Centre for Water Resources Management

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Photos by Peter Enright

Abstracts of the 2005 Presentations

McGill

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Macroscopic and Microscopic Aspects of Microbial Transport in Porous Media

NATHALIE TUFENKJI, Assistant Professor, Department of Chemical Engineering, McGill University, 3610 University Street, Montreal, Quebec, Canada.

Abstract:

The transport and attachment behavior of microorganisms in aqueous media is of significant interest in various environmental applications such as *in–situ* bioremediation and riverbank filtration. Microbial adhesion is also important in the medical and dental fields where emphasis is placed on the prevention of biofilm formation. In this talk, I will present some work I completed during my graduate studies at Yale where I studies various aspects of microbial transport in porous media. I will also discuss my current research interests and projects being developed in my lab here at McGill.

The migration and fate of microbial particles in subsurface environments is controlled by their capture (physicochemical filtration) by mineral grains. Typically, filtration models used to describe microbe removal in porous media predict exponential decrease in microbial particle concentration with travel distance. However, a growing body of laboratory-scale column experiments suggests that the spatial distributions of retained microbes decay non-exponentially. The observed behavior may be attributed to heterogeneities in the interactions between microbial particles and sediment grains which can be represented by a distribution in the particle deposition rate coefficient. Experiments conducted with model latex colloids and *Cryptosporidium* oocysts under well-defined physicochemical conditions are used to gain insight into the mechanisms that control the non-exponential deposition of microbes. Implications to the transport and fate of microorganisms in subsurface environments will be discussed.

Phosphate sorption in a sandy-loam soil as affected by fertilizer sources

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Phosphate (PO_4-P) sorption in soil has close relationship with P supply to plant and P loss to groundwater. It plays an important role in plant nutrition and environment protection. The objective of this study was to determine how soil P sorption reactions (adsorption and desorption) were affected when equivalent rates of inorganic and organic P fertilizers were applied to a sandy-loam soil. Four years after the fertilizer treatments were established, soils receiving annual applications of cattle manure had a 25% lower P adsorption capacity at equilibrium (solution P concentration = 0.2 m*M*) than soils that were fertilized with triple superphosphate. In addition, manure-amended soils had 49.5% more surface charge (soil solution pH = 6). These results suggest that manure applications that increase soil surface charge can reduce the capacity of P adsorption. The second experiment investigates fertilizer effects on P desorption. Soil samples were collected in October 2004 after harvest and fractionated by a dry-sieving method into four aggregate sizes, namely 6-2 mm, 2-1 mm, 1-0.25 mm, and 0.25-0.053mm. Ten grams of each aggregate fraction or whole soil (passed through 2-mm sieve) was placed in a 20-ml column and leached with artificial rainwater for 8 days. Results showed that about 80% more PO_4-P was desorbed from soils receiving manure than triple superphosphate. This suggests that the organic acid molecules may promote desorption of PO_4-P. In soils receiving cattle manure, more PO_4-P was desorbed from the 0.25-0.053 mm fraction than its whole soil, while in the soils receiving triple superphosphate, more PO_4-P was released from the 6-2 mm aggregate fraction. It indicates that the large aggregates in inorganically fertilized soils are less stable and release more P than the small aggregates. We conclude that under equivalent total P application, manuring not only decreased P retention by the soil but also increased P release into the soil solution, thus may result in more dissolved PO_4-P transport from agricultural land to waterways than inorganic P application.

Quantifying nitrous oxide emissions from agricultural fields

Lynda Blackburn, ***Natural Resource Sciences***

Abstract

Agricultural systems are known to emit nitrous oxide (N_2O) – a potent greenhouse gas in a temporally and spatially discontinuous fashion. A roving micrometeorological tower flux system designed to quantify greenhouse gas (GHG) emissions from diffuse sources such as agricultural fields, was used to make continuous measurements of N_2O fluxes at the field scale. Two field sites were chosen from Western Quebec and Eastern Ontario which had representative local management practices (using manure) and legume/forage cropping systems. The experiment was designed to capture the expected large emissions associated with the spring snowmelt period and growing season field management activities or precipitation events.

