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GWF Data Policy Unpacked

Lead Author: Krysha Dukacz, School of Geography and Earth Science, McMaster University
Presenting Author: Krysha Dukacz, School of Geography and Earth Science, McMaster University
Email address: dukaczka@mcmaster.ca
Co-Authors:
Amber Peterson, GWF DM Core, University of Saskatchewan
Bhaleka Persaud, University of Waterloo
Gopal Saha, WLU

Poster #: 1

Abstract:
The broader policies and practices regarding research data collection and dissemination are evolving to maximize the impact of investments, increase collaboration and produce synergies. The GWF Data Policy is a progressive and living document to help guide GWF researchers to meet new expectations while also working to protect their data, share data responsibly and contribute to the GWF body of work through internal data sharing. This presentation will describe the goals of the GWF data policy, decipher some of the language to help interpret the policy and identify opportunities for researchers to participate in the development of operational processes used in its implementation.

Dataset Publication: Who, When, Why, What, and How?

Lead Author: Laleh Moradi, Global Institute for Water Security, University of Saskatchewan
Presenting Author: Laleh Moradi, Global Institute for Water Security, University of Saskatchewan
Email address: amber.peterson@usask.ca
Co-Authors:
Amber Peterson, Global Institute for Water Security, University of Saskatchewan

Poster #: 2

Abstract:
Dataset publication has been growing in popularity in recent years. Most journals are encouraging dataset publication, and some have even made it mandatory. Here we provide answers to the main questions that researchers have surrounding dataset publication. The list of questions includes: Who should publish data and when? Why should I publish my data? How do I publish data? What can be included in a dataset?

Data Management Throughout the Research Lifecycle

Lead Author: Krysha Dukacz, School of Geography and Earth Science, McMaster University
Presenting Author: Amber Peterson, GWF DM Core, University of Saskatchewan
Email address: dukaczka@mcmaster.ca
Co-Authors:
Bhaleka Persaud, University of Waterloo
Gopal Saha, WLU

Poster #: 3

Abstract:
Data collection and management is an integral part of the research lifecycle which starts at the planning phase and ends with the preservation and sharing of data and results. It is an iterative exercise that evolves as the research project develops. Here we describe the data management steps at each phase in the research lifecycle and how the GWF data management core team can assist. This includes highlights of the benefits, suggested best practices and resources to help researchers manage their data.

Adding and Incorporating Non-Standard Data to an Existing Data Repository - Driving Square Pegs into Round Holes

Lead Author: Douglas W Mulholland, Cheriton School of Computer Science, University of Waterloo
Presenting Author: Douglas W Mulholland, Cheriton School of Computer Science, University of Waterloo
Email address: dwm@csg.uwaterloo.ca
Co-Authors:
Don Cowan, Cheriton School of Computer Science, University of Waterloo
Paulo Alencar, Cheriton School of Computer Science, University of Waterloo
Les Stanfield, Ecohealth Solutions

Poster #: 4

Abstract:
Vast amounts of diverse and disparate data are being generated on every imaginable topic and field of study. In most cases, data are stored in custom-built repositories or databases with a limited ability to accommodate non-standard data but invariably “unconventional” data is discovered, that should be added to the system after that system has been built. Variations from a standard can be relatively minor, such as the choice of units of measure, they can be such that the new data is only levering some of the resources of the existing system, or the new data may be completely foreign to many aspects of the existing repository (e.g., security concerns, provenance, reliability, etc.). The Computer Systems Group at the University of Waterloo has designed, built and operates numerous data repositories in several sectors, including environmental data, community social services information, health services analysis and professional education. Mr. Mulholland will speak on how an ongoing requirement to extend and adjust existing systems to handle new types and structures of data is addressed in their iEnvironment project.

An Approach for Transferring Software Architecture Knowledge

Lead Author: Banani Roy
Presenting Author: Banani Roy
Email address: banani.roy@usask.ca
Co-Authors:
Rayhan Ferdous, University of Saskatchewan
Paromita Sengupta, University of Saskatchewan
Kevin Schneider, University of Saskatchwean

Poster #: 5

Abstract:
When migrating a legacy software system to a new environment it is important that software developers have a good understanding of the system's software architecture to help ensure key features and qualities are preserved when legacy dependencies are removed. In this paper, we propose a method for transferring software architecture knowledge from a team conducting an architectural evaluation of a legacy system to a team of software developers tasked with migrating the software. We combine both static and dynamic techniques to support knowledge transfer. To evaluate our approach, we conducted a case study, applying our approach to a large, popular scientific modelling software system that has been actively developed and used over the past thirty years. The software was developed with Borland C++ and the technologies used are now less supported and continue to restrict future development. Numerous similar applications exist and yet no suitable re-engineering tools are available. As part of the case study, we migrated the software to a modern environment and design by removing its dependency on older technologies. Our findings show that our proposed method is promising in using architectural evaluation both to understand large scale legacy systems and to guide software maintenance activities such as migration.

Visualization of hydrography similarity using t-Distribution Stochastic Neighbour Embedding (t-SNE) technique

Lead Author: Weigang Tang, School of Geography and Earth Science, McMaster University
Presenting Author: Weigang Tang, School of Geography and Earth Science, McMaster University
Email address: w29tang@hotmail.com
Co-Authors:
Sean Carey, School of Geography and Earth Science, McMaster University

Poster #: 6

Abstract:
Catchment classification is an effective tool to identify and group catchments that are hydrologically homogenous. Understanding the hydrological similarity will facilitate regionalization of streamflow and promote the knowledge mobilization among catchments. We attempt to provide a tool that allow visualization of hydrograph similarity and fast identification of flow regime type for any given Annual Daily Hydrographs (ADHs). t-distribution Stochastic Neighbor Embedding (t-SNE) was implemented to project ADHs, which were collected from the historical flow data at stream gauges located across in western North America, on a 2D map. The flow regime similarity of between ADHs is indicated by their distance on the t-SNE map. As a non-parametric technique, t-SNE does not produce the mapping function from high- to low-dimensional space, leading to difficulty to project new ADHs on the existing t-SNE map. Therefore, a neural network, called encoder, was trained to approximate the mapping between original feature space of ADHs and t-SNE 2D map. For any given ADH with unknow flow regime type, the encoder is able to predict its location on an existing T-SNE map, and its flow regime type can be estimated according to the flow regime type of its nearest neighbors on the map.

The Cuizinart – A tool for automatic subsetting of large gridded datasets and data dissemination in GWF and beyond

Lead Author: Juliane Mai, Dept Civil and Environmental Engineering, University of Waterloo
Presenting Author: Juliane Mai, Dept Civil and Environmental Engineering, University of Waterloo
Email address: juliane.mai@uwaterloo.ca
Co-Authors:
Martin Gauch, David R. Cheriton School of Computer Science, University of Waterloo
Bhaleka Persaud, Dept. of Earth & Environmental Science, University of Waterloo
Homa Kheyrollah Pour, Dept. of Earth & Environmental Science, University of Waterloo
Jimmy Lin, David R. Cheriton School of Computer Science, University of Waterloo

Poster #: 7

Abstract:
The Cuizinart is a system that allows for the subsetting of large scale gridded datasets. Similar to the CaSPAr system that provides a platform for ECCC's numerical weather predictions, the Cuizinart allows the user to select variables, time periods, forecast horizons (if applicable), and a polygonal domain. The system then processes the requested data either on ComputeCanada's system Graham and provides the data via Globus or using PySpark.
The current available data on the Cuizinart are WRF datasets over either the CONUS domain or over Western Canada, and remote sensing of inland waters and land-surface temperature data. The database can easily be extended to additional (geo-referenced) datasets produced or used in GWF. The only requirement to make a dataset available through the Cuizinart is that the data should be provided in NetCDF format following at least the CF-1.6 standard. This system attempts to ease the data distribution within GWF and beyond.
The presentation will include a live demo of the system.

Uncertainty-based representation of object-based spatial phenomena using Discrete Global Grid Systems data model

Lead Author: Majid Hojati,Dept of Geography & Environmental Studies,Wilfrid Laurier University
Presenting Author: Majid Hojati,Dept of Geography & Environmental Studies,Wilfrid Laurier University
Email address: hoja4090@mylaurier.ca
Co-Authors:
Colin Robertson, Dept of Geography & Environmental Studies,Wilfrid Laurier University
Rob Feick,School of Planning,University of Waterloo

Poster #: 8

Abstract:
One of the more challenging aspects of transforming climate and environmental change science into adaptive responses for communities is in the handling of uncertainty. While scientists are trained to work with and manage uncertainty, non-scientists and decision-makers typically expect answers that are unambiguous and certain. There are two main types of uncertainty which can be modeled. Aleatoric uncertainty is related to the level of noise which exists in observations, while epistemic uncertainty captures the level of uncertainty in model parameters. In geographic data, uncertainty can relate to data capture and measurement, inherent vagueness and ambiguity of some geographic phenomena (e.g. shoreline location), and differences in how users conceptualize geographic features. In this paper, we consider how a discrete global grid systems (DGGS) can be used to manage data capture and measurement uncertainty specifically with respect to location, attribute, time period, logical inconsistencies, and incompleteness. DGGS are a new data model for the digital earth framework which is derived from multi-resolution hierarchical tessellations. These grids can be in different shapes, but the common attribute of these shapes is an equal-area property. One feature of DGGS is that data uncertainty can natively integrated to the data model. This feature has particular promise for science/community data integration where data are heterogeneous and user communities often differ in formal and local knowledge bases. This study investigates how uncertainty-based representations of object-based geographical phenomena, including points, lines, polygons and curves, can be modeled in terms of their levels of heteroscedastic aleatoric uncertainty using a DGGS data model. The source of uncertainty in geographical data is assumed to be in location data (i.e. positional accuracy, spatial extent). First, a probability density function is defined for each geographical object including point, line, and polygon and curves to describe a confidence region around each vertex. This probability level could be applied to all types of geographical objects since all are constructed from sets of vertexes. A confidence region is then modeled into the DGGS structure as a set of DGGS cells that have resolutions corresponding to the level of confidence for each Using this approach for each type of point, line, polygon and curve, a specific region is defined using DGGS cells and each cell in this region is assigned into a level of uncertainty in coordinate data. A demonstration analysis shows how uncertainty regions in a DGGS data model can be incorporated into spatial analysis and used to visualize the spatial structure of data uncertainty.

