an unfertilized control was utilized to assess our objective. Crop biomass was sampled biweekly from 40 to 84 days after planting (DAP) for the determination of Nitrogen Nutrition Index (NNI) as the reference for N stress. Moreover, foliar N content analyses were performed on different dates during the growing season. Weekly hyperspectral reflectance data derived from a portative spectroradiometer (ASD FieldSpec HandHeld) was used to compute three different VI: Normalized Difference Vegetation Index (NDVI), Red Edge (RE) 740/720 index and Modified Chlorophyll Absorption Reflectance Index (MCARI). Primary results revealed a high correlation (r2=0.74) at 66 DAP between RE and foliar N content in addition to significant correlations starting at 50 DAP. Further analyses are conducted to assess other VI such as the Transformed Difference Vegetation Index (TDVI) in order to select the most sensitive indices to NNI variation.

DESCHAMPSIA CAESPITOSA GROWTH AND TRACE ELEMENT UPTAKE FROM CONTAMINATED SOILS

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Industrial sites often contain several trace element (TE) contaminants whose varying chemical, physical, and biological behaviours make remediation efforts complex. The use of plant species which can accumulate multiple contaminants may be a suitable remediation technique, especially for large contaminated areas which warrant inexpensive and in situ remediation methods. Most previous phytoremediaton studies have focussed on phytoextraction from soils contaminated with only one or a few TEs. The objective of this growth room study was to examine the growth of multiply-harvested Deschampsia caespitosa in contaminated soils and its effectiveness in taking up TEs. Potted D. caespitosa plants were grown with or without fertilizer in two contrasting soils (organic and mineral) contaminated with multiple TEs from a smelter. Two non-contaminated soils (organic and mineral) were included for comparison. Above-ground biomass was harvested three times and assessed for yield and TE concentrations. Preliminary results from the first harvest show that above ground biomass was affected by both soil type and fertilizer addition with the highest yield coming from the fertilized non-contaminated mineral soil. Also, D. caespitosa accumulated significantly higher concentrations of lead, arsenic, cadmium, copper, and zinc from the contaminated organic soil than from either of the non-contaminated soils. Further results from the second and third harvests will also be presented in this poster. Knowledge gained from this study will contribute towards the development of effective phytoremediation strategies for soils contaminated with multiple TEs.

SORBED AND AQUEOUS PHASE CHROMIUM SPECIATION DURING REDOX-SORPTION TREATMENT OF CONTAMINATED WATER

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Chromium (Cr) is a common contaminant due to its extensive use in industries such as metal processing, wood treatment, and pigment production. The effect of Cr contamination on environmental and human health is heavily dependent upon its speciation. Hexavalent chromium [Cr(VI)], a known carcinogen that dominates Cr-contaminated groundwater, is highly mobile due to its anionic form. Trivalent chromium [Cr(III)] is much less toxic and relatively immobile due to its cationic form. The objective of this study was to characterize Cr speciation during redox-sorption treatment of water containing Cr(VI). Various concentrations (0-15 mM) of sodium dithionite were added to 10 mM Cr(VI) solutions to give six Cr(III):Cr(VI) ratios ranging from 0:1 to 1:0. The resulting Cr solutions were then treated with one of two iron (Fe) oxide sorbents synthesized from either ferric chloride or ferrous chloride. After a 24-hour reaction period, the Fe oxides were removed by filtration and rinsed. They were then analyzed for Cr and Fe speciation by x-ray spectroscopy. The speciation of Cr remaining in the aqueous phase was determined using ultraviolet-visible and atomic absorption spectroscopy. Preliminary results show that both types of Fe oxide sorbed Cr and that the ferrous-derived oxide may have experienced Fe speciation changes due to the treatment. Also, as more dithionite was added to the Cr(VI) solution to give a higher aqueous Cr(III):Cr(VI), Cr(III) increasingly dominated the sorbed fraction. Since Cr(III) is sorbed more strongly than Cr(VI), these results suggest that redox-sorption treatment using Fe oxide and dithionite may be a viable remediation strategy for Cr(VI)-contaminated groundwater.

DIAGNOSTIC NUTRITIONNEL DU GOYAVIER (PSIDIUM GUAJAVA) AU BRÉSIL

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Le Brésil est le premier producteur mondial de goyaves du type rouge. La nutrition minérale des goyaviers a une incidence directe sur la productivité et la qualité des fruits récoltés. Afin d'améliorer le diagnostic nutritionnel de cette espèce fruitière, nous avons mené une expérience pluriannuelle en vergers commerciaux irrigués dans la plus grande région productrice de goyaves du pays, à Vista Alegre do Alto, dans l'État de São Paulo, avec des goyaviers 'Paluma' âgés de sept ans cultivés sur un Ultisol. Le dispositif expérimental était un plan factoriel en blocs aléatoires, soit quatre doses d'azote combinées à 4 doses de potassium, répétées trois fois. Il y avait cinq arbres par parcelle. Les doses d'azote étaient 0, 500, 1000 et 2000 g N plante-1 et celles de potasse étaient 0, 550, 1100 et 2200 g K2O plante-1. Les sources d'engrais étaient de l'urée (45% N) et du chlorure de potassium (60% K2O). Nous avons évalué l'état nutritionnel du tissu foliaire, la fertilité du sol, la production et la qualité nutritive des goyaves au cours de trois cycles de production. L'analyse statistique a montré que l'engrais azoté augmentait l'acidité du sol. L'application d'engrais potassique a augmenté le K échangeable dans le sol. La production de fruits a augmenté avec les doses de N. Les rendements ont fluctué selon la saison de récolte (l'été ou l'hiver). L'analyse compositionnelle avec la transformation log ratio isométrique (ilr) orthonormale a montré une forte altération dans la balance [K] | [Ca, Mg] dans le sol et les feuilles avec l'application de K. La période à laquelle les feuilles et les sols ont été échantillonnés a affecté la quasi-totalité des ilr dû soit à des variations saisonnières (hiver/été) soit, pour les métaux polyvalents, à des applications variables de pesticides.

COMPARING GEOSTATISTICAL INTERPOLATION TECHNICS AND *E*-SVR MODEL TO DIGITAL MAPPING OF SOIL SURFACE TEXTURE USING RADARSAT-2 DATA

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This study aims to assess the contribution of RADARSAT-2 polarimetric SAR data in digital mapping of soil surface texture (sand, silt and clay contents) of the Rouville County, near Montreal, Canada. Firstly, compositional data transformation using isometric log ratio (ilr) was applied on soil texture data in order to transpose the simplex into multidimensional real space which is more suited to statistical analysis. Thereafter, two assumptions on the relationships between radar data and the *ilr* components were evaluated: a) as linearly dependent by applying cokriging (CO) and regression kriging (RK); and b) as nonlinearly dependent by applying the novel nonlinear SVM regression (the ε-insensitive support vector regression - SVR). The results were compared to the ordinary kriging (OK). The environmental variables used to define composite covariates were different polarizations and polarimetric parameters from H/a/$\bar{\alpha}$ eigenvalues sets, the Freeman - Durden and the Touzi decomposition algorithms. Using 283 soil samples for training and 88 for validation, the results showed that the prediction error (RMSE) obtained by OK was 10.8% for silt 11.4% for clay and 13.7% for sand respectively. The ε-SVR produced the best prediction accuracy compared to the geostatistical interpolation technics. Compared to OK, the improvement of the digital mapping accuracies (% RMSE reduction) with ε-SVR was significant: RMSE reduction = 16.5% for sand, 29.0% for silt and 27.9% for clay. It was followed by RK with RMSE reduction ranging from 14.0 to 24.6% and then CO (2.5-27.7%). Among the studied digital soil mapping options, using SAR polarimetric data extracted from RADARSAT-2 images as covariates were found to be very useful to digital mapping of soil surface texture. The polarimetric parameters related to soil surface moisture were found the most significant ones among the covariates in term of DSM accuracy.

GREENHOUSE GAS EMISSIONS FROM ANNUAL AND PERENNIAL CROPS FERTILIZED WITH SOLID AND LIQUID HOG MANURE

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We compared the effects of liquid and solid swine manure on direct and indirect nitrous oxide (N_2O) emissions, methane (CH_4) emissions and soil respiration from soil during the growing season of 2011 at the University of Manitoba Ian N. Morrison Research Farm in Carman, Manitoba. The experiment was a split-plot design, with two cropping systems (annual vs perennial) as the main plots and nutrient treatments as subplots with four replicates per treatment combination. Nutrient treatments include liquid (LHM) and solid (SHM) hog manure. Manures were incorporated and left on the soil surface for annual and perennial systems, respectively. Unfertilized plots were included as a control (CON). We used the static chamber method to measure direct soil N_2O emissions, CH_4 emissions and respiration, and lysimeters to estimate N leaching for indirect N_2O emissions associated with those losses. Soil temperature, moisture and available N levels were also measured. In the annual system, SHM significantly improved soil moisture (11-15% higher) relative to the CON and LHM treatments likely due to improved soil organic matter level with the addition of the solid hog manure while soil moisture was unaffected in the perennial system because of surface application. Average soil nitrate concentration increased in the following order: CON<LHM<SHM in the annual system and CON<SHM<LHM in the perennial system. Across cropping systems, emissions of N_2O increased markedly following manure application with average N_2O emission rates of 0.03, 0.1 and 0.2 kg N ha^{-1} d^{-1} in the CON, SHM and LHM plots, respectively. In the annual system, N_2O emissions increased sharply following LHM and SHM application, whereas in the perennial, only LHM promoted N_2O emissions. In both annual and perennial systems, unamended plots consumed CH_4, whereas both LHM and SHM promoted CH_4 emission from soil, with much higher emissions occurring within 2 weeks after manure application to the annual plots. Soil respiration was significantly (P=0.002) affected by manure amendment; plots receiving SHM respired 13 and 21% more CO_2 relative to LHM and CON plots, respectively. Nitrate leaching and indirect N_2O emissions were low in the perennial system but increased 3.2-fold in the annual system. These preliminary results suggest that the perennial system amended with SHM is more efficient in terms of limiting greenhouse gas emissions.

NEW TECHNOLOGIES FOR DSM TO SUPPORT TRADITIONAL SOIL SURVEY

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Soil is a fundamental natural resource, the basis of human life. Knowledge and understanding of soil characteristics and behaviours are necessary to insure conservation of soil quality and to maintain soil productivity potential for future generations. Traditional soil surveys have generated great knowledge; however, this approach is often too expensive and time-consuming to answer the needs of soil data users, who are increasingly demanding more precise and reliable information on the spatial and temporal variability of soil characteristics. The increasing power of tools such as geographic information systems, global positioning systems, remote and proximal sensors are suggesting new ways forward. “Predictive” or “digital” soil mapping (DSM) has emerged to address the challenge of better understanding and viewing these large data sources describing soil distribution and functioning. In order to describe selected tools used in DSM work at various survey intensity levels (SIL1, 2, 3), this presentation will provide an overview of some research results obtained by the Pedology and Precision Agriculture Laboratories of AAFC in the last ten years in collaboration with CSA, INRS-ETE and UQAM. Combining an ASTER and a multitemporal series of RADARSAT-1 images gave good classification accuracy of soil drainage in the Bras d’Henri watershed (SIL3) while the combination of one LANDSAT-7 and a series of RADARSAT-1 images was successfully used to produce digital maps of soil surface texture groups in the Monteregie area (SIL3). Using ancillary variables derived from a fine quad-pole RADARSAT-2 image and different spatial inference models (cokriging, regression kriging and support vector machine regression) allowed significant reduction of the root-mean-squared error (RMSE) associated to digital maps of sand, silt and clay contents produced by anisotropic ordinary kriging at the 1: 20000 scale (SIL 2) in the Rouville county (Monteregie). Fine spatial resolution imagery (IKONOS, Quickbird, CASI) and proximal sensing technologies (soil electrical conductivity and gamma radiometry) improved the precision of DSM at the microwatershed (SIL2) and field (SIL1) levels. Digital maps of sand, silt, clay, and organic matter content, maximum

phosphorus sorption capacity and soil drainage are very helpful when implementing precision agriculture and conservation. When available, geo-referenced soil morphological databases collected during soil survey work can also be used as ancillary variable sources for improving DSM of analytical soil properties. In this way, DSM does not replace traditional soil survey work, it just proposes to use soil legacy data in combination with new technologies to carry forward our knowledge and understanding of the soil resource.

DIGITAL SOIL MAPPING USING MORPHOLOGICAL AND ANALYTICAL SOIL LEGACY DATA AND GEOSTATISTICAL ANALYSIS

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Around 48000 soil profiles have been described during soil survey works conducted by Agriculture and Agri-Food Canada between 1982 and 2009 in the Monteregie agricultural area, located in the south-east of Montreal. These data have been coded, georeferenced and stored in archives. The objective of this poster is to demonstrate the usefulness of morphological soil data (MSD) as ancillary variables when cokriging (CO) analytical soil data (ASD). The usefulness will be assessed in terms of reducing the root-mean-square error (RMSE) associated to digital soil maps (DSM) of sand, silt and clay contents of the surface layer (0-30 cm) derived by CO in comparison to ordinary kriging (OK) of ASD. The analytical soil dataset was split into two parts, one for training (n=3055) and the other for validation (n=1352). Soil particle size analysis was determined by the hydrometer method. In the MSD set, soil texture (by feel) has been recorded at the subclass level (19) according to the Canadian System of Soil Classification standards. These qualitative data have been converted into percent of sand, silt, and clay contents using the average value of each soil textural subclass computed from ASD. As sand, silt and clay contents are compositional data, they were transformed by using isometric log-ratio (ilr1 and ilr2). Afterward, a back transformation was applied on the digital maps of ilr1 and ilr2 to obtain sand, silt and clay maps which sum is always equal to 100. Anisotropic and isotropic semivariograms, ordinary kriging and cokriging were computed using Geostatistical Analyst toolbox of ArcGIS v10. Anisotropic models were selected as being more efficient (Jackknife cross-validation test). Variographic analyses revealed the presence of a high spatial structure (C/(C0+C)>0.75) for ilr1 and ilr2. Compared to OK, CO using MSD significantly improves DSM accuracies by reducing RMSE (RMSE reduction of 12.0% for sand, 7.5% for silt and 6.0% for clay). Using compositional analysis gives better digital soil texture maps than using raw particle-size data. When available, morphological soil data recorded during conventional soil survey works should be used for deriving DSM.

CORN NITROGEN RESPONSE AND RESIDUAL SOIL NITRATE ARE AFFECTED BY SOIL TEXTURE, N RATE AND GROWING SEASON CONDITIONS

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Appropriate N management needs to consider the specific relations between soil texture, growing season characteristics, and N fertilizer rate. This study conducted on a 15-ha field near Montreal, (Canada) assessed the effect of soil type (clay, clay loam, and fine sandy loam), year (2000 to 2002), and N fertilizer (0 to 250 kg N ha^{-1}) on corn (Zea mays L.) yield and N uptake, economic optimum N rate (Nop), and residual soil nitrate (RSN). The effects of N fertilization, soil texture (fine sandy loam>clay>clay loam), and year (2000>2001>2002) were highly significant on corn yield and N uptake. Averaged across years, Nop was 181, 161, and 125 kg N ha^{-1} in the clay, clay loam, and fine sandy loam, respectively. High amounts of RSN (0-0.20 m) were observed in 2000 (165 kg NO_3-N ha^{-1}) and low ones in 2002 (30 kg N ha^{-1}). Soil texture effect was significant on RSN evaluated to 0-0.60 m in 2002 with values ranging in the following order: clay (218 kg NO_3-N ha^{-1}) > clay loam (182 kg NO_3-N ha^{-1})> fine sandy loam (118 kg NO_3-N ha^{-1}). Estimated RSN at Nop (13 to 77 kg NO_3-N ha^{-1}) were much lower than the measured ones (30 to 165 kg NO_3-N ha^{-1}). Nitrogen rate equivalent to Nop would have allowed decreasing RSN by 100 kg NO_3-N ha^{-1}.

Variable rate N application according to soil texture and to the Nop can reduce input production costs and therefore environmental risks by decreasing RSN.

THE ABILITY OF SOIL CHEMICAL AND BIOLOGICAL INDICES TO PREDICT SOIL NITROGEN SUPPLY OF CONTRASTING SOILS

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Assessment of the soil nitrogen (N) supply capacity is essential to optimize N fertilizer use. The soil N supply capacity of soil samples (0-15 cm) collected from 2004 to 2007 across four Canadian provinces was evaluated by comparing a group of chemical N availability indices with soil mineralizable N pools and a field-based measure of soil N supply. Soil N supply was estimated by corn (*Zea mays* L.) N uptake corrected for starter fertilizer N. Two subgroups were created based on the soil texture and were compared to the whole data set. Grouping soils provided limited benefits in predicting soil potentially mineralizable N (N_0), but improved the prediction of soil N supply. The N_0 was weakly related to soil N supply for the whole data set (r = 0.09) and in fine-textured soils (r = 0.37) but the relationship was improved (r = 0.68) in medium- to coarse-textured soils. The N_0 was not necessarily a good predictor of soil N supply under field conditions which emphasizes the need to also consider environmental conditions. The UV absorbance of a 0.01 *M* $NaHCO_3$ extract at 205 nm ($NaHCO_3$-205), the hot KCl extractable NH_4-N (HotKCl-N) and Pool I (a labile mineralizable N pool) plus NO_3-N were the most promising N availability indices because they are easy to perform and they were positively and significantly related to soil N supply in the whole data set as well as the soil texture subgroups ($0.28 \leq r \leq 0.62$). This study demonstrated that grouping soils based on texture can increase the proportion of variation in soil N supply explained by N availability indices when data from contrasting environmental conditions, soil types and years are used

SOIL QUALITY ASSESSMENT AND RATING FOR PEAT-MINERAL MIX COVER SOILS IN OIL SANDS RECLAMATION

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Peat mineral mix (PMM) is widely used as cover soils as an integral part of oil sands reclamation for developing healthy forest stands. Peat materials at different stages of decomposition are mixed with sandy substrates that are considered to have a fair quality, mostly from B horizons of Brunisols, selectively salvaged during the pre-disturbance stage of the mining operation. The objective of this research was to examine the impact of mixing peat materials with mineral soils on the overall quality of cover soils used for reclamation. We developed and applied a quality rating framework for PMM using non-linear scoring functions. The functions were based on the relationship between the carbon content of the PMM and soil quality indicators such as water holding capacity, cation exchange capacity, and nitrogen concentration, among others. Soil physical, chemical, and nutrient dynamics related indicators were observed to improve with increasing carbon concentration. An increase in the peat proportion in the PMM increased water holding capacity. This presentation will demonstrate the development of soil quality ratings based on the relationship between soil carbon concentration and soil quality indicators related to overall reclamation goals.