In the summer of 2003 and spring of 2004, measurements were made using a tunable diode laser trace gas analyzer (TDL-TGA) over a crop of edible peas which was followed by a forage cropping system in Coteau-du-Lac, Quebec. From May 2004 through to the present, similar measurements have been made over an alfalfa-grass cropping system in Richmond, Ontario. At Coteau-du-Lac, solid dairy manure was applied following the pea harvest. At Richmond, liquid dairy manure was applied following each of three cuttings of the alfalfa crop.

The results indicated somewhat low emissions during the initial snowmelt period. The summer emissions from the pea field were small and continuous. As expected, emission peaks were noted following fertilizer application and major rainfall events.

The results of these experiments will be used for verifying GHG exchange models and updating coefficients used in calculating emissions in the national GHG accounting system for exchanges of agricultural origin in Canada.

Flow dynamics and sediment transport around paired deflectors for fish habitat enhancement

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Schemes to restore fish habitat in rivers often involve installing instream structures such as current deflectors to create and maintain riffle-pool sequences. The presence of deep pools is a critical component of a high-quality physical habitat for fish as it provides sheltering and cool temperatures during the summer months. Recently, some laboratory studies have shed more light on the complex flow dynamics and resultant bed topography around deflectors. However, no field study has been carried out so far. Natural rivers, unlike laboratory flows, exhibit many additional complexities which need to be taken into account when implementing instream structures. Many schemes to restore fish habitat experience low success rates or require costly maintenance after only a few years. To improve the success rate, we need to develop tools such as numerical modeling to test scenarios prior to the implementation of structures.

The objective of this research is to characterize flow dynamics and sediment transport around paired deflectors used to enhance fish habitat in a natural river. The studied reach is in the Nicolet River (Qc), where several paired deflectors and dug pools have been implemented between 1995 and 1999 to improve fish habitat. Calibrating and validating such a model requires accurate measurements of these parameters in the natural river. Repeated detailed bed and bank topography surveys were taken with a total station to monitor bed morphology changes and the dynamics of the riffle-pool sequences. Bed shear stress estimates were obtained from an Acoustic Doppler Velocimeter at several locations. Bedload sediment transport was assessed by two methods: tracer rocks and sediment traps. Two hundred painted particles were deployed at two cross-sections divided in five zones in order to investigate the sorting of sediment, thickness of the active layer and distance moved. Three sediment traps were installed downstream of the deflector in the riffle cross section to obtain bedload transport rates and the size of moved particles. Results show marked differences in flow dynamics and bedload sediment transport patterns between the left and the right bank downstream of the deflectors. This is surprising considering that paired deflectors should, in theory, produce a relatively symmetrical disruption to the flow field on each side. The percentage of recovery of tracer particles became increasingly lower during the field monitoring season due to factors such as sediment and algae deposition on the painted rocks. It therefore became difficult to relate accurately individual particle movement to flood events. To solve these problems, tracer alternatives such as Passive Integrated Transponder (PIT) tag will be used during the next field seasons.

Development of Statistical Downscaling Methods for Simulating the Daily Precipitation at a Local Site.

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Degree: *Masters of Engineering, U1*
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Abstract

Studies of climate change impact at a local site usually require daily time series of surface weather variables, such as precipitation, for future climate scenarios. Recently, Global Climate Models (GCMs) have been widely used to simulate present climate and project future climate with forcing by greenhouse gases and aerosols. The spatial resolution of these models, however, remains quite coarse and do not permit a good estimation of surface weather variables at a small local scale. Statistical downscaling (SD) has recently emerged as a widely used technique that establishes relationships between local weather variables and large-scale GCM results.[1] Several SD methods have been proposed in recent years.[2] The main objective of this research is therefore to develop statistical models that could accurately describe the relationships between the climate variables at the regional scale and the precipitation characteristics at a local site.