Spatial data model development for community/science data integration

Lead Author: Chiranjib Chaudhuri, Department of Geography and Environmental Studies, Wilfrid Laurier University
Presenting Author: Chiranjib Chaudhuri, Department of Geography and Environmental Studies, Wilfrid Laurier University
Email address: chiranjibchaudhuri@gmail.com
Co-Authors:
Colin Robertson, Department of Geography and Environmental Studies, Wilfrid Laurier University

Poster #: 9

Abstract:
The advent of greater computing power and smarter information technology have provided a new way to model, analyze, and visualize the environmental systems and support decision making. Diagnosing the environmental changes in key biomes and developing the large-scale science associated with global scale modelling, land-atmosphere feedbacks, and landscape change have becoming more viable with the power of big data platforms. The data models developed for handling spatial data at desktop machines may not be optimal for big data platforms that serve multiple user communities. We developed a new big data system for water science that aims to provide a common platform for environmental data modelling and integration into decision-support systems and end-user applications. Key design requirements included ability to incorporate heterogeneous data representations, which vary from raster and vector to times-series and spatial time-series, as well as the need for advanced analytics, handling data uncertainty, and accommodating data sharing and aggregation requests. Discrete Global Grid System (DGGS), recently defined in an Open Geospatial Consortium Specification, provide a potential data model to meet these requirements. DGGS are a hierarchical spatial partitioning system of the earth which are increasingly employed as the data model for Digital Earth representations. We implemented an aperture-3 hexagonal DGGS within a parallel database system. Routines were developed to map common data types onto DGGS cells - including but not limited to, raster such as DEM and NDVI, vectors such as catchment boundaries and flowlines, time series such as discharge and meteorological variables, and spatial time series such as gridded rainfall and temperature. To create a baseline model data layer we also developed a Weather Research and Forecasting Model system and created a high-resolution cloud-resolving model result layer based on WRF-simulations. Subsequently, a variety of DGGS algorithms, such as parent-child finding, spatial queries, zonal statistics, neighbourhood finding, distance calculation among others. A case study analysis was developed for large-scale hydro-climatic change detection over the Tsá Tué Biosphere Reserve (Great Bear Lake Watershed) to demonstration current capabilities. The simulation from WRF as well as the meteorological variables from the stations were converted to a DGGS representation. Different strategies were employed for trend analysis and change detection of temperature and precipitation patterns. While temperature data were compared for the same DGGS cell as the stations, precipitation were analyzed as a spatial field; comparing both gridded and station-level data. The big data system coupled with a DGGS data model shows promising results in terms of storing heterogeneous environmental observational and model data, and providing methods to analyze large-scale trends over time and space.

An introduction to the IMPC-GWF data visualization system

Lead Author: Ehsan Sotoodeh Mollashahi
Presenting Author: Ehsan Sotoodeh Mollashahi
Email address: ehsan.sotoodeh@usask.ca
Co-Authors:
Shervan Gharari
Saman Razavi
Carl Gutwin

Poster #: 10

Abstract:
Proper visualization of scientific findings is essential for the communication of the results to other scientists, and in cases, to the general public. The size and transdisciplinary nature of Global Water Futures, GWF, and Integrated Modelling for Prediction and Management of Change in Canada's Major River Basins, IMPC, amplify the need for effective and dynamic tools for communication of the modeling result with the broader community and stakeholders. In this live demonstration, we present the latest development of the IMPC-GWF data visualization system. The special features of this system include:
•Visualization of NetCDF and shape files
•Deep search in time, where users can explore the time series of a specific variable in time for a given point on the map.
•Comparison of two or more spatial points for a product.
•Pop-up panels that can be used to compare various products visually next to each other for a given spatial domain.
•Clear separation of front-end and back-end, which enables using features of visualization without need for background knowledge in computer sciences
The demo version of the systems is available online at http://gwf-demo.usask.ca/
The demonstration will be aiming at introducing the tool and its capabilities, possible hands-on experience as well as receiving feedback for improving the tool.

Blockchain: Sharing Data while maintaining all Rights and Control

Lead Author: Ralph Deters, UoS, Computer Science
Presenting Author: Ralph Deters, UoS, Computer Science
Email address: ralphdeters@gmail.com
Co-Authors:
Graham Strickert, GWF
Tanvi Jain, UoS, UoS, Computer Science
Mengxuan Liu, UoS, Computer Science

Poster #: 11

Abstract:
Blockchain: Sharing Data while maintaining all Rights and Control
Large data-sets aka Big Data, are essential for the countless machine learning, data analytics and model-driven approaches. While it is common to focus on key technical issues of volume, variety, velocity, veracity and value of the data it is important to note that questions regarding the rights and control of the data are nearly always ignored.
Blockchain Technology has been identified as an effective tool for managing the rights of data owners and ensuring that they have at any moment full control over "their" data. Using the blockchain as an access-control and provenance tool enables the data owners to grant/revoke access and to monitor the usage of the data they provided. Especially in situations where data is used to create new artifacts e.g. machine learning, Blockchain technology emerges as the only practical solution.
The presentation focusses on the key challenges of managing and tracking data use and compares the centralized data-management approaches with the fully decentralized blockchain approach. We present a light-weight blockchain designed to manage data access and track data usage (data provenance) for a range of data storage situations including fully distributed data lakes and traditional (centralized) database approaches. The performance evaluations demonstrate that the blockchain scales well and is able to handle very large volumes of data access requests and provide real-time tracking of data usage.

A New Method for Global Sensitivity Analysis from Given Data

Lead Author: Razi Sheikholeslami, Global Institute for Water Security, University of Saskatchewan
Presenting Author: Razi Sheikholeslami, Global Institute for Water Security, University of Saskatchewan
Email address: razi.sheikholeslami@usask.ca
Co-Authors:
Saman Razavi, Global Institute for Water Security, University of Saskatchewan

Poster #: 12

Abstract:
Global Sensitivity Analysis (GSA) techniques are powerful tools for understanding how various processes in complex environmental systems models interact, and for determining how the system behavior varies by changing these processes. However, it is not uncommon for complex environmental systems to exhibit highly sensitive behavior to model structure and parameters, making it difficult to identify a correct set of governing equations (i.e., the best model). Even when the governing equations of the underlying system are known, perfectly fitting them to data in is not always guaranteed due to the highly nonlinear interactions and inevitable observation error. In such cases, we may only have timeseries of observational input-output data, while traditional sampling-based GSA techniques require having a "model" to quantify the influence of input variables on the response variable of interest.
To address this challenge, we introduce a new Data-driven Variogram Analysis of Response Surfaces (D-VARS) for GSA purposes. Unlike the traditional approach, the proposed method extracts the sensitivity-related information from the available data and does not need having an input–output functional relationship (i.e., model). The D-VARS starts by building covariance functions to characterize the spatial correlation properties of the response variable, purely based on data. With the covariance functions extracted from the data, D-VARS then uses an effective procedure based on the concept of directional variograms and covariograms to compute several types of scale-dependent sensitivity indices. Furthermore, in the presence of correlated input variables where the independent marginal distribution functions cannot sufficiently represent the input uncertainty, the D-VARS technique enables user to effectively conduct a GSA. In this study, the D-VARS method is tested on a well-known analytical benchmark function and results confirm that it provides a robust estimation of sensitivity indices. As a second case study, we apply the proposed method on the empirical time series collected from the southern boreal forest at Boreal Ecosystem Research and Monitoring Sites (BERMS), Saskatchewan, Canada. Our results indicate that the D-VARS can successfully recognize the dominant input variables, and therefore provides greater insight into the role of inputs and feedbacks on variability of the response variables.

Considerations for a data and information service for the Water-Energy-Food (W-E-F) Nexus and its potential benefits for the Lake Winnipeg Basin

Lead Author: Richard G. Lawford
Presenting Author: Richard G, Lawford
Email address: rlawford@gmail.com
Co-Authors:

Poster #: 13

Abstract:
Food security is essential for all societies. Food production flourishes when water, energy, and land are abundant, but often it is limited by the relatively fixed amount of water circulating in the hydrosphere, the lack of new land for cropping, and the depletion of critical minerals and fossil fuels in many source regions. An integrated Water-Energy-Food (W-E-F) Nexus planning and management approach, the focus of a recent Future Earth cluster project, promises benefits such as improved resource efficiencies, more coherent resource and environmental policies, and more efficient management of data, information and knowledge resources.
Drawing on insights from four regional workshops held as part of the Future Earth W-E-F Nexus Cluster project, this presentation explores the potential of an integrated data and information system to enhance W-E-F Nexus sustainability. In particular, it discusses how such a multidisciplinary system could be designed, developed and operated to meet the information needs of W-E-F Nexus decision-makers. The Lake Winnipeg Basin could derive a number of benefits from this approach to the management of water and other critical resources linked to water in the basin. The presentation will conclude by summarizing these benefits and by suggesting a pathway for achieving them.

Blockchain based Identity management and enhanced security framework for crowdsourcing water science project

Lead Author: Tanvi Jain, Computer Science, University of Saskatchewan
Presenting Author: Tanvi Jain, Computer Science, University of Saskatchewan
Email address: tanvi.jain@usask.ca
Co-Authors:
Liu Mengxuan, Computer Science, University of Saskatchewan
Graham Strickert, School of Environment and Sustainability, University of Saskatchewan
Ralph Deters, Computer Science, University of Saskatchewan

Poster #: 14

Abstract:
Distributed water science (DWS) is a project to develop application tools to support from the public or communities. The DWS tools can help get new types of data for water resources with the added value of engaging the public in raising awareness for all the environmental challenges our natural resources are facing. Although this qualitative and time specific data is hard to collect, partly because of all the pertaining security and privacy threats. Users are not always in favor to expose their identities or share sensitive data. In order to protect the privacy of users and data they share, we propose blockchain technology as a solution to provide decentralized trusted community-based network giving users control over what information gets shared and with whom on the pseudo-anonymous framework. Blockchain, also known as distributed ledgers provides decentralized, tamper-free record keeping of transactions in a trust-less environment. Coupling blockchain technology with smart contracts specifically tailored to provide policies and cryptographic algorithms can be used to evaluate trust among users. The users can grant, delegate or revoke access to the network nodes as per policies the network users are agreed on, but also share and control the whole infrastructure. This solution allows data integrity, immutability with the decentralized network structure, giving individuals and organizations control over their own identities which centralized systems generally do not. To authenticate proof of origin and existence, a unique hash is generated for every digital artifact stored and embedded on the chain by the decentralized trusted time-stamping service. This unique fingerprint is embedded in a transaction and can be used to prove the identity of the contributor with giving away the actual user as no data is visible to the network operators and no one can track the user across relying parties exemplifying confidentiality, security on the resilience network against the common security attacks.

ContourMove: Exploring Temporal Changes in Large Geo-Spatial Data

Lead Author: Michael Beyene, Department of Computer Science, University of Saskatchewan
Presenting Author: Zonayed Ahmed, Department of Computer Science, University of Saskatchewan
Email address: zonayed.ahmed@usask.ca
Co-Authors:
Zonayed Ahmed, Department of Computer Science, University of Saskatchewan
Dr. Chanchal Roy, Department of Computer Science, University of Saskatchewan
Dr. Christopher Dutchyn, Department of Computer Science, University of Saskatchewan
Dr. Debajyoti Mondal, Department of Computer Science, University of Saskatchewan

Poster #: 15

Abstract:
We have developed an interactive system to visualize change in geo-spatial data. As a case study we used the weather research and forecasting (WRF) model output. ContourMove first extracts the change information as directional vectors from 9 months of soil moisture dataset. Then it visualizes the vectors over the contour map of the first day, i.e., the vectors depict the changes occurred over time. However, such a straight-forward visualization would be cluttered and unreadable. Hence, ContourMove uses various computational techniques to filter and visualize important changes, and provides support for real-time user interactions.

re:mote – Low-cost Software and Hardware Infrastructure for Water Quality Sensing in Indigenous Communities

Lead Author: Emil Sekerinski, Computing and Software, McMaster University
Presenting Author: Emil Sekerinski, Computing and Software, McMaster University
Email address: emil@mcmaster.ca
Co-Authors:

Poster #: 16

Abstract:
The re:mote software and hardware infrastructure comprises motes with various (commercial and research prototype) sensors for collecting water quality data, a mesh network connecting motes through a base station to a server, a time series database and a (multi-lingual) web server running on the server hardware, and notebooks for analyzing data programmatically. Only open-source software and low-cost hardware are used, allowing the setup to be used for education and maintained by communities. An overview with a demonstration is given.