CHEMICAL FRACTIONATION OF HEAVY METALS IN SEPARATED AND UN-SEPARATED LIQUID SWINE MANURE

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Due to accumulation of heavy metals in soils and subsequent plant uptake, it is important to investigate effects of processing technologies on chemical forms of metals in livestock manure prior to application to farmlands. This study is a part of a broad research project to characterize the elemental composition and partitioning of nutrients in liquid swine manure separated into liquid and solid fractions by various techniques. The specific objectives were to determine the bioavailability of metals in the swine manure and separated solid-liquid fractions using the sum of water-soluble and exchangeable metals, and to examine the efficiency of separation techniques in partitioning bioavailable metals into the solid fraction. The raw manure was separated by three techniques: (i) centrifuge method with a flocculant; (ii) centrifuge method without a flocculant; and (iii) rotary press with a flocculant. The compositions of Cd, Cu, Zn, and Ni in the raw manure and separated solid-liquid fractions were determined using the modified sequential fractionation scheme of Sposito et al. (1982). Samples of the raw manure (RM), separated liquid (SL) and separated solid (SS) were sequentially extracted with deionized water, followed by KNO3, NaOH, Na2EDTA, and HNO3, to characterize water soluble, exchangeable, organically-bound, carbonate-precipitated, and residual metals, respectively. Concentrations of metals in extracts were determined using an ICP-OES. Concentrations of water-soluble Cd and Ni in the manure fractions were: SL > RM > SS, while amounts of water-soluble Cu and Zn were: SL > SS > RM ($p < 0.05$). The trend in bioavailability of metals in the raw manure and separated solid and liquid fractions was generally consistent with that observed for metal solubility in water. The centrifuge method with addition of flocculant was the most efficient technique in partitioning bioavailable metals into the solid fraction. This study showed that the partitioning of environmentally and agronomically available metals is influenced by the separation technique. These findings will also help to facilitate the choice of a suitable solid-liquid separation technology for livestock manure processing.

PROVISIONAL SOIL CA, K AND P THRESHOLDS FOR SUGAR MAPLE (ACER SACCHARUM MARSH.) IN SOUTHERN QUEBEC

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The objective of this study was to determine the accuracy of currently suggested soil norms for diagnosing foliar Ca, K, and P deficiencies in sugar maple (Acer saccharum Marsh.) stands, and to develop better soil norms for providing more accurate diagnoses of limiting nutrients for sugar maple, as it would be diagnosed using available foliar norms. The dataset used for calibration comprised 246 sugar maple stands in southern Quebec. Also, independent data from the literature were used to validate the developed soil indicators and associated thresholds. With respect to predicting Ca deficiency, the combination of Ca saturation of the mineral B horizon (threshold: <= 28.4%), and the humus Ca/Mg ratio (<= 5.322) and Ca saturation (<= 59.7%) best partitioned the foliar Ca diagnosis with an overall accuracy of 80.5%. This combination had a better accuracy than the previously suggested soil thresholds for diagnosing Ca deficiency. With respect to predicting K deficiency, the combination of either optimum thresholds of the K/Mg ratios in the humus (<= 0.324) and upper B (<= 0.436) soil horizons and the humus Ca/Mg ratio (<= 4.382) had the best overall accuracy (76.3%). With respect to predicting P deficiency, the combination of base saturation (<= 33.4%) and Mg saturation (<= 9.6%) of the mineral B horizon and humus K/Mg ratio (<= 0.187) yielded a conservative diagnosis with 92.0% specificity and an overall accuracy of 72.3%. The overall accuracy of the developed soil classifiers for the diagnosis of Ca, K, or P deficiency with the validation dataset was similar as with the calibration dataset ($p >= 0.141$). There was no difference in accuracy for the developed soil thresholds between distinct physiographic formations (Appalachians or Laurentian mountains; $p >= 0.530$). The developed soil thresholds represent a major improvement in the diagnosis of Ca, K, and P in sugar maple stands in southern Quebec compared to the recommended current soil thresholds.

ANALYSIS OF INFORMATION QUALITY ASSOCIATED WITH AN INTEGRATED USE OF SPATIAL AND TEMPORAL SOIL DATA

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A number of site-specific crop management practices, such as fertilization and irrigation, rely on accounting for spatial and temporal changes in soil attributes. Combining both types of measurements is achieved by placing temporal monitoring soil sites in field areas representing different water and nutrients holding capacity. For example, to optimize irrigation scheduling, sets of soil water content monitoring sites have been used to measure soil water depletion in field locations at different elevations and with different soil types. It has been known that selecting proper locations for the monitoring sites could affect data interpretation quality. This work investigates the effect of the number and placement of temporal soil matric potential monitoring sites when estimating a water stress indicator in every location of the field during a crop growing season. It has been found that a low number of temporal monitoring sites can be used with relatively low water stress index prediction error once locating these sites is done according to a set of selection criteria. The study was completed using soil sensor maps from six large production fields and a multivariate model relating water stress index to field elevation and apparent soil electrical conductivity.

L'ANALYSE COMPOSITIONNELLE EN SCIENCE DU SOL : REVISITER LE PASSÉ ET PRÉPARER L'AVENIR

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L'analyse compositionnelle des données (CoDa) prend racine au 18ième siècle avec le diagramme ternaire de Tobias Mayer où sont décrits les mélanges des couleurs primaires rouge, jaune et bleue en diverses proportions. Au 19ième siècle, il fut utilisé dans les études sur les mélanges de métaux dans les alliages et sur la compatibilité des liquides (a+b+c = 100%). Au début du 20ième siècle, il fit son entrée en pétrologie puis en classification des roches, des sols et de l'eau. Au tournant du 20ième siècle, Karl Pearson mettait déjà les biologistes en garde contre les fausses corrélations générées par la façon d'exprimer les éléments d'une composition. En 1934, Lagatu et Maume présentèrent le premier diagramme ternaire illustrant les interactions entre N, P et K dans la plante. Pourtant, l'espace compositionnel clos à 100% possède des propriétés numériques encore ignorées systématiquement dans le traitement des données compositionnelles qui pourtant constituent la plupart des bases de données en sciences de la nature. La raison est la façon de passer de la géométrie de la distribution des données dans un triangle à leur analyse algébrique non biaisée. Les premiers efforts en ce sens furent accomplis en agronomie par E.R. Beaufils avec le DRIS dont l'empirisme a été corrigé par L.E. Parent et M. Dafir pour l'adapter au formalisme de CoDa élaboré par John Aitchison en 1986. C'est en 2003 que Juan José Egozcue et Vera Pawlowsky-Glahn développèrent le concept des balances entre les composantes d'un tout. Les concepts de CoDa ont permis à L.E. Parent et à ses collaborateurs de vérifier des théories et des hypothèses sur l'agrégation des sols, l'équilibre nutritif des plantes, la décomposition des matières organiques dans les sols et la contamination de l'eau. Ces concepts, qui tardent à s'installer en sciences des sols et en écologie comme ce fut le cas en géologie il y a 25 ans, offrent de grandes possibilités pour mieux comprendre les processus de transformation de la matière et améliorer la classification des sols, de l'eau, de l'air, des plantes (signature nutritive) et des résidus organiques (e.g. C et N organiques) à partir de leur composition.

ANALYSE DE DONNÉES EN SCIENCES DU SOL AVEC R

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L'analyse de données en sciences du sol demande d'effectuer des séries de calculs variant en nombre et en complexité. R est un logiciel libre (donc gratuit) reconnu comme une option de premier choix pour l'analyse de données, notamment pour sa fiabilité, sa convivialité et la grande étendue de ses capacités. En effet, de nombreux modules peuvent être greffés à R, dont certains permettent d'effectuer les opérations nécessaires à l'analyse compositionnelle, l'ordination écologique ou pédologique, la méta-analyse et la géostatistique. Or, ces techniques, pour lesquelles les tableurs sont peu adaptés, sont de plus en plus utilisées en sciences du sol. Cette communication donne un aperçu des possibilités offertes par R en science du sol.

ESTIMATING ADEQUATE TIME SPANS FOR SOIL HYDROLOGY FIELD EXPERIMENTS

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Humankind has shown an interest in soil hydrology for thousands of years, mainly in terms of improving agricultural productivity. Recently, applications of soil hydrology are numerous and far-reaching including irrigation management, surface water and groundwater contamination, groundwater recharge, flood forecasting, climate change modeling, drainage system design, civil engineering, etc. Soil hydrology can be expressed through the soil water balance (WB) equation: WB = P + ET + RO + D ±S; where P is precipitation, ET evapotranspiration, RO runoff, D drainage, and S change in soil water storage. If each component of WB is measured without error, WB = 0; otherwise, WB is a positive or negative quantity, its magnitude depending on relative errors in P, ET, RO, D, and S. Using deterministic models, such as DRAINMOD 6.0 applied in this study, WB is generally less than 1% and therefore is ignored. In terms of the remaining components, S changes very little from year-to-year, but depending on soil, plant, and weather conditions, the remaining components may vary substantially. Often environmental policy development requires long-term average values of these four components. Therefore, soil hydrological data must be collected over a long enough time period to be meaningfully applied to policy development. The main objective of this study was to estimate the required minimum time span for soil hydrology field experiments that will yield meaningful data for scientific analysis and/or environmental policy development. Since long-term field data is relatively scarce, the WB for 12 regions of Ontario were estimated with DRAINMOD 6.0 using three different generic soil textures (sand, loam, and clay) and daily climate data over a 48-year period. Moving average and autocorrelation approaches were applied to the model output to determine the required time spans for achieving P, ET, D, and RO that are within a specified range of their long-term average values. Results generally show that P and ET require a much shorter duration than D and RO to generate average values that approach corresponding long-term average values typically used in environmental policy development. This study accentuates the importance of maintaining long-term field sites for soil hydrology data collection.

ANALYZING AND IMPROVING THE WATER-TABLE FLUCTUATION METHOD OF ESTIMATING GROUNDWATER RECHARGE

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The focus of the project is on measuring and quantifying groundwater recharge (GWR) using the water-table fluctuation (WTF) method. This method requires measuring the change in water-table (WT) height (Δh) during recharge (R) events and volumetric soil specific yield water content (θ_{S_y}), (*and/or*) perhaps more correctly volumetric soil fillable water content (θ_F). The rise in WT can also result from other non-precipitation-related WTF causes (e.g., Lisse effect, temperature variations, barometric, lateral flow, Reverse Wieringermeer effect, encapsulated air, pumping), which must be counted for. The measurement of the storativity (S) terms (θ_{S_y} *and/or* θ_F) is, indeed, not clear-cut and often they are taken as being constant with depth, time, WT movement (Drying-Wetting) history and heterogeneity. In fact, these two terms are controversial in their definition, thus in their use, in the literature and may either overestimate the R, when using θ_{S_y}, or underestimate it, when using θ_F. To resolve some of these questions, a novel-automated method is under development, at the University of Guelph's Elora Research Station (ERS) and Arboretum, along with a novel multi-event time series model.

The long-term expected outcomes and significance of this study are;

1. Establishing accuracy in defining and evaluating the θ_{S_y} and θ_F and using them accordingly in estimating GWR with the WTF method in order to overcome some of the existing substantial gaps in our knowledge of groundwater (GW) storage variation.
2. Obtaining GWR measurements at the local scale on a year-round basis, which are currently scarce or even completely lacking for many regions of Ontario and thus would provide a valuable database for guiding development of any policy requiring GWR.
3. Using this database to calibrate and test estimates of the spatial and temporal variability in regional-scale (watershed scale) GWR from approximate statistical techniques or deterministic means using precipitation and soil texture, for example.
4. Providing guidance on how to supplement equipment at pre-existing weather stations to measure GWR at the station. Guidance might include how many WT wells, piezometers, soil water content and temperature sensors, tensiometers and Drain Gauges need to be installed to estimate GWR within a desired confidence interval.

SOILS ARE SURFICIAL PALEOSOLS – AN INSIGHT INTO PODZOL PROFILES AS REPOSITORIES OF HOLOCENE FOREST ENVIRONMENTS

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The structure and composition of modern podzolic soil profiles are the result of short- and long-term soil-forming processes, in particular climate, vegetation and local ecosystem disturbances. Most podzolic soils developed in thick till and fluvioglacial deposits were formed early in the Holocene and, unless major solum instability, they were able to maintain their original structure until today. Since initial forest establishment in early Holocene, tree fall and uprooting have been major forest and soil processes favoring soil renewal and forest regeneration. Tree uprooting contributes largely to soil mixing, down slope soil movement, and burial of organic materials from the forest floor. As a result, post-disturbance windthrow tends to increase the organic content of the soil, in particular after a forest fire when uprooting of large burned trees incorporates variable amounts of charcoal. When buried, charcoal is among the most resistant organic material, and well-preserved charcoal can be identified botanically and radiocarbon-dated. Charcoal macrofossils are preserved in the two main compartments of the soil, i.e. the surface compartment and the mineral soil compartment. The residence time of charcoal is shorter in the surface compartment than in the mineral compartment. Modern soils can be viewed as surficial paleosols given the fact that they retain past ecological events in the form of macroscopic charcoal fragments from different forest environments subjected to fire disturbance by tree uprooting. It is concluded that soil macrofossil analysis may be a useful paleoecological tool to reconstruct long-term forest fire history at the stand scale. Several examples from different soil environments will be presented to validate the «paleosol personality» of modern soils.

RÉGIES D'IRRIGATION BASÉES SUR LE POTENTIEL MATRICIEL DU SOL EN PRODUCTION DE CANNEBERGE

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En production de canneberge, une gestion de l'irrigation basée sur le potentiel matriciel (PM) permet aux plantes de conserver une zone de confort hydrique idéale à leur croissance. Selon Bonin (2009), cette zone pourrait être maintenue en démarrant l'irrigation lorsque PM atteint -6,5 kPa. Une gestion plus sèche de l'irrigation pourrait être envisagée, mais nécessite une étude au champ. L'objectif de ce projet est de déterminer le meilleur traitement d'irrigation par aspersion à utiliser pendant la saison de croissance qui permette de maximiser les rendements et de minimiser les pertes d'eau. Chacun des quatre producteurs du projet a fourni un champ dans lequel a été installé un dispositif expérimental en blocs complets permettant d'y tester trois traitements d'irrigation. Les parcelles d'un traitement étaient instrumentées de trois tensiomètres et d'un débitmètre. Les traitements étaient basés sur le déclenchement de l'irrigation lorsque différents PM étaient atteints. La valeur PM du traitement témoin (-6.5 kPa) correspondait à celle utilisée par le producteur. Le traitement humide (-5,5 à -6,0 kPa) utilisait une valeur PM plus élevée que celle du traitement témoin et du traitement sec (-7 à -10 kPa), qui avait une valeur PM encore plus basse. Suite à la première année du projet, les rendements associés au traitement sec (-7 à -8.5 kPa) ont été supérieurs de 0.2 à 14% en comparaison avec les rendements du traitement témoin tout en ayant utilisé de 14 à 78% moins d'eau. Pour le traitement humide, les rendements ont été inférieurs de 3% à ceux du traitement témoin et les quantités d'eau utilisées ont été supérieures de 168 à 200%. Les rendements associés à un traitement trop sec (-10 kPa) ont été inférieurs de 15% aux rendements du traitement témoin. Il apparait donc que des économies importantes d'eau d'irrigation peuvent être obtenues avec une régie serrée de l'irrigation en production de canneberge. Ceci est d'autant plus important que l'irrigation en période de production représente environ 35% de la consommation annuelle d'eau de la canneberge. La canneberge étant une plante bisannuelle, une deuxième année de tests est nécessaire afin d'effectuer des recommandations aux producteurs sur la gestion de l'irrigation.

RATE OF FREEZING IS POSITIVELY RELATED TO N_2O EMISSIONS DURING FREEZE-THAW CYCLES

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Increases in N_2O emissions are commonly measured after soil freeze-thaw cycles. Many of the lab studies however tend to use freezing rates that are much more rapid than what is typically seen in eastern Canadian agricultural soils. The difference in freezing rates between lab studies and field conditions may result in a bias when scaling up the results from these incubations. We took two soils of contrasting textures, a sandy loam and a silty clay, and incubated them in mason jars using various temperature regimes to examine the effects of different freezing rates, temperatures and durations. We incorporated the equivalent of 60 kg ha^{-1} total N as pig slurry into 100 g of soil (DW basis) to ensure organic C and mineral N would be available for denitrification. We had nine temperature treatments in total: one control (+1ºC) treatment, and 8 freezing treatments. The freezing temperatures were -1 or -3ºC; the rate of freezing was either 0.2ºC day^{-1} (slow freeze), or rapid freezing (*i.e*. air temperature dropped to target temperature and soils freeze over a period of two to three hours); and the duration of freezing was equivalent to either -20 or -40 degree days. Preliminary results indicated that soils experiencing rapid freezing emitted more than 10 times more N_2O than those that experienced slow freezing. Soils frozen at -3ºC also emitted more N_2O than soils frozen at -1ºC and both emitted more than the control soils. There were however similar emissions between soils experiencing different durations of freezing.

WILL THE EFFECTS OF CLIMATE CHANGE ON CANADIAN AGRICULTURAL SOILS EVEN BE DETECTABLE?

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Human-induced climate change will undoubtedly lead to many adverse changes in soils and the human activities they support, yet clearly not all soils are equally vulnerable to the effects of climate change. Agricultural soils are not recognized as a distinct taxa in our classification systems, but they do share a common set of traits - for example, cultivation generally reduces porosity of the plough layer and (through homogenization and tillage translocation) decouple the plough layer hydrologically from the underlying horizons. Arguably the net effects of cultivation reduce the vulnerability of agricultural soils (compared to their non-agricultural ancestors) to climate change of the scale envisioned for Canada in the next century. The greatest threat may lie in the increases in the range and frequency of climatic extremes, which can lead to crossing of thresholds that lead to destabilization of the soil surface through processes such as water or wind erosion. The risk of these catastrophic events can be substantially lessened by another attribute of agricultural soils - our ability to alter management practices to reduce their vulnerability.