At present, multiple regression methodology has been applied to meteorological data at the Dorval Station. 26 CGCM variables obtained via the NCEP Quebec grid were used as predictors in a stepwise regression algorithm, with the normalized daily precipitation values as the response variable. This yielded 22 significant predictor variables with an R-square of 0.3. When a weighted least squares methodology was employed, 15 predictors resulted with an R-square of 0.8. At this preliminary stage of the research, the fit in either approach is far from accurate, because the residuals are not randomly distributed. For the validation phase, the distribution of residuals has to be determined. Furthermore, the correlations between the predictors themselves have to be assessed, either via physical knowledge, or statistical techniques such as ridge regression and generalized least squares. The next stage of this research will attempt to incorporate the advanced methodologies of generalized linear modeling, particularly truncated Poisson regression, in order to extend a validated statistical model to other local sites in the Quebec region.

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A database management system for groundwater modeling in the Basin of Mexico

Carrera-Hernández Jaime J., and Gaskin, Susan
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Keywords: Geographic Information Systems, Relational Database Management Systems, Groundwater management, Mexico City.

Abstract

The concept of water management evolved from a piece meal approach to a Basin level management after the International Conference on Water and Environment in 1992. This concept shifted to Integrated Water Management in Rio, later in that same year. Behind this idea was the introduction of land and water related aspects in water management at the Basin level. However, this seldom occurs in practice, mainly due to a lack of proper tools to achieve an integrated river basin and sustainable approach. These tools should help to simulate, visualize and compare different water management scenarios.

In an Integrated Water Management approach, the development of Regional Groundwater Models should be used. Groundwater Flow Models are required in order to predict the impact of different management policies in the future and all data required should be easily accessible to decision makers and modelers. Data accessibility to several users can be provided by a Relational Database Management System (RDBMS) which can integrate both qualitative and quantitative data without the need of a GIS. The RDBMS can incorporate data such as location of wells, pumping rates, groundwater level depth and elevation, rainfall depth as well as temperature and pan evaporation data.

In this presentation, the development of a database for groundwater in the Basin of Mexico is shown, as it encloses one of the biggest cities in the world: Mexico City and its Metropolitan Area (MCMA). The Basin's aquifer system comprises the most important part of the water supply system for the MCMA; the heavy dependence on this system has taken its toll and a decline in the potentiometric level of up to 80 meters was recorded by 2002 in some areas (Edmunds et al., 2002).

The database comprises rainfall depths, monitoring wells, extraction wells and lithology records in the Basin of Mexico, as well as topography as a Digital Elevation Model (DEM). In order to build this database, the authors have gathered all the information which is currently spread through the existing water supply agencies and previous studies realized in other areas of the Basin. In order to show the usefulness of this database, the evolution of the groundwater level in the Basin of Mexico is studied from 1984 to 1997 using the proposed database and compared with maps obtained in previous studies (DGCOH, 2000).

This database is being used to develop the first comprehensive groundwater flow model through the use of the *r.gmtg* module (Carrera-Hernández and Gaskin, 2004) which integrates the finite difference groundwater flow MODFLOW and the GRASS GIS.

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A Preliminary Study of Karst Surface Features in Support of Groundwater Management (Barbados): Procedures, Challenges, and Perspectives of GIS Application

Hsin-Hui Huang, *Bioresource Engineering*

ABSTRACT

Barbados, known as a paradise with white sand beaches and gorgeous sunshine for tourists, has been reported as one of the most water scared countries. Its sole natural water resource is groundwater and 10% of the islands water is supplied by a desalination plant. Since the decline of the sugarcane industry, tourism has become a major economical resource. This large influx of tourists, along with a high population density (≈628 p/km^2) has led to serious challenges with regards to both water quality and quantity. To address the problem, a geographic information system (GIS) has been implemented for the use of groundwater management. Through the processes of acquiring, establishing, and integrating a data set, the difficulties of applying GIS technologies for a small coastal island like Barbados was presented.