The development and Testing of Bioavailability Sensors

Lead Author: Gagan Gill, Department of Chemistry, Wilfrid Laurier University
Presenting Author: Gagan Gill, Department of Chemistry, Wilfrid Laurier University
Email address: gill4920@mylaurier.ca
Co-Authors:
D. Scott Smith, Chemistry, Wilfrid Laurier University

Poster #: 17

Abstract:
Water quality monitoring is a universally critical topic and sustainable provisions of high-quality water is a major challenge of the 21st century. Water quality monitoring has been widely addressed since the mid 19th century because of poor water conditions, a consequence of industrialization. Many watersheds and water sources both in Canada and across the world are under stress from the effects of industrial activities, such as mining and climate change. Population growth in urban areas, agricultural practices and extraction of resources, all tend to introduce pollutants such as metals, microorganisms, industrial waste products and many other contaminants into watersheds. The increased introduction of pollutants has become a global issue of concern, and there is a critical need to monitor these effects. Various chemical and biological monitoring methods are presently utilized to help guarantee the availability of high-quality water. However, these techniques still face some challenges including high costs, complex design, professional training and onsite limitations. To address these arising concerns, my research involves the development and testing of in situ water quality sensors that are cost-effective, simple to use, highly selective and onsite. My research focuses on the development of fully integrated quantitative sensors that are tailored for the detection of the bioavailable fraction of Ag+ and Pb2+. The sensors utilize DNAzymes as the transducing element and proposes to be highly selective and sensitive. The sensors will range from applications that involve high metal concentrations and long-term monitoring for regions contaminated by mining industries to those that deal with lower metal concentrations and rapid monitoring (house-hold). The successful development and testing of a bioavailable sensor will allow for the improvement of water quality. By implementing these sensors into the environment, we will be able to address the needs of users by monitoring, detecting and preventing unsafe levels of metal contaminants entering into the environment.

Opportunities and constraints in applications of eDNA techniques in environmental assessments of aquatic systems

Lead Author: Renata Mont'Alverne, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Renata Mont'Alverne, School of Environment and Sustainability, University of Saskatchewan
Email address: renata.montalverne@usask.ca
Co-Authors:
Bram Noble, Department of Geography and Planning, University of Saskatchewan
Tim Jardine, School of Environment and Sustainability, University of Saskatchewan

Poster #: 18

Abstract:
Sampling genetic material shed by organisms in the surrounding environment, also known as environmental DNA (eDNA), is a recently developed solution for successfully accomplishing fast and reliable environmental predictions and protection by identifying the presence of species of interest. Gaining a better understanding of the needs of potential end-users and policy gaps while the technique is still being developed and refined is key to a more effective science-policy interface, as it provides support to scientists and decision-makers through useful, timely and usable knowledge. Following a qualitative framework, 32 interviewees from Alberta, Saskatchewan, Ontario, and the national level representing five groups (academia, private sector, government, law, and non-governmental agencies and Indigenous communities), provided their perceptions about eDNA. In parallel, provincial and federal acts and regulations were analyzed in order to identify favorable sections or challenges for eDNA incorporation into policy. Preliminary findings from the interviews suggest that acceptance by technicians and lawmakers is a greater challenge for eDNA incorporation into environmental frameworks than by legislation itself, though some regulations require more extensive investigation than eDNA is capable of providing and may represent barriers to its adoption. In addition, most interviewees agreed on the potential of this technique but highlighted some limitations, such as not being able to determine abundance as opposed to presence/absence. They also emphasized the need for validation and the adoption of standards, suggesting more work is needed before the technique is widely practiced.

Microwave Sensing and Microfluidics for Water Detection

Lead Author: Carolyn Ren, Mechanical and Mechatronics Engineering, University of Waterloo
Presenting Author: Carolyn Ren, Mechanical and Mechatronics Engineering, University of Waterloo
Email address: c3ren@uwaterloo.ca
Co-Authors:

Poster #: 19

Abstract:
Microfluidics that deals small volume fluids presents tremendous potential for environmental assessment and protection thanks to its continuous flow nature that offers the potential for integration of multiple processes. Microwave sensing is a remote, highly sensitive technology operating at GHz range. It differentiates materials based on their electrical properties such as dielectric constant and electrical conductivity. Integration of both microwave and microfluidics offers unique advantages for sensing and sample processing at high speed in an integrated manner. Moreover, such an integrated device could operate at norther cold region which makes it more attractive than other methods. This talk will introduce the fundamentals of microwave sensing and microfluidic platform technologies that have potential for water detection. Some examples of preliminary studies towards water sensing will be presented and discussed as well.

Comparative review of freshwater monitoring approaches towards consideration of cumulative effects

Lead Author: Elaine Ho, School of Environment, Resources and Sustainability, University of Waterloo
Presenting Author: Elaine Ho, School of Environment, Resources and Sustainability, University of Waterloo
Email address: e23ho@uwaterloo.ca
Co-Authors:
Dr. Simon Courtenay, School of Environment, Resources and Sustainability, University of Waterloo
Dr. Andrew Trant, School of Environment, Resources and Sustainability, University of Waterloo

Poster #: 20

Abstract:
Two phases of a five-year project are presented here: the exploratory study (Muskoka River Watershed, 2016) and the initial phases of research under Global Water Futures (in the Grand River Watershed, 2017-2020). First, a review of existing and developing water monitoring programs from across Ontario, Canada and abroad provide insights on best practices and opportunities for improving inclusivity, accessibility and collaboration in water management. Initial lessons from key informant interviews with current monitoring professionals and aquatic scientists are also shared. Second, a new process for identifying and prioritizing water monitoring indicators, which was developed during the exploratory study in 2016, is presented. This new process will be adapted and applied to the monitoring framework being developed in the current research under Global Water Futures. The new process was tested in the context of the Muskoka Watershed Council, and was found to offer the following benefits: standardization of methods used to prioritize, less bias/more representation of perspectives not necessarily 'in the room', lowered cost when the need to reassess indicator lists arises, indicators are more relevant for decision-making, and monitoring programs increase in adaptability to fluctuating resources.

Surface Fouling Detection and Removal: Electrical Impedance Spectroscopy and Electric Field Induced Desorption

Lead Author: Nan Zhang, Chemical Engineering, McMaster University
Presenting Author: Charles-François de Lannoy, Chemical Engineering, McMaster University
Email address: delannoy@mcmaster.ca
Co-Authors:
Nan Zhang, Chemical Engineering, McMaster University
Saif Syed, Chemical Engineering, McMaster University
Zeinab Housseini-Doust, Chemical Engineering, McMaster University
Charles-François de Lannoy, Chemical Engineering, McMaster University

Poster #: 21

Abstract:
Surface interactions are critical for many sensors. Electrochemical-based sensors (e.g. pH, DO, ORP sensors) for examples rely on the electrochemical reactions or interactions that occur at an electrode/counter-electrode surface. Resistance-based sensors (e.g. Temperature sensors) measure the change in a metal's resistance as a function of applied temperature. In each of these sensors, changes in the material's surface properties has a significant impact on the measurement of the input (e.g. heat, proton concentration, oxygen concentration). The changes to these measurements can impact the signal strength, value, and reproducibility. Surfaces exposed to aquatic environments are prone to surface fouling, which can change sensor materials' surface properties. Environmental surface fouling can include organic fouling, colloidal fouling, or biofouling. Therefore, fouling monitoring and fouling removal is critical for the long-term environmental operation of many sensors.
This work investigates the use of electrochemical impedance spectroscopy (EIS) on the surface of electrically conductive surfaces to precisely measure the onset of surface fouling. These results were correlated to applications for sensor surfaces operating in aquatic environments. To measure the onset of fouling in simulated sensor surfaces, an electrochemical cell was developed in which an electrically conductive membrane acted as a working electrode and a graphite electrode acted as the counter electrode. Surface colloidal fouling was simulated with latex beads, while biofouling was simulated with both pure strains of Pseudomonas Aeruginosa as well as with natural bacteria cultured from Hamilton, ON tap water.
Latex beads were pressure deposited onto membrane surfaces in a dead-end filtration cell. Changes in membrane permeance, membrane surface energy, and membrane roughness were quantified as a function of fouling severity. Small changes in membrane surface properties were statistically resolvable in electrochemical Nyquist plots. Specifically, it was observed that the higher frequency (103 ~ 106 Hz) diameter of the semicircle in Nyquist plots increased with greater fouling, while the impedance in the diffusion region (1 ~ 103 Hz) decreased with increased latex fouling. Similar experiments were performed with bacterial cultures. Pseudomonas Aeruginosa biofilms were grown on electrically conductive membranes and changes in membrane permeance, membrane surface energy, and membrane roughness were similarly quantified. Changes in EIS signals and impedance measurements were similarly correlated to changes in surface fouling severity.
By fitting the EIS results with a proper equivalent circuit we could differentiate the initial stages of fouling layer formation These preliminary experiments demonstrate that EIS is a highly sensitive technique for detecting small changes to surface impedance of electrically conductive surfaces as a result of surface fouling. Therefore, EIS may be a practical, highly sensitive, low power technique for measuring the onset of fouling on sensor surfaces.

Homebrew hydrology: Designing and building research equipment in-house

Lead Author: Keegan Smith, School of Geography and Earth Science, McMaster University
Presenting Author: Keegan Smith and Ian Martin, School of Geography and Earth Science, McMaster University
Email address: smithk53@mcmaster.ca
Co-Authors:
Ian Martin, School of Geography and Earth Science, McMaster University

Poster #: 22

Abstract:
The persistent challenge of hydrological field research is to maximize data collection at minimal cost in both money and time. Equipment budgets are often stretched thin and time for field preparation can be scarce. Researchers need time to familiarize themselves with their study area and scientific theory, to develop penetrating research questions, and to analyze and present available data – in addition to other duties like teaching and departmental obligations. The demands of academic research therefore leave little time to explore new or unconventional avenues for data collection. As a result, fieldwork often relies on expensive instrumentation from third-party suppliers, or students are required to spend time on the nuts and bolts of their methods, rather than data analysis and publication.
But what if there was another way?
This presentation showcases three ongoing research projects at McMaster University, from three different Global Water Futures projects across the country, where the skills and knowledge of GWF research technicians were put to use in building novel instrumentation. See how specialized knowledge of snow hydrology was used to design and build specialized meltwater collectors and gain new insights into the spring energy and water balance of a human-built northern wetland! Hear about the collaboration with researchers from McMaster and other institutions, which resulted in a sophisticated system to “watch the forest breathe”! Learn how the technicians put their electronics skills to the test by repurposing existing sensors, extending them into a role unimagined by their creators and discovering how the wetlands are all connected! By funding technical staff positions, Global Water Futures has created a unique opportunity for research groups to divide their labour and develop novel, low-cost sensing technologies, or improve practices with existing technology. In the spirit of knowledge mobilization, we show preliminary data and experiential knowledge from projects across the spectrum of field hydrology.