MODELING ROOT WATER UPTAKE BY ROMAINE LETTUCE: LINKING TIPBURN DAMAGES TO WATER STRESS

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Lettuce production in Southwestern Quebec represents an economically important crop for Canada. This vegetable is grown almost exclusively on organic soils in this region. However, lettuce has significant risks of water stress during periods of high evapotranspiration demand. Yield reductions can be very important following insufficient water availability periods, mostly due to tipburn. Managing irrigation is however a very complex operation as the diagnosis of the soil water status is technically difficult and evolves rapidly. The objective of this study was to investigate the mechanisms of water transport in the root zone and their implications in tipburn of Romaine lettuce. A comprehensive study of water flux in the root zone was performed using a mathematical model describing the process of water absorption by lettuce under field conditions. Climatic variables (rainfall, temperature, solar radiation, relative humidity, wind speed) were measured to estimate the water needs of Romaine lettuce under different conditions. Root water uptake modeling helped to identify the water transfer mechanisms in the root zone responsible of water stress. Rapid and consistent trends in the risk of Romaine lettuce to show tipburn symptoms were found. This plant can tolerate some water deficit days prior to harvest without problems. However, meet the evapotranspiration demand, root zone matric potential should not exceed a threshold value. Beyond this point, soil unsaturated hydraulic conductivity will limit the supply of water to the plant. Based on these findings, water needs of Romaine lettuce can be predicted with real-time measurements of soil water potential and irrigation brought fast enough to limit tipburn damages.

IMPROVE DIGITAL MAPPING OF SOIL SURFACE TEXTURE USING HIGH SPATIAL RESOLUTION IMAGERY

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Cokriging models have been successfully employed to improve the spatial estimation accuracy of several soil physical properties. High spatial resolution satellite imagery has potential for digital soil mapping (DSM). The objective of the project was to improve the prediction of digital soil surface texture maps using high spatial resolution imagery. The project was carried out on an experimental sub-watershed (470 ha) located near Quebec City. Soil particle size analysis of 167 soil samples was determined by the hydrometer method. The sand, silt and clay contents (compositional data) were transformed by using isometric log-ratio (ILR). The dataset was split into two groups, one as the training dataset (n = 141) and the other one as the validation dataset (n = 26). Reflectance data (B1, B2, B3 and B4) and multiples algorithms band ratios (Brightness (BI), Soil Color (SCI), Redness (RI) and Iron Oxide (IOR) were used as ancillary variables in cokriging ilr1 and ilr2. These ancillary variables were extracted from two high resolution images acquired with the IKONOS and Quickbird satellites on May, 15 and 30, 2008, respectively. Anisotropic and isotropic semivariograms, ordinary kriging and cokriging were computed using Gesotatistical Analyst toolbox of ArGIS®v10. No significant anisotropy was detected. Variographic analyses revealed the presence of a high spatial structure ($C/(C_0+C) > 0.9$) for ilr1 and ilr2 allowing DSM by kriging. Thereafter, covariates were used for cokriging to see if it improves the accuracy of maps created by kriging. A back transformation was applied to kriging and cokriging models to obtain sand, silt and clay maps. Then, the model performance was assessed using the validation dataset by comparing the root-mean-square error (RMSE) and the mean absolute error (MAE) of the kriging and the cokriging models. Cokriging models give lower RMSE and MAE between estimations and measurements than kriging when using RI of the IKONOS and B3, BI, SCI and IOR of the Quickbird. The most significant improvement of the estimation is with B3 of the Quickbird, the improvement is up to 12.4% for clay, 5.0% for sand and 3.5% for silt.

HYDROGRAPH SEPARATION PROCEDURE TO DETERMINE THE SOURCES OF THE PHOSPHORUS AND NITROGEN LOADS IN AN AGRICULTURAL WATERSHED

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The majority (68%) of P exported from Quebec to the Missisquoi Bay was estimated to originate from agricultural non-point source pollution (Troy et al. 2007). Surface and subsurface (tile drain) runoffs are the major flow pathways that contribute to the P transfer to surface water body from agricultural fields. The efforts to reduce P loads following the implementation of agricultural best management practices (BMPs) in a watershed need to be validated at the outlet. The use of the electrical conductivity (EC) to predict the sources (surface vs subsurface) of P transfer was readily used by Michaud et al. (2009). Although, no validation of this procedure was realized in relation to the runoff water quality from agricultural plots. Runoff and tile-drain water quality was measured from sandy loam soils (5 fields) and clay loam soils (5 fields) in the Ewing watershed, a subwatershed of the Pike River. The sites were sampled (19 discrete sampling) from October 2008 to May 2009. Drainage and runoff water samples were sampled simultaneously. At the same moment, the water quality of the Ewing Stream (P speciation, conductivity, pH, turbidity, water level and flow rate) was monitored at the watershed exit. Water discharge from the Ewing watershed were plotted in relation to the tracers fluxes (Ca, NO3-N and EC) and the P fluxes (dissolved, particulate and total P forms). Predicted P fluxes at the Ewing outlet using the sampled fields' water quality and a hydrograh separation procedure gave satisfying results. This approach confirmed our ability to estimate the impact of BMPs on the surface and subsurface water quality for a large agricultural watershed.

A NEW ALGORITHM FOR MACROPORE FLOW IN SWAT FOR BETTER PHOSPHORUS LOSS ESTIMATES

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Preferential flow through soil macropores may account for losses of 0.2 to 5 kg phosphorus (P) ha^{-1} $year^{-1}$ from agricultural fields into tile drains. Yet this pathway is missing from the Soil and Water Assessment Tool (SWAT), a watershed hydrological transport model that is widely used. The objective of this work is to present a conceptual approach to a new subroutine (algorithm) in SWAT for macropore flow. This approach allows SWAT to divide predicted quantities of water and P into surface runoff, matrix flow, and macropore flow pathways. This algorithm will be based on dual-porosity and capacity-type approaches that divide the soil into macropore and matrix regions. After adding this algorithm, the new SWAT model will be evaluated for the Ewing watershed (32 km^2) in southern Quebec. The watershed will be divided into subbasins and further divided into Hydrologic Response Units (HRU's), unique combinations of soil type and land use in a subbasin. Daily surface, matrix and macropore flows of water and P will be predicted for each HRU and aggregated for the watershed. The model will be calibrated and validated by comparing predicted results with data collected at the outlets of the watershed (2001-2010 period) and from 10 fields (2008-2009 period), which correspond to HRUs in the watershed model. The new SWAT model is expected to indicate the relative contributions of surface versus subsurface losses of P, so that interventions to reduce P losses can be better targeted to specific transport pathways.

MICROBIAL COMMUNITY STRUCTURE AND DECOMPOSITION PROCESSES IN PEAT SOILS OF THE JAMES BAY LOWLANDS, CANADA

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Northern peatlands are a large repository of atmospheric carbon due to an imbalance between primary production by plants and microbial decomposition. The James Bay Lowlands (JBL) of northern Ontario are a large peatland-complex of ecological significance, but remain relatively unstudied. Climate change models predict the region will experience warmer and drier conditions, potentially altering plant community composition, and shifting the region from a long-term carbon sink to a source. We collected a peat core from two geographically separated (ca. 200 km) ombrotrophic peatlands (Victor and Kinoje Bogs) and one minerotrophic peatland (Victor Fen) located near Victor Bog within the JBL and characterized (i) archaeal, bacterial, and fungal community structure with terminal restriction fragment length polymorphism of ribosomal DNA, (ii) estimated microbial activity using community level physiological profiling and extracellular enzymes activities, and (iii) the aeration and temperature dependence of carbon mineralization at three depths (0–10, 50–60, and 100–110 cm) from each site. We hypothesized that pH is the dominant control of microbial community composition and activity among sites and depths, substrate utilization patterns of carbon compounds will differ between the bogs and the fen, and microbial activity and community composition will correlate with carbon mineralization. We observed similar dominant microbial taxa at all three peatlands despite differences in nutrient content and organic matter quality. In contrast, we observed differences in basal respiration, enzyme activity, and the magnitude of substrate utilization, which were all generally higher at Victor Fen and similar between the two bogs. However, there was no preferential mineralization of carbon substrates between the bogs and fens. Microbial community composition did not correlate with measures of microbial activity but pH was a strong

predictor of activity across all sites and depths. Increased peat temperature and aeration stimulated CO_2 production but this did not correlate with a change in enzyme activities. Thus microbial activity in the JBL appears to be influenced by the quality of the peat substrate and the presence of microbial inhibitors, which suggests the existing peat substrate will have a large influence on future JBL carbon dynamics.

MODIFICATION OF SOIL TEMPERATURE MODULE IN SOIL AND WATER ASSESSMENT TOOL

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Soil temperature plays an important role in hydrological modelling. It determines the rates and directions of soil physical processes and of energy and mass exchange with the atmosphere. Moreover, it also governs the types and rates of chemical reactions which take place in the soil. Finally, soil temperature strongly influences biological processes such as microbial activity. All of those processes are of importance in assessing the impact of land management practices on water, sediment and agricultural chemical yields in agricultural watersheds. The Soil and Water Assessment Tool (SWAT) was developed for this purpose and has been widely used all over the world. However, the soil temperature module used in SWAT is an empirical model derived from data in Southern America where snow package has little influence on distribution of temperature in soil profile. In other words, it fails to accurately simulate soil temperature in high latitude areas such as Northern America with large snowfalls forming thick snow packages above the soil surface. Hence, the percolation and microbial activity such as decomposition would not be correctly estimated during in winter time. To better assessing impacts of landuse change and nonpoint source pollution with SWAT model, a physical-based soil temperature module was developed and tested in this study. And the model was derived from heat transfer theory and energy balance equation. Finally, the results showed that modified SWAT model dramatically improved the performance for percolation and nitrite leaching simulation, especially in winter time. In addition, biochemical processes such as nitrogen and phosphorus cycling in soil profile were also getting better estimation results.

CARBON DYNAMICS IN FOREST SOILS OF BRITISH COLUMBIA

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This study was conducted to investigate the fashion with which organic C distributes vertically and changes along different types of coniferous dominated stands with respect to its total and fractions. Also, the climatic and vegetal factors were tested to determine their influences on such variations. Seven locations representing natural and mature forest stands within seven biogeoclimatic zones of British Columbia were selected. The zones included BWBS: boreal white and black spruce; ICH: interior cedar-hemlock; ESSF: Engelmann spruce-subalpine fir; IDF: interior Douglas-fir; PP: ponderosa pine; CWH: coastal western hemlock; MH: mountain hemlock. At each location three sites were chosen and samples from the F and H horizons, and top (0 – 30 cm) and sub (30 – 60 cm) mineral soil were taken. Soil samples were analyzed for total C and N, and organic C fractions including nonpolar, water-soluble, and acid-soluble extracts along with acid-insoluble residues. Climatic factors including mean annual temperature and precipitation, mean temperature of warmest and coldest months, precipitation as snow, and annual and summer heat-to-precipitation ratios were estimated using ClimateBC model. The vegetation coverage of lichens, herbs, bryophytes, shrubs, and trees were also measured at each sampling site. The results showed that lignocellulose index (LCI) decreased consistently from organic horizons at 0.6 down to 0.2 in deeper layers of mineral soil while the C:N ratio did not pass below 20 even in the mineral layers. Among the climatic factors, precipitation and heat-to-moisture were found to be better variables to determine the variation of organic C and its fractions suggesting that the water deficiency during drought was important factor within the study sites. The abundances of herbs and shrubs were influential factors in the quantity and fractionation of C in organic and sub-mineral layers.

QUANTIFYING THE INFLUENCE OF WETTING AND DRYING ON THE MICROSTRUCTURE OF SOIL CRUST USING FRACTAL ANALYSIS OF CT IMAGERY

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Fractal analysis is now an accepted method to quantify soil structure. Wetting and drying cycles can change soil structure. Thus, fractal techniques might characterize soil structural variations resulting from wetting and drying. In this study, the effect of saturation and subsequent drying on the structure of soil surface crust, collected from the Mojave Desert, Nevada, was quantitatively evaluated by imaging a sample by high resolution X-ray Computed Tomography. The well-structured crust was scanned at saturation and three moisture tension levels: -20cm, -200cm and oven dry. Semi-variance analyses of the grey-scaled images in orthogonal directions showed that the Hurst exponent was highest at saturation and progressively lower at higher moisture tensions. This suggests that saturation caused the maximum irregularity of soil structure of the sample and that drying led to higher regularity between voids and solid phase. Results of a box counting method applied on segmented images, further indicated that fractal dimension of voids, i.e. void complexity, was slightly higher at lower moisture contents. Whereas the Hurst exponents are based on X-ray attenuations, affected by soil structure and mineralogical composition, the box counting dimensions solely represent soil voids. It was concluded that fractal analysis could reflect variations of microstructure. It was also determined that increasing the number of replicates would yield more precise results. The apparent contradiction between the two fractal methods supports further analysis, such as the one of non-rigid registration, may be required.

SOURCE OF ERODIBLE PARTICULATE ORGANIC NITROGEN IN AGRICULTURAL TILE DRAINAGE WATER DETERMINED WITH ^{15}N AND ^{13}C STABLE ISOTOPES

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Particulate organic nitrogen (PON) represents 10 to 60% of N lost via subsurface tile drainage from agricultural fields into the Missisquoi Bay in Southern Quebec. To reduce PON loading in waterways, we need to know the source of the erodible PON found in subsurface tile drainage. This study compared the natural abundance of stable isotopes in PON and organic matter fractions, assuming that similar stable isotope values could indicate the origin of PON. Sequential density fractionation was done on three soil layers (0-20, 20-40, 40-60 cm) collected from two agricultural fields with contrasting texture (clayey *vs.* sandy) located in the Pike River watershed, Southern Quebec. Whole soils were separated into 2 light fractions: non occluded light fraction (NOLF, $\rho<1.9$ g cm^{-3}), occluded light fraction (OLF, $\rho<1.9$ g cm^{-3}) and 3 dense fractions (ρ= 1.9-2.1, 2.1-2.3, 2.3-2.5 g cm^{-3}). Stable isotopes of $\delta^{15}N$ and $\delta^{13}C$ were measured in each fraction. The PON samples were from tile drainage water collected from the same agricultural fields at 18 discrete events during spring 2011, filtered (0.45 µm) and the sediments analyzed for $\delta^{15}N$ and PON concentration. The $\delta^{15}N$ of soil organic matter fractions were consistently greater in topsoil than subsoil layers (5.96 ‰ in 0-20 cm *vs* 5.22 ‰ and 3.94 ‰ in 20-40 cm and 40-60 cm layers of clayey soil; 4.49‰ in 0-20 cm *vs* 1.90‰ and 1.70 ‰ in 20-40 cm and 40-60 cm layers of sandy soil). In clayey soil, the $\delta^{15}N$ of PON was similar to the $\delta^{15}N$ values of the 2.1-2.3 g cm^{-3} fraction of topsoil, as well as the $\delta^{15}N$ values of the 2.1-2.3 g cm^{-3} and NOLF fractions in the 40-60 cm layer. There was little similarity between $\delta^{15}N$ of PON and $\delta^{15}N$ of soil organic matter fractions in the sandy soil. We concluded the erodible PON fractions entering the Bay originated mainly from the dense 2.1-2.3 g cm^{-3} fraction in clayey soils, but need further research to determine the source of erodible PON coming from sandy soils.

THE COMPONENT P INDEX - NARROWING THE GAP BETWEEN PROCESS-BASED MODELS AND FIELD EVALUATION TOOLS

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The P Index is a widely used tool to target mitigation efforts to the parts of the landscape with the greatest risk of P losses to surface water, with versions in use in 47 US states and at least two Canadian provinces. To be effective, it should account for the risk of losses of both particulate and dissolved P through both surface and subsurface pathways without requiring the detailed inputs or complex calculations that are needed for process based models. All of the current P Indexes currently in use fall short of this goal, but the Component P Index is suggested as a model that can help to bridge the gap between easy to use field level tools, and complex, difficult process-based models.

IMPACTS OF 50 YEARS OF CONSISTENT CROPPING AND FERTILIZATION ON THE PHYSICAL QUALITY OF A BROOKSTON CLAY LOAM SOIL

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Field-crop production requires good soil physical quality to be economically and environmentally sustainable in the long term. Hence, the objective of this study was to determine the impacts of 50 years of consistent cropping and fertilization on the physical quality of a Brookston clay loam soil in southwestern Ontario. The cropping treatments included conventionally tilled monoculture corn, monoculture Kentucky bluegrass sod, and corn-oat-alfalfa-alfalfa rotation with conventional tillage during the corn phase. The fertilization treatments included no fertilization of any kind, and chemical fertilization according to the annual soil test for monoculture corn. An adjacent never-cropped area under native deciduous trees and grasses was included in the study to allow comparison of cropped and virgin soil. Intact soil cores (10 cm diameter by 10 cm long) were collected from several depths (0-10, 10-20, 20-30, 30-40, 40-50 cm) for laboratory determination of various soil physical quality parameters (soil water desorption curve, bulk density, organic carbon content, saturated hydraulic conductivity, relative field capacity, etc.). Long-term impacts of cropping and fertilization on the physical quality of Brookston clay loam were compared amongst treatments and to the virgin soil condition. Preliminary results indicate that 50 years of consistent cropping and fertilization affected the physical quality of only the top 20-30 cm of Brookston clay loam soil.

ASSESSING CARBON RETENTION AND LOSS IN AGROFORESTRY SYSTEMS IN QUEBEC, CANADA

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The practice of incorporating trees into traditional agricultural settings, through tree-based intercropping (TBI) or as shelterbelts along field borders, has been put forward as a means of increasing C sequestration while reducing emissions by impeding or even reversing C loss from agricultural soils. However, C retention is influenced by many factors (e.g. quantity and decomposition rate of C inputs, management decisions, environmental conditions) that may change over the lifespan of the plantation. The objective of this work is to improve understanding of mechanisms influencing C retention and loss in agroforestry systems by evaluating soil carbon content and litter fall characteristics (biomass and C content by material type) in eight-year-old TBI sites at St. Paulin, Quebec and St. Edouard, Quebec. Estimated C input from litter fall will be related to changes observed in soil C stocks since the last spatially-explicit soil sampling was done (four years ago). Historic data, such as wood and crop biomass production, from these and comparable sites in North America will be compiled to propose an overall picture of C cycling and potential long-term C storage potential in agroforestry systems in cold temperate climates. Findings from this study will contribute to understanding of C cycling in agroforestry and could suggest policies or incentive programs that would fit into Canada's overall C reduction strategy.