Barbados is not a volcanic island, its coral rocks have developed into a typical karstic topography. Geo-morphological features include disrupted surface drainage, closed depressions, caves, and open underground drainage systems. Recently, environmental impacts, especially water contamination and saltwater intrusion, have been rising dramatically because of the ever expanding water demands of tourism (hotels, golf courts), food industry trades, and of urbanization. Across the island, surface depressions (sinkholes) provide direct routes to dispose of wastewater (only 10% of the population is serviced by a sewage treatment system) into the karstic aquifers. Because of limited sewage treatment systems (only 10% of the population has access); groundwater contamination contains bacteria from human and animal sources, agrichemicals from farming, as well as chemicals and trash that have been dumped on the surface. Thus, surface features such as sinkholes, dry gullies, and geology were collected and mapped for further analysis of sinkhole characteristics and distribution. Two-dimensional thematic maps were created, and a digital elevation model (DEM) will be generated based on contour.

There is no doubt that this study has faced various technically difficulties, plus anthropogenic effects could not be ignored. In addition to the technical tools being developed in this study, a valuable conclusion to include is that differences between policies, cultures and customs need be taken into account in order to realize such technical advances. The proposed power point presentation will report established results, and discuss challenges and perspectives of GIS implementation in Barbados.

Quantifying tillage translocation and erosion under intensive potato production systems in north-western New Brunswick

Kevin Tiessen, (*Natural Resource Sciences)* Guy Mehuys, David Lobb, Edward McKyes

In cultivated landscapes across Canada, tillage erosion is increasingly being recognized as a serious form of soil degradation. Tillage erosion, a distinct process from wind and water erosion, occurs whenever tillage operations cause more soil to be translocated downslope than upslope. Tillage erosion is suspected to be a function of the erodibility of a landscape (i.e. hilliness and steepness of a hillslope) and the erosivity of the tillage system used on that landscape (i.e. number and type of tillage operations for a crop). However, the existing relationship between landscape erodibility and tillage erosivity under Canadian cropping systems is based on little data. Currently, tillage erosion experiments conducted in Canada represent only conventionally tilled corn-based production in Ontario (Lobb et al. 1995; Lobb et al. 1999) and conventionally tilled cereal-based production in Saskatchewan (unpublished). The objective of this project is to establish the relationship between landscape erodibility and tillage erosivity for a conventional and a conservational potato-production system in the topographically complex landscapes of north-western New Brunswick. Both conventional and conservational potato production systems require numerous tillage operations (i.e. primary fall tillage, secondary spring tillage, planting, hilling and harvest operations), and generally, conservational tillage systems differ from conventional systems in that a chisel plough is used for the primary tillage operation instead of a mouldboard plough. Preliminary results for the primary tillage operations suggest that both the chisel and mouldboard plough are highly erosive, as soil movement downslope was approximately twice that upslope for each implement. In addition, a direct relationship was observed between the mass of translocated soil and both slope gradient and tillage speed. We suspect that the threat of soil erosion to the sustainability of potato production in New Brunswick has been greatly underestimated because only water erosion has been seriously considered to date.

Legume Production in Central Asia:
Effects of Deficit and Alternate Furrow Irrigation on Common Bean (*Phaseolus vulgaris*) and Green Gram (*Vigna radiata*)

Maryse Bourgault, *Plant Science*

Global water scarcity is a growing problem, exacerbated by population growth and climate change. The agriculture sector uses more water than any other. In dryland areas, such as Central Asia, there is little crop production without irrigation, and much of the crop production is cotton. There is a need for better water use and food self sufficiency in the area. The objective of the reported work was to evaluate physiologic and agronomic variables of legumes grown under a range of irrigation regimes, to determine best practices for production in the Aral Sea basin (Uzbekistan).