Optofluidic device-based biosensor for the monitoring of cyanobacteria

Lead Author: Chang-qing Xu
Presenting Author: Faculty of Engineering
Email address: zhang749@mcmaster.ca
Co-Authors:
Yushan Zhang
Faculty of Engineering
Tianyi Guo
Forsee Instruments Ltd.

Poster #: 23

Abstract:
The need to rapidly, accurately, and inexpensively detect cyanobacteria in freshwater and drinking water is a growing priority all around the world. Cyanobacteria can create serious harmful algae blooms (HABs) along with other algae, contaminating fresh water sources. As little as 1 µg/L microcystin LR - toxin produced by toxic cyanobacteria – can be hazardous to human health reported by World Health Organization [1]. The negative effects of cyanobacteria blooms attract more research attention to monitor the cyanobacteria in freshwater. Traditional microscopic identification and enumeration, high-performance liquid chromatography (HPLC), enzyme-linked immunosorbent assay (ELISA), chlorophyll-a fluorescence and in-vivo fluorometry (IVF) are the reported methods to monitor cyanobacteria. In this project, optofluidic device based microflow cytometer are fabricated to monitor cyanobacteria in freshwater.

Optimization of environmental DNA extraction for use in detecting aquatic vertebrate biodiversity

Lead Author: Nathanael Harper, Biology, University of Waterloo
Presenting Author: Nathanael Harper, Biology, University of Waterloo
Email address: nathanaelharper.nh@gmail.com
Co-Authors:
Heather Ikert, Biology, University of Waterloo
Barbara Katzenback, Biology, University of Waterloo
Paul Craig, Biology, University of Waterloo
John Giesy, Veterinary Biomedical Sciences, University of Saskatchewan

Poster #: 24

Abstract:
Environmental DNA (eDNA) is the mixture of genetic material shed by the resident fauna into the environment and can be isolated from an environmental matrix such as water. Metabarcoding, a big-data analysis technique that can assign taxonomic identity to reads from a genetic sample without a priori knowledge of the biodiversity present, can then be applied to eDNA samples and is known as eDNA metabarcoding. eDNA metabarcoding from water samples is an emerging biological survey technique that can non-invasively provide precise biodiversity information on the fish and amphibians inhabiting waterways. To date, little research has examined the potential for eDNA metabarcoding to monitor fish and amphibian populations in a well characterised watershed such as Ontario's Grand River. Our research aims to compare the detection rates of fish and amphibians obtained via environmental DNA metabarcoding to the detection rates obtained through conventional biological survey methods, allowing for head to head comparisons of the two methods. Pilot surveys were conducted in Bauman Creek, a 1.8 km long tributary to the Grand River. At 4 distinct reaches of Bauman Creek, eDNA water samples were taken in conjunction with conventional electrofishing surveys. Water samples were filtered prior to eDNA extraction using commercially available kits. eDNA extraction methods were successfully optimized to remove PCR inhibitors, ensure DNA template integrity, and monitor for any potential contamination. In parallel, six primer metabarcoding PCR primers were tested to ensure widespread detection of target species. Detection of target species by candidate primers was predicted in silico by Primer-BLAST, tested in vitro with DNA extracts isolated from target species and confirmed in silico through PCR using eDNA samples. We identified a suitable primer set that detected all recorded fish and amphibian species in our study area, while yielding the species-specific amplicons necessary for assigning taxonomic identities. Initial electrofishing surveys revealed changes in species biomass and biodiversity across seasons and further comparisons with forthcoming eDNA metabarcoding data will be used to assess the utility of eDNA metabarcoding as an end user tool for biomonitoring. Ultimately, the validation of eDNA metabarcoding will facilitate fish and amphibian monitoring and conservation in the Grand River watershed.

From Lab to Field: Using fibre optics for remote monitoring of soil oxygen

Lead Author: Alison Mao, Earth and Environmental Sciences, University of Waterloo
Presenting Author: Alison Mao, Earth and Environmental Sciences, University of Waterloo
Email address: a5mao@edu.uwaterloo.ca
Co-Authors:
Tatjana Milojevic, Earth and Environmental Sciences, University of Waterloo
Auristela Bantegui, Earth and Environmental Sciences, University of Waterloo
Fereidoun Rezanezhad, Earth and Environmental Sciences, University of Waterloo
Philippe Van Cappellen, Earth and Environmental Sciences, University of Waterloo

Poster #: 25

Abstract:
Laboratory environments can provide excellent settings for understanding isolated processes and developing and testing new tools for environmental research. However, applying those lab tools to a natural setting comes with numerous challenges. Here we are presenting recent results from oxygen data collected at an agricultural field site in Southern Ontario, using a multi-fibre optode sensor system. This presentation will focus on the process of transitioning the use of the sensor from monitoring soil oxygen in a laboratory setting to a field setting. In particular, we will discuss the challenges, opportunities, and lessons learned so far (e.g., sensor modification for field environments, maintaining connection for data transfer, accounting for environmental factors influencing sensor performance, etc.).

Delineating Effluent Exposure and Associated Risk to Aquatic Organisms Downstream of a Uranium Mine in Northern Saskatchewan using Autonomous Sensors

Lead Author: Beatriz Cupe, Toxicology Centre, University of Saskatchewan
Presenting Author: Beatriz Cupe, Toxicology Centre, University of Saskatchewan
Email address: bec975@mail.usask.ca
Co-Authors:
Maira Mendes, Toxicology Centre, University of Saskatchewan
Karsten Liber, Toxicology Centre, University of Saskatchewan

Poster #: 26

Abstract:
The McClean Lake Uranium mining and milling operation is located in the Athabasca Basin Ecoregion of Northern Saskatchewan. Treated effluent from the operation is released into the east basin of McClean Lake, then drains into Collins Creek and eventually flows to Collins Bay in Wollaston Lake. Although the concentrations of individual metals in the effluent may not be toxicologically significant, the cumulative effect of these metals could potentially represent a toxicological risk to aquatic organisms, especially benthic macroinvertebrates. This study is aimed at determining whether or not there is a cumulative risk from effluent exposure (combined metals and major ions) to macroinvertebrates in McClean Lake and to identify whether or not the cumulative risk is different in different parts of the lake and at different times due to variable and incomplete effluent mixing. To delineate effluent distribution and movement within the system, and cover different areas within the downstream lakes, an autonomous, real-time water quality monitoring system was deployed (Libelium Smart Water sensors) at 10 locations along Vulture Lake, McClean Lake East basin (exposure sites), Collins Creek (downstream site) and McClean Lake West basin (reference location). Each sensor unit was deployed with attached probes to measure pH, conductivity (EC), turbidity, dissolved oxygen (DO), and temperature and send data every 4 hours. Water and sediments, as well as macroinvertebrate samples, were collected at the same monitoring locations. Major ions, metal(oids) and routine water quality (pH, EC, DO, and temperature) were measured in water, and metals(oids), particle size and total organic carbon in sediments. The toxicological risk to invertebrates was assessed by calculating Hazard Quotients (HQs) based on water quality benchmarks for the long-term protection of freshwater aquatic life. Sensor data was collected for 4 weeks (August and September 2018) via an external cloud server that was accessible from any device with an Internet connection. The preliminary results indicated that there were significant spatial and temporal changes in effluent exposure based on conductivity measurements in Vulture Lake and McClean Lake East basin. Similarly, the HQs for zinc, arsenic, selenium, sulfate, and fluoride were higher than water quality benchmarks at some locations. The taxon richness and abundance of macroinvertebrates were relatively low at all the stations, possibly related to the sampling technique chosen (Hester-Dendy artificial substrate samplers) that is selective for mobile and drift-prone species. In general, benthic community indices showed no correlation with field measurements of EC, which is used as a surrogate for effluent exposure. Thus, these results suggest that there are no measurable adverse effects on macroinvertebrate communities. Finally, in order to have more consistent readings from the sensors and develop a better understanding of effluent distribution, regular probe cleaning should be performed every 14-18 days. For 2019, sensor data will be collected for 8 weeks (1-2 measurements/day) and three sensor units will be relocated to better define effluent distribution. Real-time conductivity measurements and other results (metals) will be used to describe seasonal changes in contaminant exposure and help estimate the variability in toxicological risk within the lake over time.

UAV-based Hyperspectral Remote Sensing for Hydrological Application: A Comprehensive Workflow for Data Processing

Lead Author: Dong Zhao, Centre for Hydrology, University of Saskatchewan, Saskatoon
Presenting Author: Dong Zhao, Centre for Hydrology, University of Saskatchewan, Saskatoon
Email address: dong.zhao@usask.ca
Co-Authors:
Phillip Harder, Centre for Hydrology, University of Saskatchewan, Saskatoon
John Pomeroy, Centre for Hydrology, University of Saskatchewan, Saskatoon

Poster #: 27

Abstract:
Unmanned Aerial Vehicle (UAV)-based hyperspectral imaging (HSI) promises to provide novel and unique information for, amongst other applications, monitoring water quality and algal bloom formation, quantifying the spatial variability of snow albedo and the influence of dust deposition, and classifying vegetation and monitoring vegetation health. Significant challenges exist in the data processing necessary to transform raw HSI data collected on a mobile and unstable platform under changing solar irradiance into a radiometrically consistent and georectified surface spectral reflectance map. Herein, a workflow that precisely and efficiently processes UAV-based HSI is presented that facilitates subsequent data distribution and analysis necessary to address pertinent research questions. The presented workflow consists of: (1) de-noising hyperspectral imagery using a modified moment-matching algorithm; (2) georeferencing scanned lines through geographical look up tables created by input geometry files and geometric co-registration with a reference orthomosaic; (3) mosaicking of georeferenced lines based on overlapping areas; (4) spectral reflectance retrieval with various strategies related to weather conditions and surface features; and (5) spectral albedo retrieval steps following Briegleb and Ramanathan's law and empirical methods. Datasets collected with a Corning microHSI 410 SHARK from July 2018 to March 2019 at prairie and Rocky Mountain research sites in Western Canada are used to demonstrate this data processing workflow at various sites. Preliminary results of UAV-based HSI demonstrate its potential to map vegetation and snow reflectance properties and their temporal dynamics at unprecedented spatial and spectral resolutions that will improve hydrological processes understanding and provides another tool to validate distributed snowmelt energy balance and evapotranspiration models at high resolutions.