NITROUS OXIDE EMISSIONS FOLLOWING DEPOSITION OF DAIRY CATTLE EXCRETA IN EASTERN CANADA

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The N_2O emission factor proposed for cattle excreta N by the Tier I IPCC methodology (EF3) is 2% (IPCC, 2006). While N2O emissions from excreta deposited by grazing animals have been reported in several publications, relatively few estimated EF3 values because measurements did not cover the entire year. This study measured N_2O and CH_4 flux and crop dry matter (DM) yield over two years (2009 to 2011) from a clay and a sandy loam soil cultivated with Timothy grass (Phleum pratense L.). A split-plot design was used on each soil type, with different application dates (either spring, summer or autumn application) as main plots and treatment (U-50: urine 50 g N m^{-2}, U-100: urine 100 g N m^{-2}, dung: 60 g N m^{-2}, and control) as the sub-plots. Regardless of application time, annual DM yield increased in all treated plots when compared to the control. Also, DM yields were generally greater when urine as opposed to dung was applied suggesting greater N-availability from the urine application. The CH_4 flux from the dung plots increased for only the first two weeks after treatment while the flux from the urine plots was similar to the control plots. Cumulative N_2O emissions on the U-50 and U-100 plots increased linearly with urine N rate on both soils, resulting in nearly identical mean emission factors for both urine rates. The emission factor for the urine was three times greater on the clay (1.02% of applied N on both rates) than on the sandy loam soil (0.26% (U100) and 0.31% (U50) of applied N). Cumulative N_2O emissions from dung plots also differed between soil types; however the impact of soil type on N_2O emissions was opposite to that of urine, with greater losses from the sandy loam (0.15%) compared with the clay soil (0.07%). These results suggest that estimates of soil N_2O emissions by grazing cattle in Eastern Canada obtained using the IPCC default methodology are overestimates of actual values and that these estimates for should include a stratification according to soil type.

VOLATILISATION DE L'AMMONIAC SUIVANT L'INCORPORATION DE L'URÉE EN BANDES : IMPACT DU TAUX D'APPLICATION ET DE LA PROFONDEUR D'INCORPORATION

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L'incorporation de l'urée en bandes étroites dans les sols agricoles est recommandée pour favoriser la rétention de l'azote dans le sol. Cette pratique peut cependant conduire à de fortes émissions d'ammoniac suite à une augmentation locale du pH du sol induite par hydrolyse de l'urée. Nous avons effectué deux expériences sur le terrain afin de déterminer l'impact de la concentration d'urée dans la bande et la profondeur de l'urée sur le placement volatilisation de l'ammoniac. La volatilisation a été négligeable lorsque l'urée a été placée à 7,5 et 10 cm de profondeur, faible à 5 cm (7% du produit appliqué l'urée-N) et forte à 2,5 cm (37%) et à la surface (50%). Les pertes par volatilisation ont également augmenté avec le taux de l'application lorsque l'urée était placée à 5 cm, en particulier à des taux supérieurs 120 kg N ha^{-1}. Les pertes d'azote ammoniacal ont été proportionnelles aux variations de pH du sol et la concentration de N-NH4 dans la bande et dans le sol de surface (0-2 cm), montrant clairement que l'urée en bandes peut conduire à une volatilisation d'ammoniac substantielle en influant sur les propriétés du sol favorisant la formation de NH3 près de la surface du sol. Pour le sol étudié, il est recommandé d'éviter une incorporation en bandes à une profondeur inférieure à 5 cm et à un taux supérieur à 120 kg N ha^{-1}.

WEBS I: RIPARIAN EXCLUSION FENCING FOR CATTLE IMPACTS ON BENTHIC INSECTS AND RIPARIAN VEGETATION IN THE SALMON RIVER, BRITISH COLUMBIA

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The purpose of riparian exclusion fencing is to prevent cattle from entering the riparian zone. The impacts this has on the river can be measured using multiple physical, chemical, and biological methods. In this case changes in benthic insect populations and riparian vegetation cover were used to monitor the health of the river after the implementation of exclusion fencing. Three replicate farms on the Salmon River had their upper reaches fenced in 2005, and the entire riparian area was fenced in 2007. In 2006, 2007, 2008, and 2010 riparian vegetation was sampled using the Greenline method at each farm. The percent of bare ground (and consequently the percent of vegetative cover) increased substantially upon cattle exclusion. In 2005, 2008, and 2010 benthic samples were taken in cross-sections of the river at each farm and analysed using four biotic indices. Most indices showed increasing stream health and decreasing pollution as time passed since the installation of the fencing. The fencing was examined after the duration of sampling and was found to be 90% intact. It appears that exclusion fencing is an effective way to prevent cattle access to riparian zones, and as such proves to be an effective Beneficial Management Practice (BMP) for improving river health within cattle pastures.

CO-INOCULATION DE SINORHIZOBIUM MELILOTI AVEC AZOSPIRILLUM BRASILIENSE : OPTIMISATION DES CONDITIONS DE PRODUCTION D'AZOSPIRILLUM BRASILIENSE DANS LES EAUX USÉES D'AMIDON ET ÉTUDES DES DOSES APPLIQUÉES

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Dans le but d'améliorer la qualité des formulations de Sinorhizobium meliloti, la co-inoculation Azospirillum - Sinorhizobium a été étudiée dans ce travail. L'Azospirillum brasiliense ATCC29710 a été produit dans les eaux usées d'amidon (SIW), des suppléments de croissance à savoir le gluconate à 0.5%w/v, l'extrait de levure à 0.5% et le mélange (extrait de levure 0.5%w/v + gluconate 0.5%w/v) ont été étudiés, la comparaison a été réalisée avec le milieu Bashan et le SIW. Les résultats ont montré que l'ajout de l'extrait de levure ou de gluconate améliore significativement le taux de croissance de 0.266h^{-1} (pour SIW) à respectivement 0.315h^{-1} et 0.316 h^{-1}. Ces taux étaient statistiquement comparables au milieu Bashan (0.324h^{-1}). La méthodologie de surface de réponse a été appliquée afin d'optimiser la quantité d'extrait de levure ajoutée et la température de croissance d'Azospirillum brasiliense dans le milieu SIW. Le Modèle obtenu (R^2 = 0,92) a montré que la production maximale de cellules était à 34 °C et avec 0.28% w/v d'extrait de levure. Un test de confirmation « check point » a été effectué : Azospirillum brasiliense a été produit dans le fermenteur 7.5 l. La concentration atteinte était de 0.90x109 CFU/ml, valeur située dans l'intervalle de confiance de la variable prédite. La comparaison entre les rendements en matière sèche des plantes de luzerne co-inoculées avec : Azospirillum Brasiliense (104, 105 et 106 CFU/plante) et Sinorhizobium meliloti (à 105 CFU/plante) a montré que la combinaison d'Azospirillum à 105 ou 106CFU /plante avec Sinorhizobium meliloti à 105 CFU/plante a permis d'atteindre le plus haut rendement en matière sèche (augmentation respectives de 20 et 17%, p=0.037912) comparativement aux plantes de luzerne inoculées avec Sinorhizobium meliloti seul à 105 CFU/plante.

NITROUS OXIDE EMISSIONS FROM CORN AS AFFECTED BY RATE, TIMING AND HISTORY OF NITROGEN FERTILIZER APPLICATION

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This study is examining the effect of rate, timing and history of fertilizer N (UAN) application on N_2O emissions in corn over a 10 yr period starting in 2009 at Elora, ON. Three N rates included 30, 145 and 218 kg N ha^{-1}; two timings comprised of N banded in mid-row at planting and N side-dressed in mid-row one month after planting, and two histories", short- and long-term, previous year's application of 115 kg N ha^{-1} regardless of the current year's rate, and applying the same rate to a given plot over the duration of the trial, respectively. From May 13 to October 17, 2011, N_2O emissions were measured on 28 days using nonsteady-state nonflow-through chambers. Overall N_2O fluxes were greater with increasing rates of N fertilizer (3.7, 21.4 and 30.9 ng m^{-2} s^{-1} for 30, 145 and 218 kg N ha^{-1}, respectively). Peak fluxes had two phases, one was during May 17 to June 6, and another was during June 23 to July 12. The first phase of N_2O emissions associated with N application at planting was higher (73.9 ng m^{-2} s^{-1}) compared to the second phase of N_2O emissions associated with N applied one month after planting (25.2 ng m^{-2} s^{-1}). N_2O emission was significantly reduced with N applied one month after planting (12.6 ng m^{-2} s^{-1}) compared to that at planting (24.7 ng m^{-2} s^{-1}). The history of N-application did not show any significant effect on the N_2O emissions. There was a significant effect of N application rates on corn grain yield (6.3, 10.2 and 10.8 Mg ha^{-1} for 30, 145 and 218 kg N ha^{-1}, respectively) indicating that though increased N application rates led to increased N_2O emissions, they also contributed to increased corn yield. On the other hand timing of N-application did not affect corn grain yield (8.6 and 8.8 Mg ha^{-1} for N application at planting and one month after planting, respectively) but significantly reduced N_2O emissions. This study provides evidence that improved fertilizer N management may result in reduced N_2O emissions under some conditions.

LA POPULATION DE RÉFÉRENCE ET LE DIAGNOSTIC DE LA COMPOSITION NUTRITIONNELLE (CND) DU GOYAVIER (PSIDIUM GUAJAVA L.) 'PALUMA' AU BRÉSIL

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Le goyavier est un important arbre fruitier tropical. Le Brésil est le plus grand producteur mondial de goyaves du type rouge. La recherche a été menée durant les récoltes de 2009/2010 et 2010/2011 dans la plus grande région productrice de goyaves de l'État de São Paulo. L'objectif était de présenter la population de référence et de comparer les normes du diagnostic de la composition nutritionnelle (CND) de 205 vergers commerciaux de 'Paluma', avec de teneurs considérées comme convenables pour la culture, d'après la littérature. Comme il est décrit par Hair et al. (2005) il y a eu une distribution normale pour la variable production (Shapiro-Wilk W=0,988; p=0,11). Les normes CND ont été élaborées selon ce qui a été proposé par Parent; Dafir (1992), Khiari et al. (2001) et Parent et al. (2009) en utilisant 187 vergers commerciaux valides, dont la mi-point d'inflexion de la fonction d'accumulation est 220,1 kg par plante, pris comme base pour définir la sous-population de référence (n=69), selon l'équation: y = 0,0000000430x3 - 0,0000283902x2 + 0,0022450870x + 0,9629945419 (R2=0,99). D'après les teneurs moyennes suggérées comme adéquates à la culture de goyave par Natale et al. (1996), et en les analysant comme des échantillons foliaires pour des comparaisons avec les concentrations standards évaluées des normes CND, on a observé que les indices IN, IP, IK, ICa, IMg, IS, IB, ICu, IFe, IMn et IZn ont été; 0,58; -0,39; -0,40; -0,02; 2,30; 0,58; -1,26; -0,35; 0,28; -0,57; 1,75 respectivement, et le CND-r2 = 12,21. Dans des conditions dans lesquelles la recherche a été menée et, en utilisant les normes élaborées par la méthode CND, on peut constater l'adéquation et la cohérence des recommandations des teneurs foliaires suggérées comme étant adéquates à la culture du goyavier 'Paluma', à l'État de São Paulo, Brésil, par Natale et al. (1996). En effectuant la même comparaison avec les teneurs moyennes «officiels» recommandées par Quaggio et al. (1997) pour le goyavier dans l'État de São Paulo, il a été observé que les indices IN, IP, IK, ICa, IMg, IS ont été: -15,077; -11,627; -14,657; -14,024; -12,623 respectivement, et le CND-r2 = 933,34. Cela montre, par conséquent, la sous-estimation de toutes les teneurs foliaires suggérées par ces auteurs, ce qui indique que les recommandations «officielles» devraient être revues pour la culture du goyavier.

MACHINE BASED SURFICIAL GEOLOGICAL MAPPING OF ARCTIC CANADA AT THE GEOLOGICAL SURVEY OF CANADA

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Terrain analysis of glaciated terrains is approaching a "tipping point" as remotely sensed digital data and digital elevation models become more available and cost-effective alternatives to aerial photographs. The challenge in remote predictive mapping (RPM) of glaciated landscapes is recognition of the series of complex steps in the traditional cogitative terrain analysis process and encapsulating them within computational workflows based on image analysis and statistical modelling. Within the SMART (Systematic Mapping of Arctic Canada by Remote Techniques) project of Geo-Mapping for Energy and Minerals Program (GEM), a methodology and data handling framework is being developed to improve mapping productivity. SMART mapping is a complex challenge that involves: i) development of a science language for glaciated terrain, ii) integration of expert knowledge and legacy datasets, iii) parsing knowledge into machine operable components (morphology, texture, shape etc.), iv) classification of attributes, v) evaluation of various geoscience data types (i.e. remotely sensed , topographic and various calculated derivative images) for surficial mapping, and vi) statistical analysis, modelling and expert systems integration of the diverse landscape attributes within a geoscience data stack. Morphology, for example, is being extracted through analysis of Digital Elevation Model data and derivatives. This work forms the basis for specific landform analysis (e.g. eskers) and as a component of the data stack. Material (texture, lithology) types are primarily being captured using remotely sensed data (LANDSAT, Radar) in concert with pixel-to-pixel-based classification algorithms (e.g. Robust Classification Method (RCM)). Lake shape and landforms are being analyzed using form statistics and object-

orientated, landscape-segmentation techniques. Spatial association of various landform metrics provides a challenge that is being undertaken using density functions and integration of specific expert interpreted data layers (drumlin, esker, etc.). Integration of this diverse suite of data layers is being completed using several techniques, including: statistical approaches, decision trees, fuzzy sets, and expert system approaches. Case studies will illustrate the process development from an initial predictive surficial materials map to a derivative predictive surficial geology map which can then be used as an aid for field-supported mapping. The transition from cognitive interpretation and recording of terrain elements to semi-automated approaches is a considerable challenge that requires careful consideration of the conceptual and semantic models employed by the geologists. The requirement to revisit the classification lexicon of glacial landscapes, landforms and geological legends will result in improved perspectives and understanding of the signatures and processes of the glaciated landscape of northern Canada derived from remote predictive mapping. It will also provide more quantitative mapping support that is being demanded by resource management clients.

AN EMERGING PARADIGM FOR SURFICIAL GEOLOGICAL MAPPING OF ARCTIC CANADA AT THE GEOLOGICAL SURVEY OF CANADA

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A challenge in remote predictive mapping (RPM) of glaciated landscapes is recognition of the series of steps in the traditional cogitative terrain analysis process and encapsulating them within computational workflows based on image analysis and statistical modelling. Within the SMART (Systematic Mapping of Arctic Canada by Remote Techniques) project of Geo-Mapping for Energy and Minerals Program (GEM), a methodology and data handling framework is being developed to improve mapping productivity. SMART mapping is a challenge that involves: i)development of a science language for glaciated terrain, ii) integration of expert knowledge and legacy datasets, iii) parsing knowledge into machine operable components (morphology, texture, shape etc.), iv) classification of attributes, v) evaluation of various geoscience data types (i.e. remotely sensed , topographic and various calculated derivative images) for surficial mapping, and vi) statistical analysis, modelling and expert systems integration of the diverse landscape attributes within a geoscience data stack. Morphology, for example, is being extracted through analysis of DEM data and derivatives. This work forms the basis for specific landform analysis (e.g. eskers) and as a component of the data stack. Material (texture, lithology) types are primarily being captured using remotely sensed data (LANDSAT, Radar) in concert with pixel-to-pixel-based classification algorithms. Lake shape and landforms are being analyzed using form statistics and object-orientated, landscape-segmentation techniques. Spatial association of various landform metrics provides a challenge that is being undertaken using density functions and integration of specific expert interpreted data layers (drumlin, esker, etc.). Integration of this diverse suite of data layers is being completed using several techniques, including: statistical approaches, decision trees, fuzzy sets, and expert system approaches. The requirement to revisit the classification lexicon of glacial landscapes, landforms and geological legends will result in improved perspectives and understanding of the signatures and processes of the glaciated landscape of northern Canada derived from remote predictive mapping.

PHYSICAL AND SEQUENTIAL CHEMICAL FRACTIONATION TO ASSESS PHOSPHORUS DYNAMICS IN BIOCHAR-AMENDED SOILS

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Phosphorus (P) runoff and leaching from agricultural soils poses an environmental risk to nearby watercourses. Biochar is a carbon-rich soil amendment made from pyrolysed biochar that may reduce P loss by changing soil physical and chemical properties. Two experiments were conducted to determine whether (1) erodible particulate P becomes

physically occluded within biochar-induced macroaggregates and (2) chemical P fractions shift from water-soluble to more sparingly soluble forms. Soils came from an on-farm experiment in Ste-François-Xavier-de-Brompton, Quebec. The experiment was designed as a randomized complete block with three types of biochar applied at 0, 5, and 10 Mg/ha, each replicated 3 times. The site was planted with barley (Hordeum vulgare) and soil samples were collected three times: before seeding, mid-growing season, and after harvest. Aggregate stability was tested using a wet-sieving method and each aggregate fraction was analyzed for total P. Our findings provide new information on biochar as a catalyst for aggregate formation, and the proportion of particulate P that may be bound to biochar-induced aggregates. The P chemistry in biochar-amended plots was characterized with sequential P fractionation and Mehlich-III extraction methods. Preliminary results indicate that water-soluble P concentration was the same or declined with biochar application, whereas sparingly soluble P fractions and the Mehlich-3 extractable P concentration tended to increase. The potential for biochar application to alter soil P dynamics at the field-scale will be discussed.

DOES AMMONIA DEPOSITION FROM POULTRY BARN EXHAUST CONTRIBUTE TO NITRATE CONTAMINATION OF A VULNERABLE AQUIFER?