The experiment was organized following a split-plot completely randomized block design four blocks and with irrigation scheduling as main treatments. The treatments consisted of factorial combinations of three factors: depletion levels (levels to which we would let the soil dry - recommended schedule, intermediate stress level, and severe stress level, based on FAO recommendations), crop (common bean - *Phaseolus vulgaris* and green gram -*Vigna radiata*), and irrigation strategy (every and alternate furrow).

Phenological characteristics were monitored every week. Destructive sampling was performed at four development stages to assess biomass dry weight, leaf area, root depth, number and dry weight of nodules. Stomatal conductance and leaf water potential were recorded before and after each irrigation. At harvest, the number of seeds per pod, 100-seed weight and yield were determined. Amount of nitrogen supplied by nitrogen fixation will be determined from the nitrogen content of biomass samples of soybean and non-fixing reference crops. Oil and protein content of seeds were also determined. Both stomatal function and crop development indicate that water applications can be reduced below recommended levels, particularly with the correct choice of crop.

Surface Irrigation for Spreading Dairy Farm Wastewater

Inamullah Ali, *Bioresource Engineering*

ABSTRACT

An important number of Canadian dairy farms manage their manure as solids and in doing so, must handle large volumes of manure seepages and milk house wastewater. A surface irrigation system was designed to dispose off these large volumes of wastewater on cropped land near the wastewater storage facility. The surface irrigation system consisted of a liquid manure vacuum pump feeding a flexible pipe of 100m to 200m, which in turn transferred the wastewater to a 45m long perforated gated pipe. The gated pipe was installed perpendicular to the slope of the field, so the discharged wastewater ran down the slope.

This project involved in characterizing the wastewaters collected from two dairy farms and applying them to a plots measuring 0.5ha (Farm A) and 0.3ha (Farm B). Control plots of approximately the same size were located on adjacent, non irrigated land. We monitored losses of wastewater through the subsurface drainage system on each farm, as well as soil available nutrients and improvements in crop yield. Two sampling wells were installed in the irrigated and control plots on each farm, and wastewater losses through subsurface drainage were monitored On Farm A, we also measured the volume of wastewater lost at the outlet of the subsurface drainage system from the large field containing irrigated and control plots. Soils from control and irrigated plots were sampled at two depths, 0-200mm and 200-400mm before and after wastewater was applied.

The wastewater collected in 2002 and 2003 had a lower nutrient content than that collected in 2004 because of more dilution from precipitation than in previous years. The wastewater of Farm A was more dilute (lower nutrient content, lower total solids) than wastewater of Farm B (manure seepage only) because Farm A had a larger manure storage and mixed of milkhouse wash waters with its manure seepage. In 2003, between 0.04 and 0.5% of the applied wastewater was lost at the outlet and sampling wells, which represented 0.25% of the total nutrient and bacteria load. The drainage water in the irrigated plot sampling well contained 80% of the TKN, 40% of the TP, 80% of the TK and 100% of the bacterial levels of the wastewater. In 2004, 4m^3 of wastewater was lost at the field outlet, which represented 1.2% of total volume applied and 0.32% of total nutrient and bacterial loads. In 2004, the soil showed better infiltration capacity and the drainage water collected in the sampling well of irrigated plot of Farm A showed 20% of TKN, 15% of TP and 20% of TK of applied wastewater. Sampling well of irrigated plot of Farm B contained 80% of TKN, 40% of TP and 80% of TK of applied wastewater. The bacterial level in drainage water was the same as that in applied wastewater except in last irrigation session in 2004 in which the Total and Fecal Coliform counts were 10 times higher than in applied wastewater.