An Implementation of layered WSN using UAV

Lead Author: Gazi Rahman, ECE, UoS
Presenting Author: Gazi Rahman, ECE, UoS
Email address: ehsan.rahman@usask.ca
Co-Authors:
Kahn A. Wahid

Poster #: 28

Abstract:
Wireless Sensor Network (WSN) is growing rapidly by both its data volume and geographical coverage depending on the application. For the water quality monitoring application the WSN would be scattered geographically and of non-continuous network. We need an assistive layer of communication to make a continuous network that will enable the WSN to be connected with the Core IoT cloud. For this purpose smart- Unmanned Arial Vehicle (UAV) would be our first preference to meet both the large geographical coverage and continuous connectivity. A logical network architecture of IoT enabled WSN with UAV as an assistive layer is proposed with its implementation.

Chemiresistive detection of copper ions in water

Lead Author: Johnson Dalmieda, Chemistry and Chemical Biology, McMaster University
Presenting Author: Johnson Dalmieda, Chemistry and Chemical Biology, McMaster University
Email address: dalmiej@mcmaster.ca
Co-Authors:
Peter Kruse, McMaster University
Ana Zubiarrain Laserna, McMaster University
Anastasia Benfield-Dexter, McMaster University
Ravi Selvaganapathy, McMaster University

Poster #: 29

Abstract:
Although copper is essential to biological function, high levels of copper intake leads to many negative gastrointestinal effects, and can even lead to kidney and/or liver failure. In Canada, drinking water has a Maximum Allowable Content of 2 ppm copper, with a Maximum Aesthetic Content of 1 ppm.[1] To ensure that drinking water is safe for consumption, many detection methods have already been put in place. One such method is atomic absorption spectroscopy, which has been found to have good precision and is reasonably interference free. However, the sample usually requires a preconcentration step, which becomes quite tedious.[2] Another method is mass spectrometry, which boasts a low level of detection and a large dynamic range.[3] Both these methods, however, require expensive equipment, and cannot be done on site. Proposed is a cheap and portable sensor which provides sufficient selectivity and sensitivity for the detection of copper ions in water.
This copper sensor is based on the usage of chemiresistors which have been functionalized to respond to a single analyte (in this case, copper). This sensing principle has been previously used to detect free chlorine in water. The resettable free chlorine sensor operates reagent-free over a dynamic range of 0.06 ppm to 60 ppm.[4] The goal of this work is to utilize the same sensing platform as the chlorine sensor to develop an economical and maintenance-free chemiresistive copper sensor for continuous online monitoring.
1. Health Canada. Copper in drinking water: Guideline technical document for consultation https://www.canada.ca/en/health-canada/programs/consultation-copper-drinking-water/document.html (accessed Mar 25, 2019).
2. Hunt, D. T. E.; Wilson, A. L. The Chemical Analysis of Water: General Principles and Techniques; The Royal Society of Chemistry: Cambridge, 1995, 398-401.
3. Xiong, X.; Jiang, T.; Zhou, R.; Wang, S.; Zou, W.; Zhu, Z. Microwave Plasma Torch Mass Spectrometry for the Direct Detection of Copper and Molybdenum Ions in Aqueous Liquids. Journal of Mass Spectrometry 2016, 51 (5), 369–377.
4. Hsu, L. H. H.; Hoque, E.; Kruse, P.; Selvaganapathy, P. R. A carbon nanotube based resettable sensor for measuring free chlorine in drinking water. Appl. Phys. Lett. 2015, 106, 063102.

CANADIAN WATER MICROSATELLITE MISSION - CONCEPT DESIGN

Lead Author: Kiana Zolfaghari, Department of Geography, University of Waterloo
Presenting Author: Kiana Zolfaghari, Department of Geography, University of Waterloo
Email address: kzolfagh@uwaterloo.ca
Co-Authors:
Marie Hoekstra, Department of Geography, University of Waterloo
Claude R. Duguay, Department of Geography, University of Waterloo
David Rudolph, Department of Earth and Environmental Sciences, University of Waterloo
Ian D'Souza, Honeywell Aerospace, Cambridge, Canada

Poster #: 30

Abstract:
Canada has vast water resources that span an enormous range in geography, climate, and ecosystems. Water supply and water quality are the two critical issues relevant to water resources, not only in Canada but globally in a warming climate. The water microsatellite mission described here aims to better prepare end users to respond to the emerging spectrum of water futures issues by revolutionizing remote sensing of water quality and quantity parameters, and permitting unprecedented interconnection and data gathering from Canadian environmental monitoring networks.

Hydrological Observations and Smart Water Sensors

Lead Author: Nicholas J. Kinar, Smart Water Systems Lab, Centre for Hydrology, University of Saskatchewan
Presenting Author: Nicholas J. Kinar, Smart Water Systems Lab, Centre for Hydrology, University of Saskatchewan
Email address: n.kinar@usask.ca
Co-Authors:
John W. Pomeroy, Smart Water Systems Lab, Centre for Hydrology, University of Saskatchewan

Poster #: 31

Abstract:
Many hydrological observations are made using electronic sensors that measure environmental phenomena. These sensors are often reliant on empirical relationships, require the use of calibration coefficients that change over time, and also collect data on regular timesteps that are often not indicative of sampling rates required for environmental phenomena. The Smart Water Systems Lab (SWSL) at the University of Saskatchewan was created by the Global Water Futures (GWF) program to develop sensors that operate on principles of environmental physics. The sensors do not require calibration or are capable of automatic calibration in the field by the use of a microcontroller. The microcontroller also allows for in-field processing of data for near-real-time feedback and Machine-to-Machine (M2M) communication interfaces permitting data transfer over ubiquitous WiFi, Bluetooth, Ethernet, RS-232, and SDI-12 interfaces. The microcontroller can also change the timestep to suit the physics of an environmental process such as snowmelt. Following these design principles, three sensors are being constructed and tested. Chione (System for Acoustic Sensing of Snow) is a sensor that utilizes audible sound waves to non-invasively measure snow depth, density, temperature, and liquid water content. Installed over the snow surface, the sensor sends sound waves into snow, receives reflections of the sound waves, and processes the acoustic data using a model of sound wave propagation through snow. The Self-Calibrating Heat Pulse Probe (SCHEPP) measures soil density and water content. Unlike nominal heat pulse probes used to measure soil properties, the SCHEPP system determines changes in the probe spacing radius over the time of measurement to improve estimates of these soil properties. The Non-Contact Stream Sensor (NCSS) utilizes ultrasonic waves to measure the distance to a stream surface and the stream surface velocity without the use of air temperature measurements. These three sensors serve as examples of how “smart” water sensors can be used to obtain important hydrological cycle measurements and provide useful data for environmental monitoring.

Low Cost, Portable, Instant BGA Concentration Monitoring System

Lead Author: Rakibul Islam Chowdhury, Dept of ECE, University of Saskatchewan
Presenting Author: Rakibul Islam Chowdhury, Dept of ECE, University of Saskatchewan
Email address: chowdhury.rakibul@usask.ca
Co-Authors:
Dr. Khan A. Wahid, Dept of ECE, University of Saskatchewan

Poster #: 32

Abstract:
Continuous monitoring of Blue Green Algae (BGA) is an important parameter for early identification of Harmful Algal Bloom (HAB). However, existing commercial BGA sensors are still very expensive. In situ chemical analysis of the water sample takes more than 24 hours to generate the result and requires expensive apparatus and an expert. The scenario inspired us to explore different commercially available sensors and try measuring BGA concentration using them. Eventually, using AS7262 and AS7263, consumer-grade smart 6-Channel VIS and NIR sensors, we have built a sensor network with a view to predicting the concentration of BGA instantly and directly from the water sample. The device is low-cost and portable. We took thousands of readings using our device and trained a machine learning model to predict the concentration of BGA of any unknown water sample. We have validated our result using both chemical analysis and existing commercial sensors. The root mean square error (RMSE) of our device is low enough to identify different levels of BGA concentration in sample water.

Low-cost free chlorine sensor

Lead Author: Si Pan, ECE, McMaster U
Presenting Author: Si Pan, ECE, McMaster U
Email address: pans2@mcmaster.ca
Co-Authors:
M. Jamal Deen, ECE, McMaster U

Poster #: 33

Abstract:
We developed a free chlorine sensor of low cost. The sensor can measure the free chlorine concentration in the tap water. If there is too little free chlorine, the disinfectedness of the water may be compromised; the worse outcome is lethal. If there is too much free chlorine, it may cause health issues; one severe disease is bladder cancer.
The end user should know the free chlorine concentration if they want to drink directly from the tap. Canada regulates 0.2 to 2 ppm of free chlorine in tap water. Our sensor works within this range, tested for two months, by comparing against a commercial standard measurement.
Our sensor does not require any prior training of skills - it only provides a reading in ppm.
Easy to fabricate, the sensor requires little to no industrial treatment to make, also discharging no hazardous by-product. The fabrication process is ideal in the setting of water, health and environment.
Our sensor works in flow-through mode, where the user does not need to handle any water samples. It can be integrated to a faucet if required to make a 'smart faucet'.
Also as a dipstick, the user can dip our sensor in a cup of water to measure the free chlorine.
The electronics were all developed in-house, so the sensor's functions are all accessible for further extension.
In future work we hope to integrate this sensor to communicate its measurements wirelessly for increased functionality.
We have Intellectual Property file in multiple countries and have on-going interest from the industry.

The Smart Water Systems Laboratory

Lead Author: Alistair Wallace, Geography and Planning, University of Saskatchewan
Presenting Author: Alistair Wallace, Geography and Planning, University of Saskatchewan
Email address: alistair.wallace@usask.ca
Co-Authors:
Dr. Nicholas Kinar, Geography and Planning, University of Saskatchewan
Dr. Dong Zhao, Geography and Planning, University of Saskatchewan

Poster #: 34

Abstract:
The Smart Water Systems Laboratory
A. Wallace, N. J. Kinar, D. Zhao
University of Saskatchewan, Centre for Hydrology
The Smart Water Systems Laboratory (SWSL) is located at the University of Saskatchewan and was established by support from Western Economic Diversification Canada, The Global Institute for Water Security and Global Water Futures. The mandate of the lab is to transform the observation of Canadian waters by detecting changes in water quantity and quality at high resolutions. SWSL develops novel sensors that measure snow, ice, open water, flood processes, streamflow, soil moisture, wetlands, vegetation and algal growth. Many of the sensors are installed on specialized all-weather drones (unmanned aerial systems) for rapid deployment across Canada with applications in the Prairies and the mountain headwaters of the Saskatchewan River Basin.
SWSL is a full featured electronics development lab with capabilities to design, build and test advanced sensors. A reflow oven, environmental chamber, electronic test equipment and soldering stations are available. The lab also has two hexcopters, two fixed wing drones and one quadcopter. Available sensors include an airborne lidar system, RGB and thermal cameras, multispectral and hyperspectral cameras and a field spectrometer. SWSL has the capabilities to store and post-process data collected from the sensors. Server clusters and RAID (Redundant Array of Independent Disk) technologies are used to collect, process, and securely archive data. Servers, circuits and network hardware are specifically designed to support the lab mandate. Network hardware and virtual private network (VPN) technologies are used to link field sites to the lab in Saskatoon.
To date over 140 airborne missions have been flown in the Prairies and Kananaskis regions. The data collected from these missions will provide insight into snowfall maximums, water quality and spatial variability of surface albedo at high resolutions.
In addition, novel prototype sensors are being constructed by the SWSL prior to production of sensing systems for eventual deployment at Global Water Futures field sites. The sensors will be available for use by Global Water Futures investigators and affiliates.