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The Abbotsford-Sumas aquifer of BC and Washington State is an important source of drinking water that frequently has elevated levels of nitrate (>10 ppm NO_3-N). Intensive production of berries and poultry, including high rates of manure application, is thought to contribute to the elevated nitrate in the aquifer. The objectives of this study are to determine if dry deposition (direct sorption) of ammonia from poultry barn exhaust contributes to nitrate leaching. To determine this, ammonia emissions from broiler (meat bird) barns; dry deposition rates of ammonia around the poultry barns; and concentrations of nitrate in soil water near the barns are quantified. The total barn ventilation rate is determined by timing fan activity and applying flow rates predetermined with a system of mobile anemometers. The concentration of ammonia in the exhaust, measured with acid traps, is multiplied by barn ventilation rates to give cumulative emission rates. The dry deposition rates are measured using soil adsorption traps arranged in a grid around the barns, with greater density of traps near primary fans. Emission and deposition are sampled weekly over 24-hour periods for one year (6 production cycles), Nitrate concentrations in the soil solution are measured with ceramic cup tension lysimeters, installed at a 45 cm depth in a grid pattern on the exhaust side of a barn; measurements are taken on two consecutive days every week for 10 months. Preliminary analysis of one growth cycle in two barns shows emission factors of 0.39 and 0.40 g NH_4-N $bird^{-1}$ day^{-1}. The emissions increase dramatically through the cycle, and are expected to vary seasonally, so multiple cycles are being monitored. Deposition levels within 3.6 meters of the fans reach 4.4% of the total emissions and water collected with the lysimeters shows NO3-N concentrations exceeding 250 mg kg^{-1} at 2.1 m and 125 mg kg^{-1} at 3.6 m from the fans. A water balance model will be used to estimate nitrate flux from the lysimeter measurements. The data will be up-scaled spatially according to poultry distribution to determine potential of dry ammonia deposition to contribute to nitrate contamination of the aquifer.

THE EFFECT OF MUNICIPAL SOLID FOOD WASTE COMPOST AND FERTIGATION ON YIELD AND FRUIT QUALITY IN STRAWBERRY PLASTICULTURE

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Municipal solid food waste (MSFW) compost is becoming increasingly available throughout Nova Scotia. However, little is understood about the nutrient and non-nutrient impacts of MSFW compost on food production systems. The objective of this experiment was to identify how MSFW compost amendment rate and fertigation adjustment affected yield and fruit quality parameters in a strawberry plasticulture. A strip plot randomized experimental design with three replications for each combination of treatment factors was used to measure the effect of MSFW compost (0, 2.5, 5.0 and

10 Mg Fresh Weight [FW] ha-1; Dry Matter [DM]: 48.3%) and fertigation rate (25, 50, 75 and 100% of the recommended rate). The MSFW compost application led to a significant linear response in late season marketable yield ($P < 0.05$). Marketable yield had a significant linear response to fertigation rate in the late season ($P < 0.05$). There were no significant interactions between MSFW compost and fertigation rate on strawberry yield parameters. Sugar content and berry mass were not significantly affected by any treatments. Total antioxidant capacity was significantly affected by an interaction between MSFW compost amendment and the low fertigation rate ($P < 0.01$). The antioxidant capacity was less than optimum with combination of low fertigation rate and low compost rates. It is recommended that MSFW compost amendment is applied at 10 Mg FW ha-1. Fertigation can be reduced to 25% of the recommended rate until September 1st then increased to 100% of the recommended rate for the remainder of the season based on first season results. It is important to note, the 100% recommended rate is already reduced by 82% compared with rates used in non-amended strawberries in the region. Overall, the new adjusted rate reduces the fertigation rate in the first year of production 47% compared with the 100% recommended rate of fertigation. The compost had some non-nutrient effects that need to be explored in more detail.

HOW COULD CROPPING PRACTICES MODIFY MAIZE P UPTAKE?

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Phosphorus (P) deficiency is a major constraint for plant production. Enhanced P uptake depends on the extent to which roots are able to increase soil available P interception or to mobilize P from less soluble sources. Potential factors involved in the mobilization and uptake of P include root morphology, mycorrhizal associations, and rhizosphere conditions. It has been found that cropping practices, such as tillage, modified maize P uptake. But, why could these practices modify maize P uptake? Maize P uptake and its potential factors were analyzed from a long-term (17 years) experimental site at L'Acadie, Quebec. Results indicated that tillage reduced maize P uptake mainly through preventing arbuscular development in roots and fine root growth in soil. Phosphorus fertilization enhanced soil available P, arbuscular mycorrhizal (AM) fungal spore density, and the percentage of fine and coarse roots, reduced overall AM fungal colonization rate, hyphal density, species richness and general diversity, but had no effect on maize P uptake. Broadly, roots and AM fungi explained a high and significant proportion of the variation in maize P uptake. Correlation analysis further revealed that soil properties, especially the soil bulk density and soil organic matter, were the important factors for maize root attributes and mycorrhizal associations. Thus, a better understanding of optimal soil conditions during field operations is needed in order to improve the benefit of AM fungi and roots for maize P uptake in the field.

SEASONAL VARIATIONS IN MICROBIAL BIOMASS, ACTIVITY AND COMMUNITY STRUCTURE IN SOIL UNDER CONTRASTING TILLAGE AND PHOSPHORUS MANAGEMENT

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The interactive effect of tillage and phosphorus (P) fertilization on soil microbiota needs to be better clarified. The effects of different tillage practices and P fertilization on the microbial biomass carbon (SMB-C), nitrogen (SMB-N), and P (SMB-P), two microbial activities (dehydrogenase and alkaline phosphatase), and the microbial community structure based on phospholipid fatty acid profiles (PLFAs) were studied over the maize growing season in a long-term maize-soybean rotation established 18 years ago in er

eastern Canada. Soil samples were collected in April, July, and October 2010, at two depths (0-10cm and 10-20 cm) in moldboard plow (MP) and no-till (NT) management fertilized with 0, 17.5, and 35 kg P ha^{-1}. Results showed significant

variations in all properties of the soil microbiota among sampling dates, and in both soil layers. All variables, except SMB-P in all treatments, were lowest in July, indicating that the soil moisture is an important factor affecting soil microbial properties. Soil microbial community structure was separated primarily by sampling dates at both depths, and by tillage only in the 10-20 cm layer, but was not influenced by P fertilization. Soil microbial biomasses, activities and PLFAs in 0-10 cm under NT were higher than under MP in April and October. Phosphorus fertilization increased SMB-P and Mehlich-3 extractable P (PM3), but had a limited impact on the other soil properties. No significant difference was observed on SMB-P and PM3 between NT and MP when no P applied, while they were significantly higher under NT than under MP when 17.5 and 35 kg P ha^{-1} was applied. In conclusion, the size, activity, and structure of the soil microbial community differed more because of tillage than P fertilization, and NT combined with P fertilization affected mainly the SMB-P.

OVER WINTER CHANGE OF SOIL PHOSPHORUS DYNAMICS AS AFFECTED BY TILLAGE PRACTICES IN A LONG-TERM SOYBEAN-MAIZE ROTATION

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Agriculture management, such as tillage practices, could affect soil phosphorus (P) dynamics during winter season with crop residue left in the field after crop harvest. The main objective of this study was to investigate the effect of tillage on over winter changes of soil P including total P (TP), inorganic P (Pi), organic P (Po), Mehlich-3 P (PM3) and microbial biomass P (SMB-P) under different tillage practices in a long-term maize-soybean rotation established since 1992 in eastern Canada. Soil samples were collected in October 2009, February 2010, and April 2010 at 0-10 cm layer from plots under mouldboard plough (MP) and no-till (NT) management and fertilized with 0, 17.5, and 35 kg P ha-1. Results showed that TP, Pi, and PM3 significantly increased from October 2009 to April 2010 by 30%, 21%, and 49% under NT, but no variation was shown under MP. However, Po significantly increased by 8% under MP, but no variation was observed under NT from October 2009 to April 2010. The content of SMB-P was increased by 50% both in MP and NT from October 2009 to April 2010. However, there is a significant decrease under MP from October 2009 to February 2010 but no variation was shown under NT. Under MP, SMB-P was negatively correlated to PM3 ($P = 0.044$), and positively correlated to Po ($P = 0.003$); while under NT, SMB-P was positively correlated to PM3 ($P < 0.001$), and negatively correlated to Po ($P = 0.015$). We conclude that NT had a greater effect on soil P transformation, especially in Po mineralization in the process of residue decomposition over winter compared with MP.

FACTORS CONTROLLING SOIL WATER STORAGE IN THE HUMMOCKY LANDSCAPE OF THE PRAIRIE POTHOLE REGION OF NORTH AMERICA

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The Prairie Pothole Region (PPR) in North America is unique hummocky landscape containing hydrologically closed topographic depressions with no permanent inlet or outlet. Knowledge about the controls of soil water distribution in the landscape is important for understanding the hydrology in the PPR. In this study, we investigated the correlation between soil water storage and different controlling factors over time. Time domain reflectometry and neutron probe were used to measure soil water storage up to 1.4 m depth over 4 yr along a 576 m long transect at St. Denis National Wildlife Area, Saskatchewan, Canada, which represent a typical landscape of the PPR. Soil and vegetation properties were measured along the transect and various terrain indices were calculated from the digital elevation map of the study area. Soil texture (e.g. correlation coefficient, r = -0.57 to -0.73 for sand) provided one of the best explanations for the variations in soil water storage by controlling the entry and transmission of water within soil in the semi-arid climate of study area. Bulk density (r = -0.22 to -0.56), depth of A horizon, (r = 0.18 to 0.49), C horizon (r = 0.29 to 0.69), and $CaCO_3$ layer (r = 0.31 to 0.79) influenced the water transmission through soil and were correlated to soil water

storage. Beside soil properties, topographic wetness index (r = 0.47 to 0.67), slope (r = -0.41 to -0.56), convergence index (r = -0.29 to -0.60), and flow connectivity (r = 0.27 to 0.60) were also correlated to soil water storage. However, multiple linear regressions showed a consistent high contribution from soil properties such as sand, OC, depth of $CaCO_3$ layer, and bulk density in explaining the variability in soil water storage. A substantial contribution from topographic variables such as wetness index, gradient, and solar radiation was also observed. Therefore, unlike other geographic regions, the soil-water storage variations in the PPR are controlled by a combination of soil and terrain properties with dominant control from soil characteristics at the field scale.

USE OF WEIGHTS OF EVIDENCE STATISTICS TO DEFINE INFERENCE RULES TO DISAGGREGATE SOIL SURVEY MAPS

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Our objective was to produce a digital (raster) soil map for a tributary watershed within the Okanagan Basin of southern British Columba by disaggregating soil series from within polygons of harmonized legacy soil maps. Individual soil series were assigned to grid cells of a 25 m digital elevation model. We used a fuzzy membership inference using the output from weights of evidence calculations to help define inference rule curves. Weights of evidence is a probabilistic calculation based on the expected spatial relation between a predictor (environmental covariate) and a mapped soil class (soil series) where covariate values are placed into classes. We used the contrast values generated by the calculation to quantify the strength of association between covariate classes and the mapped soil series and the Studentized contrast values to identify statistically significant associations. In this way we could identify the most robust predictors for each soil se-ries and define the membership rule curve for each covariate for each soil series within the ArcSIE (soil infer-ence engine) software. A limiting factor function was used to integrate the fuzzy membership values of all covariates to produce a single value for each soil series for each grid cell. The inference was run for each of 23 soil series to produce a final map. Field validation indicated satisfactory (>70%) prediction accuracy for the method although uncertainty at individual grid cells as measured by dispersion of membership (entropy) values was highly variable.

ESTIMATION OF GROSS NITROGEN TRANSFORMATION RATES USING THE STABLE ISOTOPE POOL DILUTION METHOD: EVALUATION OF POTENTIAL SOURCES OF ERROR

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The isotope pool dilution method is a useful technique for estimating gross nitrogen transformation rates within soils, however when recently used within a three-year barley-red clover-potato crop rotation on Prince Edward Island, calculated rates were highly variable. This study examined the effects of potential sources of error on estimates of gross N mineralization and nitrification rates within this rotation experiment. Three sources of error were considered: the precision of NO_3-N and NH_4-N concentration determinations using a segmented flow analyzer; the precision of 15N atom percent enrichment determination from isotope analysis; and the variability in soil inorganic N concentrations between soil cores used for time 0 and time 24 hour soil cores from within the same plot. Analytical variability using the flow analyzer was calculated using the standard deviation (SD) of results from ten replicates of known NH_4 and NO_3 standards. Atom percent enrichment errors were calculated using the SD from five $15NO_3$ and $15NH_4$ standards (at 10 atom percent excess) diffused onto filter disks and analyzed using an elemental analyzer interfaced with an isotope ratio mass spectrometer. Soil variability was estimated by calculating the difference in inorganic N concentrations between pairs of soil cores sampled from each plot. The analysis was performed using a selection of gross transformation rates estimated from each phase of the potato crop rotation in 2010. For each source of error examined, values used in calculating the transformation rates were changed by ±2 SD and the resulting change in the transformation rate was determined. Variation in soil inorganic N concentrations between soil cores was the largest source of error, particularly within the potato phase

of the rotation. Suitability of the stable isotope pool dilution method to estimate gross N transformation rates within all phases of the crop rotation was evaluated taking into consideration the possible effects of these errors. Keywords: mineralization, nitrification, isotope pool dilution, 15-nitrogen, potato, inorganic N.

ANIONIC EXCHANGE MEMBRANES AS A PREDICTOR OF NITROGEN SUPPLY FROM CONTROLLED-RELEASE NITROGEN FERTILIZER IN POTATO PRODUCTION

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Efficient nitrogen (N) management is important for reducing N losses and enhancing potato (Solanum tuberosum L.) yield and quality. Controlled-release N fertilizers (CRN) can increase potato N use efficiency by synchronizing N supply with N demand. In practice, it is difficult to accurately predict N supply from CRN fertilizers because N release depends on soil moisture and temperature. The objectives of this study were to (1) evaluate how CRN rates affect potato marketable tuber yield, total plant N uptake, and NO_3 adsorbed on anion (NO3AEMs) exchange membranes, and (2) determine the relationships between total plant N uptake and NO3AEMs early in the growing season as a criterion to predict N supply to potatoes. This study was conducted on a sandy loam soil (series Morin and Pont-Rouge) located in Ste-Catherine-de-la-Jacque-Cartier near Quebec City, Canada where four CRN rates (60, 120, 200 and 280 kg N ha^{-1} applied at 100% at planting) were compared with a control (no N applied). Treatments were arranged in a randomized complete block design with four replicates. Four AEMs were buried to a depth of 20 cm between two plants and collected every 14 or 15 days from 21 and 28 days after planting (DAP) until harvest in 2010 and 2011, respectively. Marketable tuber yield and total plant N uptake were responsive ($P < 0.001$) to the applied CRN fertilizer. The NO3AEMs were proportional to the CRN fertilizer rates suggesting that the AEMs have the ability to distinguish CRN fertilizer rates. There were more periods of high NO3AEMs concentrations in 2011 compared to 2010. At harvest, NO3AEMs were significantly greater in the 200 and 280 kg N ha^{-1} plots than the control indicating a NO_3 leaching potential from these CRN rates. The NO3AEMs sampled 40 to 50 DAP ($R2 = 0.86$, $P = 0.001$) were better related to total plant N uptake than 20 to 30 DAP ($R2 = 0.79$, $P = 0.004$). The N supply from CRN fertilizers and soil to potatoes can be predicted by AEMs early in the growing season.

NITROGEN AND TILLAGE REVERSAL EFFECTS ON GHG EMISSIONS IN A BLACK CHERNOZEM SOIL

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Tillage reversal, the conversion of land management systems from no tillage to conventional tillage, can be used to deal with weed infestation and accumulation of crop residue in no tillage systems. However, tillage reversal may increase greenhouse gas (GHG) emissions and decrease the capacity of the soil to store carbon. The objective of this study was to determine the effect of tillage reversal and fertilizer N application (0 vs. 100 kg N ha^{-1}) on GHG fluxes. The experiment used a split-plot design with the mineral N application treatment applied at the main plot level and the tillage reversal treatment applied at the sub-plot level. The experiment was conducted on an Orthic Black Chernozem at the Ellerslie long-term experimental site. All the plots are under continuous barley (*Hordeum vulgare L.*) rotation. The rates of CO_2 fluxes ranged between 8 and 758 mg CO_2-C h^{-1} m^{-2}. Both tillage reversal and N application increased CO_2 emission ($p=0.08$ and 0.006, respectively). As expected, N_2O emission rates during growing season were generally small, ranging between 1.2 and 52.8 μg N_2O-N h^{-1} m^{-2}. No significant N and tillage reversal effects on soil N emission were observed. All the research plots acted as a methane sink. CH_4 oxidation rates were in the range of 2.3~65 μg CH_4-C h^{-1} m^{-2}. Nitrogen application decreased methane oxidation ($p=0.005$ for the zero tillage and 0.02 for the tillage reversal treatments). Rates of N_2O emission and CH_4 oxidation were different between different sampling dates ($p<0.0001$ for CO_2 and $p<0.01$ for methane). There was a positive relationship between temperature and the emission rate of CO_2 ($p=0.005$) but not that of CH_4 ($p=0.06$). Overall, our results indicate that: tillage reversal may not necessarily increase the overall emission of GHG; and N fertilizer application increased carbon loss from the soil through increased emissions of CO_2 and CH_4 but had no measurable effect on soil N.

AN ARTIST'S EYE ASSESSES SOIL LANDSCAPE COLOUR AS DIAGNOSTIC INPUT FOR PREDICTIVE DIGITAL SOIL MAPPING

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Soil colour has been historically a diagnostic classification parameter used by soil surveyors throughout the world. The Munsell Colour chart aids in standardizing these observations between pedologists. A version of this chart may also be found, in a somewhat enhanced colour wheel form, within a painter's kit. This study probes common ground for the examination of colour in a soil landscape through the eyes and experiences of both mapping pedologists and an artist painting that landscape. Soil colour reflects mineral composition, organic matter levels and soil moisture or drainage status. These are among the diagnostic elements for soil series classification. They are captured also by the artist's eye in selecting the paint colours to mix and blend in crafting soil landscape paintings. Colour, in these landscapes, is also dynamic. It changes with soil moisture and vegetation cover status under different seasonal conditions in different years for each agricultural landscape region. Predictive digital soil mapping (PDSM) incorporates geospatial information layers from a wide range of sources. Remote sensing images, over a multi-year time span and at a range spatial resolutions, provide means by which to examine soil landscape colour as a diagnostic component of PDSM for soil unit delineation. Red, green and blue (RGB) colour codes for Munsell Colour chart soil colours were developed from a series of digital photos taken by a skilled artist under natural sunlight conditions with the sun position at zenith. These were compared with those obtained through a flatbed digital scanning process. An innovative image colour analytical tool called “Image Sandbox”, developed by Niagara College in Ontario, was used to differentiate soil colour domains across agricultural fields on high-resolution digital orthoimagery according to these natural-light Munsell Colour RGB codes. These georeferenced soil colour-bounded layers were input into the inference engine as part of the PDSM protocol. Paintings of this same agricultural soil landscapes were made using this digital colour palette. This study explored an approach and successfully harnessed the soil landscape colour observations of an artist as diagnostic elements aiding PDSM.