For both farms, the wastewater application had a significant effect on soil Mehlich III P and K for soil depth of 0-200mm but not for deeper layers. On Farm A, at a 0-200mm soil depth, wastewater application had a significant effect on all soil nutrient levels while distance down the slope from the irrigation pipe did not affect

and application date had a significant effect on P, K, Mg and P saturation. On Farm B, wastewater applications had a significant effect on soil pH and K at a soil depth of 0-200mm, while distance down slope from the irrigation pipe had an impact on soil pH, Ca and Mg and application date had a significant effect on soil P and saturated P. Wastewater application significantly increased the yield of mixed cereals by 31% compared to control plot and irrigated crop had more protein and fiber. Although 65 to 75% of the soil surface was covered by irrigation wastewaters, applying wastewater through surface irrigation did not increase the variability in soil nutrient content. Nevertheless, the high K content of the wastewaters should be considered and application of wastewater should be rotated between the fields on yearly basis.

Applying wastewater with tanker (custom applicator) is estimated to cost $\$3.65/m^3$, while the surface irrigation system is much lower, at $\$0.57/m^3$. To minimize wastewater losses through the subsurface drainage system, applicator should respect the soil infiltration rate and capacity. It would be preferable to apply wastewater to moist soil.

Modeling Crop Water Requirements for Irrigation Scheduling in Humid Regions

Rufa O. Doria and Chandra A. Madramootoo

Irrigation scheduling is the process by which an irrigator determines the timing and quantity of water to be applied to the crop. The challenge is to estimate crop water requirements in the context of soil type, crop growth stages and climate. In water stress sensitive crops, irrigation should be carefully scheduled to avoid losses from over or under irrigation. The goal of this research is to determine the amount of water a certain crop needs in a specific area and be able to develop an appropriate irrigation scheduling program.

In humid regions such as Canada, the area is characterized by an excess of rainfall over and above the storage capacity of soils during late autumn, winter, and early spring

. Precipitation is somewhat reasonably uniform throughout the year and evapotranspiration reduces soil moisture in the summer, the crop growing season. A deficit in soil moisture is actually produced hence, supplemental irrigation is needed. A careful simulation on the different conditions on soil and crop type is important in order to obtain a maximum yield during the supplemental irrigation activities

Through a daily water balance, simulation on various water supply conditions were performed using the FAO CROPWAT model in order to schedule the irrigation requirements and estimate the corresponding yield reduction for nine (9) crops and three (3) soil types using the nine (9) weather stations in Southern Quebec.

The evapotranspiration (ETo) for a specified reference crop characterizes the rate at which water, when readily available within the root zone, is evaporated from the plant soil surfaces in response to climatic conditions. Data from the Climate Normals of Environment Canada were used in the weather parameters of the model in the estimation of ETo using the Penman-Montieth equation. An average of 135.77 mm/mo of ETo for the growing season (May to October) and an average of 99.3 mm/mo of rain on the same season were obtained. Crop ET (ETc) for a given crop can be computed from a reference ET and an appropriate ET crop coefficient (Kc). By knowing the water holding capacity of the soil, the root depth of the crops, irrigators can use the ET information to apply the right amount of water to the crops to meet the crop's evapotranspiration needs without significant reduction in yield.

Key words: FAO CROPWAT model, evepotranspiration, crop water requirements,
Irrigation requirements