The Rate and Controls of Nitrogen Biogeochemistry in Prairie Potholes, Canada

Lead Author: Amy Hergott, SENS, University of Saskatchewan
Presenting Author: Amy Hergott, SENS, University of Saskatchewan
Email address: aeh089@mail.usask.ca
Co-Authors:
Dr. Emily Cavilere, University of Saskatchewan
Dr. Colin Whitfield, Global Institute for Water Security, University of Saskatchewan
Dr. Helen Baulch, Global Institute for Water Security, University of Saskatchewan

Poster #: 35

Abstract:
The Prairie Pothole Region of Canada is under anthropogenic stress. Climate change, land modification, and pollutant release are having substantial impacts on the landscape. As food production demands increase in concert with global population, the use of agricultural fertilizers to supplement plant growth also rises. Nitrogen is the nutrient most applied to agricultural landscapes. High application rates, combined with other anthropogenic activities, such as fossil fuel combustion, has stimulated nitrogen accumulation in both managed and natural ecosystems. Excess nitrogen poses a threat to biodiversity, human health, and water quality. Despite these threats, prairie wetlands, also known as potholes, may help offset these inputs through many transformative biogeochemical processes, reducing the risk of nutrient export and pollution to adjacent water bodies. By investigating major nitrogen transformation processes of prairie potholes, denitrification, dissimilatory nitrate reduction to ammonium, and algal uptake, we can better understand the rates and drivers of nitrogen retention. Isotopic compounds of 15N will be used to explore these pathways across a range of concentrations, seasons, and wetland classes found throughout the prairie provinces. Preliminary data found algae to show a high capacity for continued removal of nitrogen, as well as a higher rate of uptake with higher in-situ concentrations. These results suggest a rapid uptake of nitrogen by algae, helping to attenuate the transport of nitrogen across water bodies. Recognizing the ecosystem services provided by prairie potholes can aid in balancing food production with the preservation of ecosystems by informing which potholes are hotspots for nutrient cycling.

Evaluation of municipal effluent discharge reveals significant improvements as a result of wastewater treatment plant process upgrades

Lead Author: Nivetha Srikanthan, Biology University of Waterloo
Presenting Author: Nivetha Srikanthan, Biology University of Waterloo
Email address: n2srikan@uwaterloo.ca
Co-Authors:
Leslie Bragg, Biology, University of Waterloo
Katie McCann, Biology, University of Waterloo
Mark Servos, Biology, University of Waterloo

Poster #: 36

Abstract:
Treatment of municipal wastewater varies greatly across Canada and is dependent on a variety of factors such as influent source, population size, and receiving water location. Wastewater treatment plants (WWTPs) are traditionally designed to remove contaminants such as total suspended solids, phosphorous and ammonia, however pharmaceuticals and personal care products (PPCPs), and endocrine disrupting compounds (EDCs) are widely prevalent but are not targets for removal. As a result, municipal wastewater is one of the largest contributors to surface water contamination. Recent changes to the regulation of Canadian WWTPs require all plants to be operating with secondary treatment or equivalent by 2020, resulting in upgrades being implemented across the country which will improve the quality of final effluent discharged into the receiving waters. The Kitchener and Waterloo wastewater treatment plants (WWTPs) are the two largest WWTPs along the Grand River watershed in southern Ontario. These plants have undergone significant infrastructure and treatment process upgrades. Effluents discharged from both plants has been analyzed since 2010 encompassing pre, during, and post upgrade time periods, allowing for an evaluation of effluent quality as a result of the upgrades. One litre grab samples were collected and extracted using solid phase cartridges. The samples were analyzed using a biological assay (yeast estrogen screen) for total estrogenicity and chemical analyses for pharmaceuticals and specific hormone concentrations (LC-MS/MS) as well as nutrients. Results show a significant decrease in ammonia concentrations which is a major indicator of improved effluent quality (e.g. nitrification). Analysis of estrogenicity, and select hormones and pharmaceuticals (e.g. estrone, ibuprofen, and naproxen) also showed decreases corresponding to upgrades at both treatment plants despite these compounds not being specific targets of the upgrades. These compounds are removed through biodegradation and respond well to treatments with good nitrification and long solids retention times. However, many compounds remain detectable and some are recalcitrant to treatment (e.g. venlafaxine, carbamazepine). Overall the upgrades implemented at these two plants have shown to have positive impacts on the quality of the final effluent discharged. A corresponding improvement in indicators of exposure and health in fish populations downstream of the treatment plants have also been reported. This data will aid in developing relationships between contaminant exposure and secondary stressors, and validating predictive models linking contaminants to specific biological endpoints.

Cyclodextrin-Based Polymer-Supported Bacterium for the Adsorption and in-situ Biodegradation of Phenolic Contaminants

Lead Author: Abdalla Karoyo
Presenting Author: Abdalla Karoyo, Chemistry, University of Saskatchewan
Email address: abdalla.karoyo@usask.ca
Co-Authors:
Jian Yang, Pharmacy & Nutrition, University of Saskatchewan
Lee D. Wilson, Chemistry, University of Saskatchewan

Poster #: 37

Abstract:
Phenol compounds, such as pentachlorophenol (PCP), are known contaminants with adverse health risks such as immunal, neurological and endocrine disorders, and cancer in extended exposure. We report in this study dual function polymer adsorbent materials with immobilized Sphingobium Chorophenolicum (SpC) bacterium cells that undergo tandem adsorption and biodegradation of phenolic contaminants. The cross-linked polymer materials, herein denoted as HDI-X systems, contain β-cyclodextrin (β-CD) with incremental amounts of hexamethylene diisocyanate (HDI) cross-linker at variable mole ratios (X = 1, 3, or 6). The adsorptive uptake properties of the HDI-X polymers with PCP and other model phenolic compounds were studied using batch adsorption isotherms. The molecular selective phenol removal (SR) capacity of the HDI-X materials was evaluated by electrospray ionization mass spectrometry (ESI-MS). The results were compared against conventional granular activated carbon (GAC) adsorbent and native β-CD, where 1D/2D 1H NMR spectral characterization of the complexes formed between the phenolic compounds and HDI-1 in aqueous solution provide insight on the intermolecular interactions and the role of cross-linking effects. Immobilization of SpC onto HDI-3 was shown to form a composite polymer/bacterium material. The composite system displays synergistic removal effects due to tandem PCP adsorption and SpC biodegradation to yield by-products such as 2,6-dichloro-1,4-hydroquinone (DCHQ). Apoptosis and cytotoxicity of DCHQ were evaluated using three breast cancer cell lines.

Wastewater treatment plant upgrades reduce adverse reproductive effects in wild fish in the Grand River, Ontario

Lead Author: Kirsten Nikel, Department of Biology, University of Waterloo
Presenting Author: Kirsten Nikel, Department of Biology, University of Waterloo
Email address: kenikel@uwaterloo.ca
Co-Authors:
Patricija Marjan, Department of Biology, University of Waterloo
Hadi Dhiyebi, Department of Biology, University of Waterloo
Gerald Tetreault, Environment and Climate Change Canada
Mark Servos, Department of Biology, University of Waterloo

Poster #: 38

Abstract:
Municipal wastewater treatment plant (WWTP) effluent is a concern for the health of aquatic ecosystems, as it contains many contaminants that can cause a variety of adverse outcomes in aquatic life. The effluents from two large WWTPs, Kitchener and Waterloo, are discharged approximately 20 km apart into the Grand River in southern Ontario, and the effects of these effluents on native fish species has been well studied. Rainbow darter (Etheostoma caeruleum) collected downstream of these discharges have demonstrated reproductive system disruptions at multiple levels of biological organization, ranging from gene expression to tissue-level changes. The Kitchener WWTP underwent major infrastructure and process upgrades in 2012, resulting in improved effluent quality. Subsequently, stable nitrogen isotope signatures in rainbow darter shifted to upstream reference conditions, sex steroid (11-ketotestosterone and testosterone) production returned to upstream reference site levels, and there was a significant reduction in intersex incidence and severity in rainbow darter males. The Region of Waterloo has also recently upgraded the Waterloo WWTP, completing the construction in 2017. This has created a unique opportunity to continue to investigate whether responses in rainbow darter previously associated with effluent exposure will return to reference levels following the upgrades. Analytical chemistry of effluent samples will be used to assess effluent quality over the study period. Stable isotope signatures in darter muscle tissue will be analyzed to assess effluent quality and exposure to the fish. Testes In vitro steroid production of 11-ketotestosterone and testosterone and a histological assessment of intersex will also be analyzed to determine the effects of the improved effluent quality on endocrine disruption. It is important to determine how these major capital investments in WWTP upgrades are influencing the health of a sentinel species in the environment in order to support future improvements in water management policy and practice.

A physically-based approach to simulate flow regime and stream temperature in the Grand River (Ontario)

Lead Author: Luca Fabris, McMaster University
Presenting Author: Luca Fabris, McMaster University
Email address: fabrisl@mcmaster.ca
Co-Authors:
Sean Carey, McMaster University

Poster #: 39

Abstract:
Climate change is likely to have substantial effects on flow regime and stream temperature. Both are key factors regulating all the biotic and abiotic processes occurring within the river system. Developing effective measures to face climate change, is therefore fundamental to preserve and improve fresh-water habitat. Models have the dual function of improving our understanding on the consequences of global warming and enhancing our capability to develop efficient mitigating strategies. In this study, a semi-distributed regional physically based hydrological model, MESH, is coupled with a one-dimensional stream temperature model, RBM, to simulate discharge and hourly stream temperature of the Grand River, the largest catchment in south Ontario. GLUE will be considered to account for model uncertainty. Single and multi-step methods are used for model calibration against discharge and temperature records. In the multi-step, the hydrological model is calibrated first, and only behavioural models used for calibrating the temperature model. Conversely, in the single-step approach flow and thermal regimes are part of the same calibration process. Validation is carried out to test the hypothesis that single-step calibrated models should provide a more accurate description of the catchment processes and thus better performances outside the calibration period. Finally, the best performing models will be utilized to test potential impacts of different climate change scenarios on flow regime and stream temperature and to asses the viability of land use management as mitigating strategy for the Grand watershed.