PROVINCIAL SOIL MAP RENEWAL IN ONTARIO: HONORING LEGACY MAPPING THROUGH INNOVATIVE PREDICTIVE APPROACHES

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The hundredth anniversary of soil map development for the province of Ontario is fast approaching (2014). Active soil survey for more than eight decades produced over 150 printed soil survey reports, maps, and summary documents (141 of these are available at the CanSIS “Soil Surveys of Ontario” website; http://sis.agr.gc.ca/cansis/publications/surveys/on/index.html). Mapping pedologists in Ontario were innovators who adapted to incorporate the newest approaches, taxonomy renewal and technology developments that occurred during their mapping project time periods. Their legacy of soil map products testifies to this evolving science. A landmark technology development has forever changed Ontario soil map product development, presentation and possibilities. Computer-based geographic information system (GIS) implementation ushered in new era for soil maps. The most recent versions of county-level soil maps for Ontario were digitized. These products have become the dominant means through which geospatial soil information is accessed, analyzed and presented by a broad range of users. Another pivotal geomatics technology innovation for soil survey work was the development of digital elevation models (DEM’s). This geospatial terrain information resource permits the mapping pedologist to examine and analyze the soil landscape in ways never before available. It was not until Ontario soil scientists overlaid the county-level digital soil map products on the provincial DEM that it was discovered that the digitizing process has distorted and shifted soil map unit polygons from their “concept” positions. This issue is not trivial. Many Ontario regulations for land use planning and environmental issues (nutrient management) lean on the digital soil classification maps and their allied property derivatives for boundary delineation. The long process of Ontario soil map renewal has begun. High-resolution DEM’s (with sub-metre vertical accuracies) are the foundation of the predictive digital soil mapping (PDSM) approach being developed and implemented. Recognizing that the legacy soil map products have scale dependencies and somewhat smoothed soil unit boundary lines, the hypothesis used for

this renewal is that the legacy soil map information is essentially correct. The original “soil concept” is honoured for all named soil series. The legacy soil series classification for each geographic location is maintained until it is tested against this “soil concept”. If rejected for that classification, it is assigned an appropriate classification based on how closely its characteristics match the “soil concept” for another soil series. Rule sets for these legacy “soil concepts” drive the inference engine for this PDSM process. A nested hierarchy of soil map products is developed in this soil map renewal process. Map production at a range of spatial scales is now a straightforward cartographic process - not the limiting factor in geospatial soil map information development. Soil map products can now be made available at the field-specific management level for farmers as well as at scales ranging upwards to the 1:50,000 regional planning scale. PDSM soil map renewal pilot projects were launched in locations with DEM’s derived through different means. Initial efforts focused on a study area with the current provincial DEM (vertical accuracy on the order of 2.5m). This effort showed promise but did not have sufficient vertical accuracy to adequately map the required terrain features where relief differences are subtle. Subsequent PDSM mapping efforts for areas with high-resolution DEM’s (sub-metre vertical accuracies) have yielded excellent results. These approaches have shaped Ontario’s current soil map renewal program.

EFFICACITÉ DES BANDES RIVERAINES INFLUENCÉE PAR LE MOUVEMENT PRÉFÉRENTIEL DE SOLUTÉS DANS LES SOLS- BUFFER STIP EFFICIENCY AS INFLUENCED BY PREFERENTIAL FLOW

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Les bandes riveraines sont actuellement utilisées comme des pratiques agricoles bénéfiques pour protéger la qualité des cours d'eau en misant sur leur capacité à intercepter les contaminants avant qu'ils n'atteignent ceux-ci. Cependant, le mouvement préférentiel (MP) de l'eau et des solutés dans les sols pourrait réduire leur efficacité. Afin de quantifier cet effet, des bandes riveraines ont été installées dans le cadre du projet national EPBH sur un territoire agricole situé dans le bassin versant de la rivière Bras d'Henri (Québec). Des plaques lysimètriques ont été installées sous les bandes riveraines adjacentes à un champ sur lesquels des traceurs ont été injectés. Le MP du traceur bleu (FD&C bleu #1) est discuté en lien avec sa présence dans l'eau de surface, les bandes riveraines et dans le sol agricole pour mieux comprendre son effet sur l'efficacité des bandes riveraines.

Buffer strips are currently used as a beneficial management practice for protecting surface water quality based on their capacity to intercept contaminants before they reach surface water bodies. However, preferential flow (PF) may decrease their efficiency. To quantify this impact, buffer strips, were implemented as part of the WEBs study along a small creak flowing through an agricultural area within the Bras d'Henri watershed (Quebec). Lysimetric plates were installed below the buffer strips adjacent to fields over which blue tracer (FD&C Blue #1) has been applied. Preferential flow of the tracer is discussed on the basis of its presence in surface water, buffer strips and soil to better understand the impact of PF on the efficiency of buffer strips.

PREDICTING SOIL PROPERTIES USING SPECTRAL MEASUREMENTS AND INDEPENDENT COMPONENT ANALYSIS (ICA)

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Calibration and prediction of soil properties from diffuse reflectance spectra remain an important area of research for digital soil mapping activities. However, spectral signature is a function of the sum of a combination of soil properties that affect overall reflectance. Independent component analysis (ICA) is a statistical method used to separate a multivariate signal (e.g. spectral signature) into additive and independent subcomponents (e.g. soil properties). The aim of this study was to evaluate the ability of ICA to predict permanent soil properties (soil organic matter content, proportions of sand, silt, and clay) from spectral measurements. Thus, reflectance spectra were measured in the laboratory over undisturbed soil cores with a full-range (400 -2500 nm) portable spectroradiometer (Analytical Spectral Devices). Spectral signatures were normalized and first derivatives of the reflectance spectra were calculated. Independent component analysis and Principal Component Analysis (PCA) were applied on the spectral signatures. Both datasets (ICA and PCA) were analyzed using two different methods: stepwise multiple linear regression and data mining (Cubing Statistics trees). Preliminary results showed that ICA provides a better accuracy for predicting soil properties.

A SPECTRO-TEMPORAL APPROACH TO SUPPORT SPATIAL PREDICTION OF SOIL TEXTURE AND DRAINAGE

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This study, conducted in the Ewing Creek watershed (Quebec, Canada), evaluated quantitative relationships between soil surface reflectance and inherent soil properties to produce digital soil maps for supporting precision soil conservation and sustainable water management. These relationships were studied at three observation levels: at the laboratory, field and catchment scales. Radiometric measurements were taken in the laboratory on 119 undisturbed soil cores during a drying process using a high resolution field spectroradiometer to simulate the Landsat (TM7) spectral bands. These reflectance values were then used to derive multi-temporal spectral indices able to quantify soil moisture, organic matter and texture. In the field, radiometric measurements were acquired under contrasting wetness conditions on 47 of the 119 sampling sites to validate the spectral indices developed in the laboratory. At the catchment scale, spectral indices were derived from TM7 images for different soil moisture conditions and compared to morphological soil description (265 profiles) through discriminant analysis. Discriminant functions were then inverted to predict soil texture (A and B horizons) and drainage of the whole watershed. Normalization of radiometric measurements taken in the laboratory under wet and dry conditions proposed a new spectral index exhibiting a significant linear relationship with soil moisture (R^2=0.80). Results show that the TM7 green band could be used to estimate the amount of soil organic matter (R^2=0.89). These relations have been validated at the field scale for both soil moisture (R^2=0.81) and organic matter (R^2=0.81). Prediction models derived from discriminant analysis confirm relevance of spectral indices in digital mapping of soil texture and drainage.

DISSOLUTION BIOLOGIQUE DES PHOSPHATES: ISOLEMENTS, IDENTIFICATION ET CARACTÉRISATION DE BACTÉRIES SOLUBILISANT LES PHOSPHATES

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La faible disponibilité du phosphore (P) soluble, facilement assimilable par les plantes, limite la productivité végétale de certains sols agricoles. Afin de remédier à ce problème, le recours aux engrais chimiques solubles, de plus en plus coûteux, est considéré comme une solution à court terme. Cependant, l'application de ces fertilisants s'est effectuée sans tenir compte de l'activité des mycorhizes et de la microflore de la mycorhizosphère, ce qui conduit souvent à des applications excessives pouvant représenter un risque environnemental. La solubilisation microbienne des phosphates joue un rôle important dans la conversion du P insoluble en P soluble. En effet, il a été démontré que certains microorganismes du sol impliqués dans la solubilisation des phosphates peuvent améliorer la nutrition phosphatée des plantes. Cette activité microbienne est améliorée lorsque les bactéries sont associées aux mycorhizes. Notre étude repose sur l'isolement de bactéries solubilisant les phosphates (BSP) à partir de 13 échantillons de sol prélevés au Québec, selon deux méthodologies différentes. La première méthodologie consiste à isoler des BSP directement à partir des sols alors que la seconde vise l'isolement des BSP fortement attachées aux hyphes du champignon endomycorhizien Glomus irregulare. Ces dernières ont été obtenus à partir de racines de poireaux mycorhizés inoculées avec des suspensions de sol contenant les bactéries telluriques Ces deux criblages nous ont permis de sélectionner huit souches capables de solubiliser les phosphates inorganiques. L'identification moléculaire de ces souches montre qu'il s'agit de Dyella japonica, Bacillus pumilus, Burkholderia phenazinium, Rahnella sp. Rhizobium etli, Burkholderia cepacia, et Burkholderia sp. (2). Ces souches sont caractérisées par une production importante d'acides organiques, de sidérophores, de phytohormones (dérivés de l'acide indole-acétique) et sont munies de diverses activités enzymatiques (phytase, phosphatase alcaline, phosphatase acide). Ces activités biologiques pourraient être impliquées dans l'amélioration de la croissance des plantes en favorisant la solubilisation des phosphates et dans l'interaction bénéfique entre les BSP et les mycorhizes. Ce dernier volet est présentement en cours d'étude.

AGRICULTURAL WATER MANAGEMENT SYSTEMS AFFECTING GREENHOUSE GAS EMISSIONS IN QUEBEC, CANADA

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Agricultural water management involves manipulation of the natural water table to promote crop production. Subsurface drainage is a common water management practice for field crop production on about two million hectares of cropland in Quebec and Ontario. Supplemental watering with sprinkler, surface drip and subsurface drip irrigation is important for many horticultural crops in Quebec. Information on how these water management practices affect greenhouse gas (GHG) production and emissions is limited, and would be improved by understanding the spatio-temporal controls on N_2O, CO_2 and CH_4 emissions in both mineral and organic soils. The objective of this study was to gather information on agricultural water management systems that affect GHG emissions in Quebec, Canada. Two sites on producers' farms were selected for this study. The site at St. Emmanuel (QC) was on a sandy-loam soil overlying marine clay with replicated plots (separated by buried plastic sheets and buffer zones) having free drainage and controlled subsurface drainage. This site is cultivated with corn and other field crops. The site at Sherrington (QC) was on an organic black soil without artificial drainage, used for vegetable crop production and receiving irrigation. Paired plots with sprinkler irrigation and no irrigation, across a gradient of soil subsistence (organic soil profile varies from a few cm to more than 50 cm) were considered in this study. Greenhouse gas emissions are measured using the closed-chamber method, headspace gases collected every 1-2 weeks and analyzed by gas chromatography to calculate fluxes. This presentation provides information about the sites, experimental design, expected findings and some preliminary results. The broader implications of this work – development of GHG mitigation technologies and best management practices aimed at reducing GHG emissions due to agricultural water management – will be discussed.

IMAGE-BASED MICROMORPHOLOGICAL QUANTIFICATION OF POROSITY IN RED LATOSOLS ON THE BRAZILIAN CERRADO, UNDER SUGARCANE PRODUCTION

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In response to increasing demand for bio-fuel, sugarcane production is expanding into the Brazilian Cerrado (savannah), especially in the area of Quirinopolis, in the south-western state of Goias. This expansion is replacing areas previously used for grain crops (such as soybean and corn) and pastures. The changing landuse is impacting various soil characteristics, but especially the porosity; this can be attributed to the nature of the distroferric Latossolos Vermelhos (Oxisols), which are highly-susceptible to compaction. Otherwise, the land is very conducive to mechanized production systems. The objective of this study was to quantitativel y analyze changes in soil porosity, from the micromorphological perspective, which can reveal incipient alterations to soil structure. Five soil profiles were selected to represent dominant scenarios: sugarcane on previous soybean land, with and without fertigation, sugarcane on previous pasture land, also with and without fertigation, as well as well-preserved Cerrrado. Intact soil samples were collected from all horizons, vacuum-impregnated with polyester resin, from which conventional thin sections (25mm) were prepared. The thin sections were digitally colour-imaged (RGB), at a spatial resolution of about 10 mm, under three illuminations: plane polarized, cross polarized and oblique incident. These images where co-registered and segmented using multi-spectral, fuzzy K-means classification (PCI Geomatica), to distinguish voids, as well as other dominant soil mineral and organic features. Specific attention was given to the analysis of the voids (using Sigma Scan Pro), to o btain measures of detectable porosity, effective (Feret) diameter, perimeter, shape factor and compactness. The results are interpreted to evaluate the relative impact of the different management systems on alteration of soil structure, leading to compaction. Samples from the intact Cerrado, as well as the Bw (oxic) horizons of all profiles, presented high porosity. The soils previously under pasture exhibited more substantial reduction of porosity in superficial horizons, than those previously under soybean production. No impact of fertigation could be discerned.

NITROGEN MINERALIZATION FROM MANURE: COMPARISON OF METHODS AND EMERGING TECHNOLOGIES FOR PREDICTION OF THE SOIL N SUPPLY

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Nitrogen (N) is the most important element in crop production, derived from N fertilizers, crop residues and soil organic matter (SOM). In humid temperate agroecosystems, N mineralization from SOM accounts for 20-80% of crop N requirements. The unpredictable nature of N mineralization means that it is challenging to subtract the soil mineral N supply from fertilizer N recommendations, which is confounded by the addition of manure. Yet, we do know that soils with a history of manure application have greater residual soil N supply, which needs to be considered to avoid adverse environmental impacts. The purpose of this review was to compare methods and identify emerging technologies that can more accurately predict the contribution of N mineralization to the soil mineral N supply and crop N uptake with emphasis on manure-amended soils. A literature review identified recent advances in N mineralization prediction from manure amended soils. Preliminary findings suggest that the carbon(C):N ratio is an important determinant of whether N mineralization or immobilization occurs in manure-amended agroecosystems but this measure does not capture stabilized organic N that is resistant to depolymerisation. Therefore, a more appropriate indicator may be the bioavailability of organic N in relation to C. Since organic N, or some fraction thereof, is mineralized it is not surprising that organic C fractions (eg. DOC, labile organic C) can better predict the soil mineral N supply compared with simple measures of NH^{4+} + NO_{3-} (eg. PSNT). Recent research suggests that C bioavailability exerts control on the depolymerisation of SOM, which regulates N mineralization. An in-depth discussion of relevant methods and emerging technologies will be presented. Future research should aim to increase knowledge of the contribution of different organic N

fractions to N mineralization and consequently to the soil mineral N supply in manure-amended soils to improve fertilizer N recommendations.

PARCELLES DE LONGUE DURÉE AU SITE DE SAINT-MATHIEU-DE-BELOEIL DU CÉROM

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Des parcelles de longue durée ont été implantées en 2008, au site du CÉROM, situé à Saint-Mathieu-de-Beloeil en Montérégie. Les informations acquises avec ce type d'installation et avec les essais qui y sont menés peuvent être très utiles. On peut citer en exemple leur utilisation pour le développement de modèles de prédiction de l'évolution de la qualité des sols (matière organique, stabilité structurale), des populations de mauvaises herbes, des différents ravageurs ou agents pathogènes. Les modèles utilisés actuellement à travers le monde pour prédire le potentiel de séquestration du carbone ont tous été développés à partir de données d'essais agronomiques de longue durée. Quatre facteurs ont été retenus : rotation, travail du sol, fumure et gestion des résidus. Quatre rotations sont comparées : 1. Maïs-soya-blé; 2. Maïs-soya-blé-fourrages-fourrages-fourrages; 3. Maïs en continu; 4. Prairie en continu. Ces quatre rotations sont comparées pour 2 types de travail du sol : labour et semis direct. Trois niveaux ont été retenus pour la fumure : minérale, organique et aucune amendement. Enfin, 2 niveaux de gestion des résidus sont évalués : exportation ou intégration des résidus. Le dispositif expérimental retenu est un split-split factoriel avec, en parcelle principale, le travail du sol (labour vs semis direct), en sous-parcelle la rotation (4 niveaux) et en parcelle de base les facteurs fumure (3 niveaux) et gestion des résidus (2 niveaux). En excluant les différents traitements n'ayant pas de justification agronomique (prairie en continu sous labour et intégration des résidus sous prairie en continu en semis direct), le dispositif final comporte 39 traitements répétés 4 fois pour un total de156 parcelles. L'unité expérimentale mesure 6 m de large et 20 m de longueur afin de répondre aux contraintes techniques des divers équipements utilisés pour la réalisation des parcelles. L'expérimentation est implantée sur un sol de la série Saint-Urbain (UB5) ayant eu les précédents culturaux suivants de 2003 à 2007 : maïs, soya, maïs, maïs et soya. Des échantillons de sol ont été recueillis sur le profil du sol (0-90 cm) pour chacune des parcelles au printemps 2008 avant l'implantation des cultures. Les analyses statistiques des rendements sont présentées pour les 4 premières années expérimentales.

REFERENCE PLOTS FOR N MANAGEMENT DO THEY HAVE A PLACE?