MALARIA VECTORS IN AN IRRIGATED AND IN A RAIN-FED DISTRICT OF SOUTHERN SRI LANKA

Angela Goodfellow, *Natural Resource Sciences*

ABSTRACT

Anopheles species composition and relative seasonal abundances were measured in an irrigated district (low historical malaria incidence) and in a rain-fed district (high historical malaria incidence) of southern Sri Lanka. Twelve species of anophelines were represented in adult and larval collections with *Anopheles vagus* (Donitz) being the most abundant. In cattle-baited net trap collections, *Anopheles* adults were significantly more abundant in the irrigated district than in the rain-fed district. In pyrethrum-spray sheet collections, cattle-baited hut trap collections and larval collections, *Anopheles* abundance was significantly greater in the rain-fed district. Houses were of poorer construction in the rain-fed district, where pyrethrum -spray sheet collections consisted mainly of *Anopheles subpictus* (Grassi) (98%) and *Anopheles culicifacies* (Giles) (2%). Hut traps also consisted mainly of *An. subpictus* (88%) and *An. culicifacies* (7%). Net trap collections consisted mainly of *An. vagus* (43%) and *Anopheles peditaeniatus* (Leicester) (31%). Larval collections also consisted of *An. peditaeniatus* (24%) and *An. vagus* (21%). Weak associations were found between species abundance and environmental factors explored in this study (e.g.,vegetation, water quality, sunlight exposure). The greater malaria risk in the rain-fed district is due in part to the occurrence of potential vectors in relatively higher numbers.

FATE AND TRANSPORT OF THREE HERBICIDES IN AN AGRICULTURAL SOIL IRRIGATED WITH MUNICIPAL WASTEWATERS

Fahmida Nilufur, *Bioresource Engineering*

Abstract

In many countries all around the world, municipal sewage and industrial wastewaters are typically treated, or sometimes only partially treated, prior to their discharge into surface water bodies. A major anionic surfactant, Linear Alkyl benzene Sulfonale (LAS), and a degraded product of a non-ionic surfactant, Nonylphenol (NP), are frequently found in municipal wastewaters. When wastewater containing surfactants and their degraded products is used for irrigation, it could have an effect on the sorption/desorption and movement of pesticides in soils. Therefore, a lisymeter study was conducted to assess the effect of LAS and NP on the movement of the agricultural herbicides through a sandy loam soil. Nine lysimeters, irrigated with water containing LAS and NP concentrations, similar to those commonly found in municipal wastewater, were used to evaluate the fate and transport of three common herbicides, atrazine, metolachlor and metribuzin. The degradation of the herbicides was studied over a ninety-day period. Herbicides were found to be degraded faster within the top 20 cm soil profile. Our results indicate that irrigation water with a concentration of $12\ mgL^{-1}$ of LAS and NP had almost no effect on the leaching of atrazine, metolachlor, and metribuzin. The concentrations of less than $0.02\ \mu gL^{-1}$ were found in water samples taken 90 cm below the soil surface. To confirm these results, a laboratory experiment was undertaken to estimate the adsorption coefficients (k_d) of the three herbicides with water containing the same concentration of LAS and NP. No significant difference on k_d value was observed in this sorption experiment. Hence, we can conclude that these results would eliminate the concerns regarding enhanced pesticide leaching brought on by LAS and NP in municipal wastewaters for irrigation.

TITLE: **Application of the Soil and Water Assessment Tool (SWAT) to two agricultural fields in the Pike Watershed, Quebec**

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ABSTRACT:

Non-point source pollution (NPS) from agricultural lands is one of the main reasons for high phosphorus concentrations in a majority of rivers in Quebec. Phosphorus levels in excess of the Canadian water quality guideline of 0.03 mg L^{-1} lead to a host of environmental problems, ranging from reduction in river water clarity to eutrophication of lakes. It has also forced closure of beaches for recreational purposes, resulting in huge losses in revenue. To counter the threat of phosphorus pollution to human health and aquatic life forms, it is important to develop agricultural management practices that minimize contamination of water at the source itself.

Since a large number of agricultural fields in Canada are artificially drained, two sub-surface drained fields in the Pike River watershed were chosen to better understand the dynamics of phosphorus transport from field to river. The field sites were instrumented in the year 2000 and function all year round. Results from five years of data showed that phosphorus losses through surface run-off account for 60% of annual total while tile drains account for the remaining 40%.

Data collected from the sites was input into the Soil and Water Assessment Tool (SWAT) to simulate hydrological processes at the field scale. SWAT is a physically based, long-term continuous model which can be used to predict the impact of management practices on nutrient transport in run-off. The model was setup for both fields by overlaying the geo-referenced Digital Elevation Model (DEM) with soil type and land use layers. The stream network was delineated and simulations were run with rainfall data collected at the sites from October 2000 to July 2004. The model was then calibrated using surface run-off and tile flow data from both the fields. A sensitivity analysis on Curve Number and soil available water capacity was also carried out. Coefficient of performance (C_p) for surface run-off and tile flow was calculated for non-calibrated and calibrated models.