Destruction of emerging pollutants by catalytic ozonation: the role of surface chemistry of carbon catalyst

Lead Author: Mohammad Mahmudul Huq, Department of Chemical and Biological Engineering, University of Saskatchewan
Presenting Author: Mohammad Mahmudul Huq, Department of Chemical and Biological Engineering, University of Saskatchewan
Email address: shafi.huq@usask.ca
Co-Authors:
Jafar Soltan, Department of Chemical and Biological Engineering, University of Saskatchewan

Poster #: 40

Abstract:
Emerging pollutants are chemical pollutants originating from pharmaceuticals and personal care products, household and agricultural chemicals. These pollutants have been recognized as one of the major stressors for the loss of freshwater biodiversity, which experienced a population decline of 81% since 1970 (Reid et al., 2018). Antibiotics, a major category of emerging pollutants, end up in waste water treatment plants (WWTPs) and finally in the water bodies, contributing to development of superbugs. Expectedly, a recent study found that urban WWTPs are hotspots for superbugs (Rizzo et al., 2013). Unfortunately, current WWTP technologies are inadequate to remove these emerging pollutants. Practical solutions to this kind of pollution include improved waste disposal management and advanced water treatment (AWT).

One AWT method is catalytic ozonation (CatOz). In CatOz, a catalyst is used to decompose ozone into hydroxyl and/or superoxide radicals. These radicals oxidize pollutant molecules into CO2 and H2O or into simpler molecules. CatOz has advantages over other AWT methods (eg. UV-ozone, UV-H2O2, H2O2-ozone), for example low cost. The heart of CatOz process is the catalyst. Researchers have studied many kinds of catalysts such as metal oxides, supported metals, activated carbon (AC) and zeolites. AC particularly stands out among them since it does not cause secondary metal pollution. However, as compared to the metal oxides, AC shows an overall poorer catalytic activity. One reason could be that the effects of AC's surface chemistry on its catalytic ability is poorly understood. Similar to AC, graphene oxide (GO) is a sp2 hybridized carbon material which has been studied by many researchers as a catalyst. Unlike AC, GO has 2D surface, thus does not have mass transfer limitations. This gives a unique opportunity to study the role of surface chemistry of sp2 hybridized carbon materials such as GO and AC without mass transfer limitation bias. The principal goal of our research is to study the role of surface chemistry (eg. density of different surface oxygen groups and defects) of GO as a catalyst in a CatOz process. This research will provide valuable information on the catalytic effects of the surface chemistry of carbon materials (i.e. AC). These information will enable us to design more effective AC for CatOz processes. We have synthesized GO by a less hazardous improved Hummer's method, reported elsewhere (Marcano et al., 2010). The as synthesized GO have been well characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy. XRD results show that the interlayer distance between GO layers is ~9.5 Å. XPS reveals that the as synthesized GO contains several oxygen functional groups including carbonyl and hydroxyl groups. This GO, when used as a catalyst for CatOz, has shown a 24% more degradation of oxalic acid (a model chemical for emerging pollutants) than single ozonation. Future work includes study of effects of surface oxygen and defect density, and individual surface groups of GO on CatOz.

Hydrologic and water quality modelling to assess the effectiveness of Best Management Practices (BMPs) in the Grand River watershed

Lead Author: Rute Pinto, Earth and Environmental Sciences, University of Waterloo
Presenting Author: Rute Pinto, Earth and Environmental Sciences, University of Waterloo
Email address: rute.pinto@uwaterloo.ca
Co-Authors:
Roy Brouwer, Department of Economics, University of Waterloo
Yongbo Liu, Department of Geography, University of Guelph
Wanhong Yang, Department of Geography, University of Guelph

Poster #: 41

Abstract:
To combat harmful algal blooms, the Great Lakes Water Quality Agreement formalized a commitment to reduce phosphorus loads into Lake Erie central and western basins by 40%. Targets have not yet been set for the eastern basin, which requires further study. It is anticipated that the Grand River watershed will be a priority for action because it is the largest contributor of phosphorus to the eastern basin. Our project focuses on agricultural sources of phosphorus as one of the largest sources of nutrients into Lake Erie. A previously developed Soil and Water Assessment Tool (SWAT; Liu et al. 2016) model for the Grand River basin was updated until 2017, covering almost 30 years of land management practices at the watershed scale. After the model recalibration and revalidation, we evaluated the environmental effectiveness of three Best Management Practices (BMP), namely Cover Crops, Nutrient Management Plan and Buffer Strips, across the watershed in reducing total phosphorous flowing into Lake Erie. Results show that Cover Crops and Nutrient Management Plans seem to be the most effective measures to reduce total phosphorous loadings at the watershed outlet, with reductions ranging between 4 to 18%. Next steps will involve the estimation of these measures' cost-effectiveness at the outlet and across the watershed.

Assessing drinking and surface water quality for the Six Nations of the Grand River, Ontario, Canada

Lead Author: Sawsan Makhdoom, Department of Biology, McMaster University
Presenting Author: Sarah Walton-Rabideau, Department of Biology, McMaster University
Email address: sarah.rabideau23@gmail.com
Co-Authors:
Patricia Chow-Fraser, Department of Biology, McMaster University

Poster #: 42

Abstract:
Sawsan Makhdoom1, Sarah Walton-Rabideau1 and Patricia Chow-Fraser1
1Wetland Ecology Lab, Department of Biology, McMaster University, 1280 Main Street West, Hamilton, ON. L8S 4L8
Impaired water quality is a major issue for Indigenous communities across Canada, including the largest populated reserve located on the Grand River, Ontario. Using mixed methods, western science researchers and traditional knowledge holders are co-developing a sampling program to monitor the quality of drinking and surface water on the Six Nations Reserve. To assess potability of drinking water, we analyzed tap-water samples for indicators of pathogenic bacteria (i.e., total coliforms) and fecal contamination (i.e., E.coli) in 75 households in the summer of 2018. To monitor ecosystem health, we measured primary nutrients (i.e., total phosphorus, total nitrate-nitrogen), limnological parameters (i.e., specific conductance, pH, dissolved oxygen, turbidity), and indicators of pathogenic bacteria and fecal contamination in McKenzie during fall 2018. More than 25% of tap water samples were contaminated with E.coli colonies, and fecal contamination levels at five locations in McKenzie Creek were above those recommended for recreational use. Corresponding nutrient levels and specific conductivity were also at levels that would compromise aquatic life in streams. The sampling program will be expanded in 2019 to include monthly sampling at McKenzie Creek as well as sites in low-order streams. We will also assess potential fecal contamination of seasonally inundated creeks in these two watersheds during flood events in 2019. These data will inform decisions to manage McKenzie and Boston Creeks to protect and enhance biodiversity and maximize ecosystem resilience within the Six Nations reserve.

Qualitative and quantitative analysis of microplastic contamination in the treatment process and in effluents of the City of Saskatoon Wastewater Treatment Plant

Lead Author: Saurabh Prajapati, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Saurabh Prajapati, School of Environment and Sustainability, University of Saskatchewan
Email address: sbp256@mail.usask.ca
Co-Authors:
Michael Beal, Saskatoon Wastewater Treatment Plant, City of Saskatoon
Saurabh Prajapati, School of Environment and Sustainability, University of Saskatchewan
Markus Brinkmann, School of Environment and Sustainability, University of Saskatchewan

Poster #: 43

Abstract:
It is a well-established fact that microplastic particles are abundantly present in the aquatic ecosystem. Wastewater treatment plants have been considered as an important channelling system of microplastics in the environment. Major sources of microplastics are microbeads from cosmetic products and microfibers from clothes that are washed down in the municipal wastewater line. The purpose of this study is to carry out a qualitative and quantitative analysis of microplastic contamination in the treatment processes and certain effluent streams of the City of Saskatoon Wastewater Treatment Plant (WWTP). Effluent streams will include wastewater after screening, primary treatment, secondary treatment, and the final discharge that is directed to the South Saskatchewan River. A reference data set was prepared by characterizing known plastic samples using FTIR Microscopy at the Saskatchewan Structural Science Centre. Subsequently, waste water and sludge samples will be taken at multiple intervals, ideally covering various flow conditions, with the assistance of City of Saskatoon WWTP. Once the samples from different stages of treatment are acquired, extraction of microplastics from wastewater sample would be executed in order to analyse and compare the results with the previously developed reference data set. A comparison will be drawn from the observations of the present study with results obtained from other WWTPs across Canada and globally. Based on these results, an attempt to propose strategies will be made to reduce microplastic contamination in effluent streams of WWTPs, and synthesize lessons-learned and recommendations for other treatment plants based on the experiences from the Saskatoon plant. Also, light will be shed on potential soil contamination through microplastics in sludge originating from activated sludge process (ASP), which is dried and subsequently used as fertiliser. These results will have implications for understanding the seriousness of microplastic contamination of the environment and by daily-use products.

Water Quality Studies at Appomattox River Watershed in Virginia: Importance of Urban Trees in Reducing Storm Water

Lead Author: Shobha Sriharan, Department of Agriculture, Virginia State University
Presenting Author: Shobha Sriharan, Department of Agriculture, Virginia State University
Email address: ssriharan@vsu.edu
Co-Authors:
Darlette Meekins, Department of Agriculture, Virginia State University
Essence Georges, Department of Agriculture, Virginia State University
Darrell Logan, s, Department of Agriculture, Virginia State University
Stacy Nelson, Department of Forestry and Environmental Resources, North Carolina State University

Poster #: 44

Abstract:
The James River watershed, one of the largest contributors to the Chesapeake Bay watershed, stretches from the western border of Virginia east to the mouth of the river in the Hampton Roads area. The Appomattox River, which flows from Lake Chesdin to Hopewell Point, feeds into the James River. A successful nutrient and sediment reduction strategy will have significant impacts on the water quality of the creeks, streams, and rivers that feed into the James River and associate coastal basins. The hypothesis of this research is that trees intercept and absorb precipitation (up to 70%) that allows the slow absorption of the precipitation into the aquifer as opposed to allowing run off and erosion from the area. These urban trees can reduce the problem of water pollution by contaminates, such as the fertilizers and pesticides from the farming practices around the Appomattox River. The goal of this study is to determine the relationship of tree canopy, vegetation cover, and topography to the quantity of run off and the deposition of soil and chemical pollutants in the tested areas. The study sites included Lake Chesdin, the cities of Petersburg, Colonial Heights, and Hopewell, and Randolph Farms of Virginia State University. The methodology included tree inventory, mapping the location of the trees, water quality monitoring of the samples at the study sites, and entering all data into the ArcGIS software for analysis. For making the tree inventory, each tree was geo-tagged and measured for specifics such as the trunk's diameter at breast height (DBH), height, and canopy breadth, and graded according to i-Tree eco specs (25ft upstream and downstream). Also noted was the topography of the area and the shrub vegetation cover from the water edge to 25ft. away from the water's edge. Using the books on Taxonomy and Trees of Virginia aided in the identification of the trees. The water quality was monitored for the following: nutrient contents (nitrates and phosphates) and pH by using the La Monte Water Quality Monitoring Equipment, turbidity by the Turbidometer, and dissolved oxygen (YSI 550A). The presentation will include the results on the location of urban trees and water quality parameters (nitrates, phosphates, dissolved oxygen, and turbidity) to interpret the importance of conservation of trees along the Appomattox River. The spatial analysis studies of Randolph Farm and Appomattox River Watershed was done to demonstrate the classification of the satellite images obtained from the USGS. The supervised and unsupervised classification operations were used to determine land categories within the Randolph Farm agricultural area and Appomattox River. The accuracy of each of the classification results were assessed by calculation of a thematic accuracy assessment and individual class accuracies, in addition to evaluation of Kappa coefficient estimates. Using ArcGIS, mapping was done to show the river and surrounding topography. We hope the studies will help in informing property owners, city planning officials, farmers, and industry to plan for the planting of trees for the increase in buffering of water contamination to the Appomattox River watershed.