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This paper aims at summarizing the benefits, limitations and conditions for success of reference plots for nitrogen (N) management. Crop nutrient status diagnosis is an opportunity to identify growth limiting nutrients and to establish sound corrective actions. However, a common problem facing diagnosis is the influence of confounding factors in the interpretation of nutrient levels or surrogate diagnostic parameters. Critical levels of nutrients such as nitrogen (N) are known to diminish as crop biomass increases over a growing season. Levels are also affected by factors such as cultivar, part sampled, operator, crop water status, and sometimes even the time of day. As an alternative to diagnoses from absolute levels of diagnostic parameters, it has been suggested to work from reference areas (plots or strips) established in the same fields where the diagnosis is needed. These reference areas are normally established weeks before diagnosis with a known level of the targeted nutrient (either nil or saturating rate). The level of the diagnostic parameter is then ratioed to the one in the reference area in order to obtain an index (“sufficiency index” or SI) of relative status that is claimed to be independent of all confounding factors. This “reference plot concept” has been proposed in the early 1990’s to handle the diagnosis of nitrogen status based on chlorophyll (Chl) assessments. Despite its potential benefits, it has not been widely implemented for a number of reasons such as the extra work invoved and the difficulty in selecting appropriate locations

for plot establishment. Recent research results have shown the influence of apparent soil electrical conductivity (ECa) on SI and the opportunity for using the natural variability of soil N supply in the field space to replace manually established reference areas. The presentation will conclude with a list of requirements for reference plots to play a useful role for crop N status assessments.

META-ANALYSES APPLIED TO NITROGEN MANAGEMENT ISSUES

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Meta-analysis refers to a statistical synthesis of results from series of studies and is used in many fields of research. This technique is commonly used to assess treatment effect (called also effect size) from series of references or experiments. It allows for a formal and reproducible investigation of heterogeneity, small study effects, and other data trends. In this study, meta-analyses were used to examine the influence of soil and weather parameters on N responses of corn (Zea mays L.) in several studies carried out in Quebec (1997 to 2008) and North American (2006 to 2009) locations. Results of the North American study showed that corn response to added N was significantly greater in fine-textured soils than in coarse-textured soils. Abundant and well-distributed rainfall and, to a lesser extent, accumulated corn heat units enhanced N response. Corn yields increased by a factor of 1.6 (over the unfertilized control) in coarse-textured soils and 2.8 in fine-textured soils at high N rates. Subgroup analyses were performed on the fine-textured soil class based on weather parameters. Rainfall patterns had an important effect on N response in this soil texture class, with yields being increased 4.5-fold by in-season N fertilization under conditions of “abundant and well-distributed rainfall.” Responses of corn yield to ISNR in the Quebec study were negatively related to overall CHU accumulation, but positively related to CHU accumulation before side-dressing. Responses were also better related to precipitation (PPT) cumulated before side-dressing than after. High and evenly distributed precipitation before side-dressing tended to increase responses to ISNR. Therefore, low CHU, low precipitations and low precipitation evenness before side-dressing reduced the impact of ISNR on corn yield production. These findings could be useful for developing N fertilization algorithms that would allow for N application at optimal rates taking into account rainfall pattern and soil texture, which would lead to improved crop profitability and reduced environmental impacts.

THE NATURE OF BURIED SOIL ORGANIC MATTER IN ERODED CROPLAND

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Recent research in our group showed that a large amount of soil organic matter (SOM) is buried in depositional areas of Canadian croplands and that mineralisation of this stock of C appears to have been constrained since burial. Typically, erosion gradually displaces soil from convex upper slope to concave, lower slope landscape positions; over time this results in large quantities of buried SOM in depositional areas. This lateral and vertical redistribution of SOM may affect landscape-scale carbon (C) dynamics which have yet to be adequately quantified. Here we analyse the nature of buried SOM at six locations across the country (Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick and Prince Edward Island). We sampled soils in 5-cm depth increments in both eroded and depositional landscape positions and then physically fractionated the soil and isolated the light fraction SOM using NaI at a specific gravity of 1.7. Buried soils contained similar or larger quantities of light fraction C than the surface of soil at both eroded and depositional landscape positions. The C:N ratios of the light fraction became wider with depth in the buried profiles, and were wider than that in near-surface soils. We conclude that buried soil in eroded cropland in Canada contains SOM that may be vulnerable to rapid loss by decomposition under changing management practices.

HYDROCHIMIE DES ÉLÉMENTS TRACES ET CONNECTIVITÉ HYDROLOGIQUE LORS D'UNE CRUE PRINTANIÈRE DANS LE BASSIN VERSANT DE L'HERMINE

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La compréhension de l'hydrochimie des éléments traces (ET) et de la connectivité hydrologique à l'échelle du bassin versant demeure incomplète à ce jour, particulièrement en période de crue printanière. En raison de la toxicité potentielle des ET, leur cycle biogéochimique dans les écosystèmes terrestres et les processus menant à leur transfert du sol au cours d'eau doivent être mieux documentés. Dans ce contexte, l'étude de la fonte printanière est cruciale pour comprendre la dynamique hydrique et hydrochimique des ET lors de crues. Les objectifs du projet sont donc : (1) de quantifier la réponse hydrochimique, telle que révélée par l'évolution des concentrations en ET (As, Cd, Ce, Pb, Y et Zn) dans le ruisseau, et (2) d'établir la réponse hydrologique du bassin versant, en particulier la dynamique de la connectivité hydrologique, en période de crue printanière. Les conditions hydrologiques et hydrochimiques sont suivies dans un bassin forestier, l'Hermine (5.1 ha), reposant sur un substrat granitique imperméable. L'échantillonnage a été fait avant, pendant (toutes les 4h) et après l'évènement hydrologique du 11 avril 2011. Des analyses chimiques (pH, EC, COD et ET dissous), cartographiques et statistiques permettent de déchiffrer la réponse hydrobiogéochimique de l'Hermine pendant la crue. En outre, la compréhension de la dynamique de connectivité contribue à l'identification des zones hydrologiques actives lors d'une crue et de cerner les sources majeures en ET.

OVER-WINTER DYNAMICS OF N_2O FROM FOUR LEGUME BASED CROPPING STRATEGIES IN EASTERN CANADA

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The characteristic release of N_2O as frozen soils melt can account for at least half of all annual N_2O emissions from cropped soils in Eastern Canada. Residual NO_3^- has been identified as a dominant controlling factor for over-winter N loss due to the effect that NO_3^- exposure has on N_2O emissions. Factors that control these emissions include the depth, degree, and rate of soil freezing as well as the influence of biochemical soil properties on denitrifiers as the soil thaws. The seasonal pattern of legume residue decomposition and the subsequent affect on N_2O emissions is much less understood, especially when tile drainage is present in the field. The objective of this study is to determine how the season and timing of red clover incorporation affects over-winter N_2O concentrations in the soil profile, N_2O emissions from the soil surface, and N_2O dissolved in drainage water. In 2010 an experiment was established in Truro, Nova Scotia to study N management in a red clover–spring wheat rotation. Red clover was grown for two years and then incorporated in September, November, or May (i.e., incorporation treatments). A fourth treatment was also incorporated in November, but above-ground red clover was removed leaving roots and residue to be incorporated. Dissolved N_2O was assessed from sub-surface drainage water. Measurements of GHG emissions were made using static chambers in addition to soil atmosphere measurements taken at three depths (15, 30, 50 cm). The period of study began in December 2011 and finished in April 2012. Preliminary results of gas concentrations in the soil profile indicate that there is strong influence of soil temperature on concentrations within the soil profile. As the soil reaches sub-zero temperatures there is a sharp increase in N_2O concentrations at all three depths, indicating that N_2O was possibly trapped in the profile by a frozen soil layer. Similarly, dissolved N_2O in drainage water increased during the freezing period until the concentration peaked as the soil started to thaw and a period of post-thaw drainage had

begun. Analysis is currently ongoing and full results will be presented.

Effect of Controlled-Release Urea on NH3 volatilization and rice production in a rice-wheat rotation in the Taihu region of China

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Proper N management is essential to prevent N losses and ensure high crop yields. Controlled-release urea (CRU) could be a good management strategy to increase the nitrogen use efficiency (NUE) by matching the release of N with crop N uptake. However, little is known regarding the effect of CRU on N losses especially NH3 volatilization in rice-wheat rotation system. A 2-yrs study was conducted in a rice-wheat rotation with paddy soil to investigate the difference of Urea and CRU base on yield, NUE, NH3 volatilization, and Total N (TN) measured at three soil layers: 0-20cm, 20-40cm, and 40-60cm, in Taihu region of China during two rice growing seasons (2010 and 2011). Four treatments were used: an unfertilized control (0N), Urea application (Urea), CRU application (CRU), and CRU application reduced by 20% (80%CRU). Treatments of CRU and 80%CRU were applied as basal fertilizer, while Urea was applied as basal and topdressing. Results showed that no significant difference was observed among Urea, CRU and 80%CRU treatments on yield in both years. However, NUE obtained with the CRU and 80%CRU treatments was greater than in Urea in both years ($P<0.05$).The NH3 volatilization losses during the two rice seasons followed the order as below: Urea>CRU>80%CRU, moreover, N volatilization rate in Urea was significantly higher than in CRU in the first week after N application in both years ($P<0.05$). However, no statistical difference on NH3 volatilization was observed between CRU and 80%CRU ($P<0.05$). After rice harvest both in two years, TN was greater in CRU than in Urea in two soil layers of 0-20cm and 20-40cm, but significant difference between CRU and Urea ($P<0.05$)was found only in 2011. We concluded that CRU is a promising N source to prevent N losses via NH3 volatilization and to increase NUE of rice produced in Taihu region. Results obtained base on two rice growing seasons show that the 80%CRU treatment may be the most effective strategy to improve NUE and reduce N losses in rice production. The study is undergoing for the next growing seasons and expected data should be useful to validate these results.

PRELIMINARY RESULTS: CAN GIS BE USED TO PREDICT THE PRESENCE OF SMECTITE CLAYS IN LUVISOLIC SOILS?

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The British Columbia Sewerage System Standard Practices Manual (2007) states that if a COLE (coefficient of linear extensibility) test results in 3 - 5% shrinkage then there is enough smectite clay to decrease soil absorption field drainage when sewage effluent is applied. Smectite clays develop from the weathering volcanic (basaltic), carbonate and shale bedrock. Do smectite clays develop in high enough concentrations in Luvisols to affect the drainage potential for onsite septic systems? Is there a relationship between Luvisolic smectite clay concentrations in soils developed on glacial tills derived from volcanic, limestone and shale rocks? ArcMap 10 was used to extract the volcanic, carbonate and shale rock types from the digital BC Geology map. The Luvisolic soils for BC were obtained from the CanSIS Soil Landscapes of Canada Version 2.2 GIS data. The Luvisolic layer was overlain over the geology theme. Three units emerged: Luvisolic over volcanic, Luvisolic over sedimentary and Luvisolic on its own. Soil samples were taken from four Luvisolic sites along a 155 km transect from Kamloops to Deka Lake BC. Latitude and Longitude coordinates for each site were plotted on the GIS map. Three sites were located on Luvisolic over volcanic rocks (Barrierie, Deka Lake and Inks Lake) and one site was Luvisolic on its own (Pass Lake). The C1 and C2 horizons for the Barriere site contained 4.44% smectite clay. The Deka Lake Ah had 4.9%, the Bt 8.7% and the BC horizon 5.6% smectite clay. The Bt horizons for Inks Lake and Pass Lake had 3.45% and 4.53% shrink swell clays respectively. In all cases the COLE readings were in the moderate range except for the Deka Lake Bt which was in the severe category. From these four sites the potential for reduced effluent infiltration is moderate to severe and the horizons are considered restricted layers. More sites across the province will be sampled to provide a larger data set. It is recommended that onsite sewage practitioner's conduct a COLE test for all horizons when Luvisolic or any high clay content soils are encountered in BC.

IN-SITU CHARACTERIZATION OF WASTEWATER FLOW AND TRANSPORT FROM AT-GRADE LINE SOURCES TO SHALLOW GROUNDWATER

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A better understanding of multidimensional unsaturated and saturated flow and transport under boundary conditions typical of on-site wastewater disposal systems is required to assess the risk to groundwater contamination. The main objective of this research is to characterize in-situ wastewater flow and transport from at-grade line sources on a shallow groundwater conditions. The research site was conducted at Wetaskiwin Rest Stop, Alberta, Canada, where ultraviolet disinfected wastewater has been disposed off to the ground via pressurized at-grade line sources since 2007. The site was characterized for wastewater plume using Electromagnetic induction (EM31) and (EM38); and by grid of 74 water table wells, 14 piezometers and 11 transducers. Groundwater was analyzed for selected tracers (pH, EC and Cl) and some microbiology (e.g. E. coli). From the results wastewater plume was identified; and wastewater plume center of mass and average flow direction were estimated. Along the horizontal plume center of mass, 30 monitoring wells in 10 nests and 31 temperature sensors in 5 nests were installed to get vertical resolution of the wastewater plume and to track contaminant transport over time. Results, implications and plans for future investigations will be presented. The research output will benefit future research on contaminant fate and transport and groundwater risk assessment plans. Key words: On-site wastewater treatment/disposal system, Wastewater plume, Groundwater contamination.

ANALYSIS OF E.COLI AND BROMIDE TRANSPORT FROM AT-GRADE LINE SOURCES TO SHALLOW GROUNDWATER

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The fate and transport of pathogens under variably saturated conditions typical of on-site wastewater treatment systems (OWTS) needs to be quantified for risk assessment purposes. In-situ spatial and temporal transport of E.coli and Br- from at-grade line sources to shallow groundwater were investigated at Wetaskiwin Rest Stop, Alberta. The site was receiving an ultraviolet (UV) disinfected wastewater for four years via a pressurized at-grade line sources. Following characterization of the prevailing groundwater flow direction and gradients, a nest of piezometers (N=30 in 10 nests) were installed parallel to the direction of groundwater flow up- and down-gradient of the wastewater line sources. The UV system was turned off for 90 day to simulate a breakdown and a pulse of Br- was applied to the source tank to track wastewater flow path and contaminant transport over time. Observed breakthrough curves of E.coli and Br- will be presented. The research output will benefit future research on pathogens fate and transport and groundwater risk assessment plans. Key words: Wastewater, OWTS, E.coli and Br breakthrough curves, Groundwater contamination.

THE EFFECT OF LONG-TERM FERTILIZATION ON SOIL WATER DYNAMICS, CROP YIELD AND WUE IN BLACK SOIL REGION IN NORTHEAST CHINA

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Black soil region in Northeast is the second largest granary of China; however, water is one of limiting factors that impact the agricultural production in dryland in Black soil region in Northeast China. The seasonal drought was caused by the uneven distribution of annual precipitation in this region. The objective of this study was to examine if different fertilization affected soil water supply in this region. A long-term experiment was conducted at the National Field Research Station of Agro-ecosystem in the Chinese Academy of Science in Hailun County in Heilongjiang province in Northeast China from 1999 to 2011, respective years including 2005 (soybean), 2006 (maize), 2007 (soybean) and 2008 (maize) ware selected in this study. Three fertilizer treatments including no fertilizer (CK), chemical fertilizer (NP) and chemical fertilizer plus pig manure (NPM) were tested. The results showed that crop received chemic fertilizer plus pig manure obtained largest evapotranspiration (ET) in observed four-year, followed by NP and CK, which resulted in that soil water storage (0-170 cm) decreased in the order of CK > NP > NPM during the growing season. Water stored in soil profile was one important source for crop water consumption with exception of precipitation. Crop received NPM and NP could used more water stored in soil profile, compared with CK, then enhance soil water supply, which mitigated soil seasonal drought, especially for NPM. It had been shown for the performance of higher crop yield and water use efficiency in NPM than that in NP and CK. Therefore, NPM was a viable management practice in the black soil zone in Northeast China for improving crop yields.

BLACK CARBON EFFECTS ON SOIL CO_2 EMISSIONS AND ISOTOPIC PROXIES FOR BLACK CARBON DECOMPOSITION: A METHODOLOGICAL STUDY

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Important due to both its role in fire-affected ecosystems as well as its proposed production and application as a carbon sequestration mechanism, black carbon (BC) is thought to be a very stable form of carbon. However, its interactions with non-BC soil organic carbon (SOC) remain poorly understood, with studies showing both positive and negative “priming effects” on SOC decomposition under BC applications. This study describes results from a 12-week greenhouse pot trial where BC-SOC priming effects and identification of an optimal $\delta^{13}C$ proxy for BC emissions were investigated using stable isotope partitioning. The experiment is a 2x2 treatment greenhouse pot trial with (+/-) ^{13}C-labelled BC added at a rate of 0.3% by mass and (+/-) corn plants as the two treatments. In order to control for pH and nutrient addition effects from BC, its pH was adjusted to that of the soil and optimal nutrient and water conditions were provided to the plants. CO_2 emissions were analyzed weekly throughout the experiment using an infra-red gas analyzer, and periodically using a gas chromatograph-mass spectrometer for isotopic partitioning. Significant BC losses occurred in the first week. We find that there may be evidence for a “negative priming” effect of BC on SOC in the system (SOC losses are lower than predicted) during week 1, but this effect disappears over time, indicating it may be due to transient effects driven by labile BC. There is an insignificant positive trend in CO_2 emissions and plant growth with BC additions. In addition, the use of different $\delta^{13}C$ proxies for SOC, BC, and plant root respiration has a significant effect on the calculated magnitude of priming. This is particularly important for BC, where the use of the $\delta^{13}C$ signature of bulk BC predicts double the priming effects than if the $\delta^{13}C$ signature of BC tars is used. Furthermore, if dissolved BC is used as the proxy, a positive priming effect is measured, rather than a negative effect, highlighting the importance of choosing an appropriate proxy for BC-derived CO_2 emissions. We discuss the implications of this fractionation for natural abundance and enriched studies.

NITROGEN DYNAMICS OF VARIOUS ORGANIC AMENDMENTS ON CEREAL CROP PRODUCTION WITHIN ORGANIC SYSTEMS IN SOUTHERN ONTARIO

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Limited research exists to guide organic cereal producers who use organic amendments as their major Nitrogen (N) source for their affects on crop yield, grain quality, plant N- uptake and N fate in the soil. Several cereal crops (winter wheat, barley, oats, winter spelt, and corn) were grown in 2011 on 8 organic farms in southern Ontario, Canada on a range of soil types. Organic amendments including composted turkey litter, composted dairy manure, fresh broiler litter and an industrial bacterial by-product were applied, in a randomized complete block design, at rates ranging from 0% to 150% of the N requirement for the specific crop to achieve maximum yield. At 3 sites red clover which had been under-seeded and soil incorporated, was evaluated for its potential in-season N contribution to the cereal crop. At maturity, the crops were harvested for measurements of dry matter yield and grain N content. Inorganic N (0-15 cm and 15-30 cm) was measured in soil samples taken prior to application of the organic amendment, post-harvest and mid-winter. Based on these field experiments, an N availability model will be constructed to evaluate best management strategies for ensuring that N release from these treatments is coordinated with crop N demand, and that N losses due to leaching and volatilization are minimized. This research will provide applicatory information for organic producers on the anticipated N contributions of these organic amendments and subsequent benefits to crop yield and quality.