Once calibrated for sediment and nutrient transport, the SWAT model will be used as a predictive tool to evaluate best management practices for agricultural fields in the region. Based on results obtained, measures to reduce phosphorus losses into streams and lakes will be suggested.

Virtual Competition: Adaptability

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Abstract

Adaptability will be studied as a factor for the success of species in ecosystems. This will be done by analysing adaptive as compared to non-adaptive species in a virtual ecosystem. Adaptation here refers to an individual's change in physical, physiological, or behaviour traits resulting from a current environmental pressure, and adaptability is the ability to go through the process of adaptation. There are two aspects to adaptability: adaptation speed, which is defined as how fast an individual can respond to a change in environment, and adaptive capacity, which is a quantitative measure of how much an organism can adapt. In terms of virtual and physical ecosystems, adaptation implies that an individual's constitution adjusts to a particular factor so as to be more effective within its environment. Examples of such factors are temperature, precipitation, solar irradiation, as well as availability of food, water, and oxygen. These factors are present in ecosystems, whether it is a desert, aqueous, or virtual environment. Consequently, individuals that reside within these systems are affected. The focus of this presentation will be adaptability as it relates to individuals in aqueous ecosystems.

An Investigative Study on Reed Canarygrass (*Phalaris arundinacea* L.), a Potential Biofuel Crop

Chris Wrobel, *Plant Science*

Perennial herbaceous crops contribute a number of desirable attributes to cropping systems: limiting soil erosion, improving water quality, diversifying salable farm products, and, when grown in rotation, breaking pest cycles endemic to annual grain crop production systems. On marginal crop land, the effect of returning to perennial plants has an even greater positive effect on erosion control. In addition to forage uses, perennial herbaceous crops can be grown for other reasons, such as biomass for energy.

Switchgrass (*Panicum virgatum* L.) has been identified by researchers as a main species for development into an herbaceous biomass fuel crop. However, it has limitations. It does not produce well in cooler climates and also performs poorly on wet soils. On the other hand, reed canarygrass (*Phalaris arundinacea* L.) is one of the highest yielding cool-season grasses and is considered most promising for biofuel production. It grows extremely well in poorly drained wet regions, withstanding flooding for long periods.

One major problem that plagues reed canarygrass is its tendency to shatter seeds readily upon ripening. This feature, along with a lack of palatability, has resulted in slow acceptance of reed canarygrass as a pasture crop.

Efficient selection of reed canarygrass genotypes could be aided if morphological traits that were associated with agronomic characters such as yield and seed retention could be identified. Folded leaf mutants were observed among reed canarygrass progeny in an observation nursery at Macdonald College. A study was undertaken to: 1) determine the relationship of the folded leaf trait to agronomic characteristics in reed canarygrass, 2) determine the inheritance of the folded leaf trait, and 3) determine the anatomical differences between the folded and flat leaf types. The three hypotheses were: (1) the folded leaf trait is associated with a desired agronomic character(s), (2) the folded leaf trait is inherited as a duplicate recessive in a two-gene model, and (3) there are distinct anatomical differences between the folded and flat leaf types.

An analysis of the results indicated highly significant differences between the folded and flat leaf types for seed retention and heading date. Leaf folding was also observed to vary among environments. Because of these observations and the widely divergent segregation ratios obtained in selected crosses, the proposed genetic model could not satisfactorily explain the observed results. And when the folded and flat leaves were sectioned a number of distinct differences were observed with respect to the turgidity of the bulliform cells and the thickness of the bundle sheath extensions. . The significance of these results with respect to the breeding of this crop will be discussed.