WATER YIELD, SEDIMENT LOAD, AND EROSIVITY OF A SMALL WATERSHED UNDER A LONG-TERM MONITORING

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With a well-instrumented and maintained watershed, the Black Brook watershed (BBW), the impacts of potato cultivation and land management practices on stream water yield and sediment load during 1992-2010 were evaluated. During the study period, yearly cumulative precipitation varied from 827.5 mm (32.58 in) to 1183.4 mm (46.59 in) with an average of 1057.5 mm (41.63 in). Monthly distribution was generally even except for July when about 10% of annual precipitation fell. The standardized precipitation index (SPI) varied from -2.3 to 1.15, indicating a range of very drought to moderately wet. Annual surface discharge varied from 351.7 mm (13.85 in) to 897.2 mm (35.32 in) with an average of 606.1 mm (23.86 in). The discharge amount accounted for 35-79% (average 57%) of precipitation in the watershed. The discharge in April accounted for 33% of annual discharge. Erosivity varied greatly from 641 MJ mm ha^{-1} hr^{-1} (38 hundreds foot-ton in/acre/hr) to 2803 MJ mm ha^{-1} hr^{-1} (165 hundreds foot-ton in/acre/hr) [average of 1520 MJ mm ha^{-1} hr^{-1}(89 hundreds foot-ton in/acre/hr)] with a slight increasing trend over year. The most erosive months were June, July, and August with the total erosivity from these months accounting for 57% of annual erosivity. Sediment load displayed a large annual variation, ranging from 5.6 t ha^{-1} yr^{-1} (13.8 tons/acre/yr) to 0.9 t ha^{-1} yr^{-1} (2.2 tons/acre/yr) with an average 3.0 t ha^{-1} yr^{-1}(7.4 tons/acre/yr). Monthly soil loss varied from 1.4 t ha^{-1} yr^{-1} (3.5 tons/acre/yr) in April to 0.0 t ha^{-1} yr^{-1} (0 tons/acre/yr) in September with an average monthly soil loss of 0.3 t ha^{-1} yr^{-1}. The soil loss in April accounted for 39.7% of annual soil loss, followed by March (12.8%) and May (9%). In total, 61.5% of annual soil loss occurred in these three months (March, April, and May). In a given year, various hydrological parameters generally followed similar patterns to multiple-year summary trends. Suspended sediment concentrations were significantly correlated to flow velocity at the 99% confident limit with a coefficient of correlation of 0.63 or 40 % of the variation in sediment concentration explained by flow velocity. Daily mean flow velocity ranged from 0.12 m^3 sec^{-1}

(4.2 ft3/sec) to 1.55 m^3 sec^{-1} (54.7 ft3/sec) with an average of 0.25 m^3 sec^{-1}(8.8), resulting in an annual discharge of 3.78 to 48.88 million m3 (133.5 1726.2 ft3/sec) of water from the entire watershed. Because of substantial sediment loading, the water of the Black Brook was unsuitable for drinking and supporting aquatic life year round and suitable for recreational use only 12% time of the year. Various beneficial management practices (in particular terraces and grassed waterways) adopted in the watershed greatly helped in reducing soil erosion at the watershed level. This was statistically verified in our study. Sediment load showed a statistically significant linear reduction ($p < 0.001$) with increasing accumulated areas protected by terraces and grassed waterways with an r^2 value of 0.65.

PERFORMANCE OF SEVERAL N FERTILIZATION STRATEGIES IN TERMS OF POTATO TUBER PRODUCTION AND REDUCTION OF NITRATE LEACHING

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A 2-year field trial of N fertilization was conducted in New Brunswick, Canada to seek the mostly environmentally friendly N fertilization in potato (Solanum tuberosum L.) production with eight treatments consisting of conventional, controlled release, organic fertilizer at two rates of 100 and 200 kg N h^{-1}, plus one conventional fertilizer split application and one control treatment with four replicates each, results showed that tuber yield of potato was hardly affected by sources of N but solely determined by the application rate of fertilizer. All fertilized treatments can increase yield at least 9% compared to the zero N fertilizer control. Tube quality parameters was not influenced by different fertilization rates and sources of N except for the specific gravity. However, nitrate dynamics in the plant and soil was influenced. Controlled release fertilizer treatment (CRF100, 100 kg N ha^{-1}) obtained the highest plant N recovery followed by conventional fertilizer (Con200; 200 kg ha^{-1}). All treatments had significantly higher NO_3-N concentrations in the soil than the Control (Ctrl). Split application, reduced rate, and organic N source treatments reduced nitrate leaching as well.

SENSITIVITY AND SCENARIO ANALYSIS OF CANADIAN AGRICULTURAL NITROGEN BUDGET MODEL (CANB V3.0) FOR ESTIMATING RESIDUAL SOIL NITROGEN AND N LEACHING ACROSS CANADIAN FARMLAND

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The Canadian Agricultural Nitrogen Budget model (CANB v3.0) was developed to estimate the two Agri-environmental Indicators of Residual Soil Nitrogen (RSN) and the Indicator of Risk of Water Contamination by Nitrogen (IROWC-N) at the regional scale for all of Canada. The national average of RSN showed a doubling from 9.3 kg N ha^{-1} in 1981 to 17.7 kg N ha^{-1} in 2006. Regional differences in RSN were significant, with RSN values less than 30 kg N ha^{-1} in western Canada and greater than 66 kg N ha^{-1} in eastern Canada. There were significant differences in N losses and N concentration in drainage water both spatially and temporally. Comparisons of the CANB v3.0 were made with the CANB v2.0 and it was concluded that the new version of CANB (v3.0) is an annual semi-dynamic model compared to the 5-yr static model of CANB v2.0. A systematic sensitivity analysis using 2006 land use practices was carried out for CANB v3.0, demonstrating that RSN values had significant positive linear relationships with fertilizer N, manure N and N fixation, but negative relationships with crop yield. On national basis, the parameters that caused the most significant changes of RSN were ranked in the order: crop yield > biological N2 fixation > fertilizer N > manure N. In the N2 fixation component, alfalfa N fixation had the leading effect on RSN compared with pulse crops, soybeans and hay. In the manure N2 component, cattle N showed a significant effect on RSN compared with poultry and pig. Changes of manure N loss parameters from storage, land application and pasture by ±50% resulted in changes of the RSN values by 7%, 2% and 3%, respectively. The most important crops affecting RSN were spring wheat, canola and alfalfa. Alfalfa and pasture yields are the most important datasets to improve. A land use scenario that involved an increase in canola and maize production for bio-energy was assessed for the impact on RSN and IROWC-N.

SOIL ORGANIC CARBON AND TOTAL NITROGEN STOCKS 10 YEARS AFTER A SINGLE COMPOST ADDITION TO BROOKSTON CLAY LOAM SOIL

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Several types of compost were applied to a Brookston clay loam as soil amendments to improve this soil's poor physical properties in the fall of 1998. The composts included household food waste compost (FWC), yard waste compost (YWC) and pig manure plus wheat straw compost (PMC). The objective of the current study was to assess the contributions of this single compost application on soil organic carbon (SOC) and total nitrogen (TN) pools in 2009, ten years after compost addition. Based on the application rate of 75 Mg/ha, YWC and PMC resulted in 10.2 and 10.8 Mg C/ha accumulation on the top 30 cm soil, which were 12.3% and 13.0% greater than the control, respectively. However, SOC accumulation was not evidenced in the treatment amended with the same amount of FWC. With the same amount of compost application (75 Mg/ha), YWC and PMC led to 0.6 Mg/ha TN increase relative to no-compost amended control, which was about 8.0% more than the control. Similar to SOC, the FWC did not increase TN relative to the control. When a twofold and fourfold increase in FWC application rate were used, the FWC resulted in 14.6 and 19.6 Mg/ha more SOC accumulation relative to the control. In the same time, a 1.0 and 1.3 Mg/ ha more TN were accrued in the corresponding treatments. Results indicate that the composts made from yard waste or pig manure plus wheat straw functioned better in soil carbon and nitrogen pool build-up relative to the compost made from food waste, and the benefits of compost addition on soil organic carbon and nitrogen stock can last more than 10 years.

IMPACTS OF FIFTY-YEARS OF CROP ROTATION AND FERTILIZATION ON SOC AND N OF A BROOKSTON CLAY LOAM IN SOUTHWESTERN ONTARIO

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The effects of different cropping systems and fertilization on soil organic carbon (SOC) and nitrogen (N) play a key role in sustainable agriculture. The objective of this study was to report the impacts of fifty years of crop rotation and fertilization management on SOC and total N of a Brookston clay loam in Southwestern Ontario. The treatments consist of cropping with monoculture corn (*Zea mays* L.), monoculture Kentucky bluegrass and corn-oats-alfalfa-alfalfa rotation and fertilization with synthetic fertilizer addition and non-addition. Results have shown that the cropping or fertilization showed significant interaction effects with the depth on SOC, total N and SOC to total N ratio (C:N) of bulk soils where the effects occurred in the plow layer (top 20 cm) but not soil underneath (20 – 60 cm). There was no significant interaction effect ($P > 0.05$) of cropping systems and fertilization on both SOC and TN. Cropping systems have affected SOC, TN and C:N ratio; however, fertilization has significantly affected only the SOC but not the TN and C:N ratio of bulk soils. After physical separation of bulk soils, the cropping or fertilization showed significant interaction effects with the depth on SOC and TN only in sand fraction (2-0.053 mm) but not in silt (0.053-0.002 mm) and clay (<0.002 mm) fractions. Cropping systems showed significant impacts on SOC and TN in sand, silt and clay fractions. Fertilization had an effect on TN in all size fractions and SOC in sand and clay but not silt fraction. Although fertilization generally had positive impacts on SOC relative to non-fertilization, the corn in rotation coupled with no synthetic fertilizer application had greater more SOC than the monoculture corn coupled with synthetic fertilizer addition. Accordingly, corn rotation is superior to fertilization for SOC accumulations in Brookston clay loam soils.

RECENT PROGRESS IN UNDERSTANDING AND PREDICTING SOIL N MINERALIZATION

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Uncertainty in the amount of N supplied to the crop through the mineralization process is one of the greatest limitations to making accurate fertilizer N recommendations. Despite decades of research, prediction of soil N mineralization remains challenging. The magnitude of soil N mineralization can be considered to be a function of substrate quality and quantity and environmental conditions. Substrate quality and quantity determine the potential for mineralization to occur, and are in turn influenced by soil properties, cropping systems, organic amendments, tillage and environment. Soil temperature and water content are the environmental factors which are most important in influencing how much of the potential for mineralization is realized. Simulation models can be effective in predicting soil N mineralization rates, but commonly require extensive data sets for calibration, and use N pools which cannot be directly measured. Many chemical indices of soil N availability have been evaluated, but no single index has been found to be effective across soils, climatic zones and cropping systems. These chemical indices are often good predictors of the size of the soil mineralizable N pools, such as the soil potentially mineralizable N (N0), but are not necessarily good predictors of the soil N supply to the crop. In comparison, biological indices such as incubation methods may be better predictors of soil N supply than of mineralizable N pool size. Simple kinetic models, which use measured values of soil mineralizable N pools in combination with environmental parameters, may have promise in predicting soil N mineralization, but questions remain with respect to how to best characterize soil mineralizable N pools and how to practically apply such models. Future progress will require better characterization of soil N supply in both space and time, improved linkages with climatic information, and better coupling of soil N supply with crop N demand.

ASSESSING IMPACTS OF RIPARIAN BUFFERS ON SEDIMENT AND NUTRIENTS LOADING INTO STREAMS AT WATERSHED SCALE USING REMM MODEL

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Riparian buffers in agriculture dominated watersheds play important roles in reducing non-point source pollution to aquatic ecosystems and are widely used as a beneficial management practice. Assessment of the effectiveness of riparian buffers by modeling is important for watershed management as field measurement-based assessment is difficult and expensive. Riparian Ecosystem Management Model (REMM) has been developed to simulate mitigation of nonpoint source pollution by riparian buffers and has been tested against field measured data and has been extensively used. However, there are problems in using the model at a watershed level, as the watershed size could impact the modeling accuracy. In this study, we classify a large watershed with size of 1331 ha into 2, 4, 8, 16, 26, and 46 sub-watersheds. It is found that the model captures more variation of riparian buffers as watershed size decreases. In the studied area, the modeling results could be more accurate when the size of watersheds is less than about 166 ha. The model is further used to assess the riparian effect in Black Brook Watershed, in which the whole watershed is divided into 8 sub-watersheds. From the model result, the effect of riparian buffers varies drastically among the sub-watersheds. The reduction rate varies from 0.26% to 30.13% for runoff, 29.4% to 74.07% for sediment, 9.61 % to 57.85% for nitrogen, and 18.61% to 68.12% for phosphorus.

BIOCHAR FEEDSTOCK AND BIOCHAR EFFECTS ON SOIL MICROBIAL BIOMASS AND ACTIVITY

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A laboratory incubation study was conducted to compare the effects of amendments with biochar feedstock and biochar on soil microbial biomass carbon (MB-C) and carbon (C) and net nitrogen (N) mineralization. Biochar feedstocks were coffee grounds and wood pellets and the biochars were prepared from these feedstocks by gasification (700ºC). Biochar and its feedstock were incorporated into a silt loam soil at a rate of 0.75% by weight and incubated for 56 days at 22 ºC. Five treatments were studied: soil; soil + coffee grounds; soil + coffee ground biochar; soil + wood pellets; soil + wood pellet biochar. CO_2 evolution was measured after 2, 4, 7, 10, 14, 21, 28, 35, 42, 49 and 56 days of incubation and net N mineralization (ammonium and nitrate-N) and MB-C were measured weekly. The data show that amendments with the coffee ground and wood pellet feedstocks significantly increased respiration rates in contrast to amendments with biochars where rates were not different from the unamended soil. Further, biochar feedstock addition significantly increased MB-C whereas the biochar amendment did not. Mineral N immobilization was evident in the biochar feedstock amendments whereas biochar amendments did not have significant effect on nitrification rates or soil mineral N accumulation compared to the unamended soil. In conclusion, biochar appears to be a rather inert amendment, showing no effect on either soil microbial biomass C or microbial activity

PHOSPHORUS LOSS IN TILE DRAINS FROM CLAY LOAM SOILS

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Phosphorus (P) movement in sub-surface flow can be a significant pathway for soil P loss contributing to eutrophication of surface water resource. Studies were conducted in clay loam soils 1) to compare soil P losses in tile drainage with surface runoff water discharge; and 2) to evaluate the effects of major agricultural management practices on tile drainage P loss, including chemical fertilization, organic amendment, and tillage practices (no-tillage vs. conventional tillage). Soil water discharges, tile drainage and/or surface runoff, were monitored for flow volumes and sampled continuously year-round using auto-sampling systems. Water samples were analyzed for dissolved reactive P (DRP) and particular P (PP). Phosphorus loss in tile drainage accounted for 65-85% of total soil P loss, in which both DRP and PP played important roles. Either the level of soil test P or the flow volume of water discharge could be the driving force of soil P loss in tile drainage, depending on the specific conditions. Increased levels of soil test P with organic amendments increased soil P loss in tile drainage, regardless of tillage practices. The effects of organic amendment on soil P loss were further enhanced with non-tillage, relative to the conventional tillage. Beneficial management practices must be developed to minimize soil P loss in sub-surface flow.

CHANGES OF SOIL PHOSPHORUS FRACTIONS INDUCED BY FERTILIZATION AND CROP ROTATION IN COMPARISON WITH THE VIRGIN FOREST

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Agricultural land use and management practices can affect soil phosphorus (P) status, and thus P bioavailability and vulnerability of losses. Most studies focused on short-term effects and limited to assessments within agricultural ecosystems. We evaluated the cumulative effects of long-term (45 years) consistent cropping systems (continuous corn: CC, continuous bluegrass: CB, and crop rotation of corn-oats-alfalfa-alfalfa: CR) and fertilization on changes in P fractions of different bioavailability in a Brookston clay loam, as compared to its status in the native forest ecosystem. Soil P was separated into various forms of inorganic (Pi) and organic P (Po) using a modified sequential fractionation procedure. Under the natural forest, soil P was predominated by moderately labile Po (44%), followed by moderately stable Pi (26%). Consistent cropping without fertilization reduced all forms of soil P except for water extractable Po, with labile and moderately labile P, mostly Po, by 60-76% and moderately stable and stable P by 30-39%, relative to the virgin soil. Consistent cropping with fertilization reduced labile and moderately labile Po in the order of CC>CR>>CB, but increased labile and moderately Pi in the order of CB>>CC>CR. The results indicate that long-term cropping, especially with CC, significantly enhanced the loss of moderately labile Po presumably through mineralization, regardless of fertilization. The increased soil P predominated by labile Pi and moderately labile Po in the fertilized CB plots suggests that P accumulation in grass field may cause increases in potential for water contamination through losses.

SOIL AND PLANT DIAGNOSTIC TOOLS TO IMPROVE NITROGEN USE EFFICIENCY

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Improved N use efficiency may result in increased yield, reduced environmental N losses, and greater recovery of applied N fertilizer which is currently less than 50% in eastern Canada. Both plant- and soil-based tests can be used as diagnostic tools to improve fertilizer N management. Plant-based diagnostic tests assess crop N sufficiency and can guide in-season fertilizer N management. Soil-based tests provide an estimate of soil N supply to adjust the at-planting fertilizer N rate. Different tools that have been tested in eastern Canada on corn, wheat, and potatoes will be presented: (1) nitrogen nutrition index (NNI), leaf chlorophyll meter reading (CMR), and petiole nitrate concentration as plant-based diagnostic tools; (2) pre-plant and in-season soil nitrate tests and ion exchange membranes as soil-based diagnostic tools. The relationship between in-season plant-based indicators (NNI and CMR) and soil NO_3-N content during the growing season and at harvest in corn production will also be presented and discussed. Our results show the potential of soil and plant diagnostic tools to better manage N in crops. However, a combination of a soil-based test to guide at-planting fertilizer N application and a plant-based test to guide in-season N management may be most the effective strategy to improve N use efficiency.