Inflammation of gill epithelia in fish causes increased permeation of polar organic chemicals via disruption of tight junctions

Lead Author: Ulyana Fuchylo, Toxicology Centre, University of Saskatchewan
Presenting Author: Ulyana Fuchylo, Toxicology Centre, University of Saskatchewan
Email address: ulf077@mail.usask.ca
Co-Authors:
Hattan Anharbi, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia
Paul Jones, School of Environment and Sustainability, University of Saskatchewan
Markus Hecker, School of Environment and Sustainability, University of Saskatchewan
Markus Brinkmann, School of Environment and Sustainability, University of Saskatchewan

Poster #: 45

Abstract:
In fish, the gill epithelial layer controls paracellular permeation of chemicals through epithelial tight junctions. Previous research has indicated that the integrity of epithelial tight junctions can be adversely impacted by gill inflammation. A loss of junction integrity could lead to greater uptake of harmful contaminants, effectively increasing their toxicity. In this study we attempted to elucidate if inflammation could induce disruption of tight junctions in fish gill epithelia, and if this in turn increases passive transport of chemicals across the epithelia. Inflammation was experimentally induced in a permanent rainbow trout gill cell line (RTgill-W1) through exposure to non-cytotoxic concentrations of lipopolysaccharide (LPS). Transepithelial electrical resistance (TEER) was used to indicate epithelial tight junction integrity. Cells were also co-exposed to LPS and oil sands process-affected water (OSPW) to determine if the hypothesized reduction in tight junction integrity would result in greater transport of OSPW from apical to basal side of a permeable cell insert membrane. Quantitative real-time PCR (qPCR) was carried out to characterize changes in transcript abundance for genes responsible for tight junction proteins (e.g. Claudins). Cells exposed to LPS showed significant reduction in TEER after 24 h of exposure. qPCR data showed that the abundance of transcripts of genes coding for tight junction proteins (i.e. Claudin 28b and 10e) were significantly decreased in cells exposed to 20, 50, and 100 mg/L LPS. Chemical analyses on OSPW content of basal chamber media showed a significant increase in transport of OSPW from apical to basal chamber of permeable cell inserts at all concentrations of LPS. An in vivo exposure of fingerling rainbow trout to dietary LPS and waterborne OSPW was carried out to confirm in vitro results. Chemical analysis showed an increase in OSPW content in fish exposed to both LPS and OSPW for 48 h, compared to fish exposed to OSPW alone. Thus, in vitro findings that inflammation of the gill epithelia can affect tight junction integrity, resulting in increased transport of OSPW across the epithelia were confirmed in vivo. These results indicate that fish living in environments high in pathogens would be at risk of greater uptake of contaminants than previously thought, indicating that we may need to adjust and re-evaluate current risk assessment practices and regulations to account for this enhanced contaminant uptake.

Evaluating soil water and temperature controls on soil carbon balance in a deciduous forest in the Great Lakes region

Lead Author: Yueqian Ma, School of Geography and Earth Sciences, McMaster University
Presenting Author: Yueqian Ma, School of Geography and Earth Sciences, McMaster University
Email address: may118@mcmaster.ca
Co-Authors:
Eric Beamsdefer, School of Geography and Earth Sciences, McMaster University
M. Altaf Arain, School of Geography and Earth Sciences, McMaster University

Poster #: 46

Abstract:
Soil water content and temperature are major controls on the soil carbon budget in forest ecosystems. Stored organic matter within the ecosystem is released into the atmosphere through heterotrophic and autotrophic activity referred to as soil respiration (Rs). An appropriate soil respiration model can assist in forest management and improve understanding of major environmental controls under future climate change. We collected and evaluated half-hourly data in the Global Water Futures (GWF) – Southern Forests Water Future (SFWF)'s Turkey Point Deciduous Observatory from a closed-path eddy covariance system as well as automatic soil CO2 efflux chambers (LI – 8100A) which monitored Rs continuously since July 2014. Observed monthly mean Rs varied from a maximum of 7.50 µmol/m2/s in July to a low of 1.11 µmol/m2/s in December and showed a seasonal trend driven by soil temperature and water content. Four models: a general exponential regression model (Rs_Ts), Q10 with a logistic soil moisture function model (Rs_Ts*SM), the Q10 model (Rs_Q10), and average and monthly Q10 model (Rs_MQ10) were used to analyze Rs and soil temperature and soil water content controls. Comparison of the four models showed that the Rs_Ts*SM model is best with an average yearly coefficient of determination of 0.68. The Rs_Ts*SM model shows that by incorporating soil water content, it is able to improve upon models such as Q10 that utilize soil temperature only to predict respiration. Study results show that Rs measurement and modeling studies should account for seasonal variations of temperature and water content within the soil. In addition to soil water content, future studies should focus on other factors such as soil pH, organic content, and nutrients.

Water Quality Modelling of Heavy metals in the Lower Athabasca River

Lead Author: Zachary Lang, Global Institute for Water Security, University of Saskatchewan
Presenting Author: Zachary Lang, Global Institute for Water Security, University of Saskatchewan
Email address: zachary.lang@sasktel.net
Co-Authors:
Karl-Erich Lindenschmidt, Global Institute for Water Security, University of Saskatchewan

Poster #: 47

Abstract:
The Lower Athabasca River (LAR) is located in North Eastern Alberta. It is the span of the Athabasca River that begins near Fort McMurray and ends at the Peace Athabasca Delta. Areas upstream of the LAR and along its banks have been subject to increased industrialization over the last few decades. One industrial activity worth noting is the intensive extraction process of removing petroleum from the Alberta oil sands. This takes place adjacent to portions of the LAR. The LAR itself has a high turbidity and a high concentration of heavy metals. The concentrations of heavy metals are a cause of concern and problems could manifest in the future if concentrations continue to rise. These problems could be exacerbated during periods of low flow. The purpose of this project is to develop a toxicant model of the LAR using Water Quality Analysis Simulation Program (WASP). WASP will simulate the fate and transport of heavy metals in the LAR. HEC-RAS, a hydrodynamic modelling software, will be used to create a hydrodynamic model of the LAR. Flow, volumes and velocities will be inputted into WASP from HEC-RAS. MEC-Surface & Hydrology System (MESH) is a modelling software used to simulate catchment drainage, providing resultant hydrological conditions. A MESH model has been developed for the region upstream of the LAR and it will be used to project future flow conditions. These values will then be inputted to HEC-RAS and in turn inputted into the WASP toxicant model. This will allow the WASP model to predict future heavy metal concentrations. Forecasting future heavy metal concentration could be of considerable interest if the effects of climate change cause water quality conditions to deteriorate. If educated predictions are made, then more precise counter measures can be developed in the present.

Water contamination resulting from oil and high-salinity wastewater spills on land in Western Canada

Lead Author: Rima Bouslama, Department of Civil, Geological and Environmental Engineering, University of Saskatchewan
Presenting Author: Rima Bouslama, Department of Civil, Geological and Environmental Engineering, University of Saskatchewan
Email address: rib519@usask.ca
Co-Authors:

Poster #: 48

Abstract:
Water contamination and quality issues play a central role in many of today's environmental sustainability challenges. A significant cause of water contamination relates to the oil and gas industry's growing anthropogenic activities.

The most deleterious impacts observed on both shallow- and deep-groundwater sources, relate to both the scale and scope of exploitation activities, and constitute a critical environmental threat for ecosystems and public health.

In Western Canada, several hundred cases of water contamination resulting from oil and high-salinity wastewater spills on land have been recorded. These leaks have occurred both at the well sites and in transmission lines.

While it may never be possible to prevent or eliminate spills completely, it is critically important that the proper protocols, procedures, and equipment are in place to limit their frequency and mitigate their harmful effects. In order to do so, it will first be necessary to catalogue previous spills, and document the relevant observations including, but not limited to the following: a) types of spilled oil and b) composition of product water.

A comparative analysis of the available data, including governmental, regulatory and industry reports, will serve to identify discrepancies between reported and actual volumes spilled and the content of said spills. In so doing, this project will provide deeper insights into the effectiveness of existing remediation efforts, and the likelihood of downward transport of contaminants into the underlying aquifers.

Ultimately, this paper will make two main inter-related contributions - better informing our collective understanding of the legacy effects of oil spills in Western Canada, thereby enhancing existing remediation and regulatory regimes. Based on the current frequency of adverse events, it is clear that such enhancement is necessary.

Expanding DNAzyme-Based Sensors through Single Modification at the Cleavage Site

Lead Author: Po-Jung Jimmy Huang, Chemistry Department, University of Waterloo
Presenting Author: Po-Jung Jimmy Huang, Chemistry Department, University of Waterloo
Email address: p8huang@uwaterloo.ca
Co-Authors:
Juewen Liu, Department of Chemistry, University of Waterloo
Donatien de Rochambeau, Department of Chemistry, McGill University
Hanadi Sleiman, Department of Chemistry, McGill University

Poster #: 49

Abstract:
DNAzymes, also known as deoxyribozymes or DNA enzymes, refer to single-stranded DNA molecules with catalytic capabilities. In vitro selection of RNA-cleaving DNAzymes is a powerful method for isolating metal-specific DNA. Although few successful examples are known, it is still difficult to target some transition metals due to limited functional groups in DNA. For instance, high thiophilicity is a common feature of many toxic metals including cadmium and mercury, but natural DNA does not contain sulfur, which might be a reason for the lack of unmodified DNAzymes for them. While using modified bases expands the chemical functionality of DNA, such modification is not commercially available. In addition, those selections are technically demanding and their analytical applications have not been widely pursued. Here, we reasoned that a single modification near the substrate RNA cleavage site might bring sufficient affinity for metal binding. Without complicating the selection process, new DNAzymes with excellent specificity and sensitivity were obtained.

Does crop rotation have significant impact on water quality?

Lead Author: Nayyer Mirnasl, Geography, University of Waterloo
Presenting Author: Nayyer Mirnasl, Geography, University of Waterloo
Email address: snmirnas@uwaterloo.ca
Co-Authors:
Peter Deadman, Geography, University of Waterloo
Anna Frank, Environment, resources and sustainability, University of Waterloo

Poster #: 50

Abstract:
One of the tools used in agricultural watersheds to mitigate the excessive transfer of nutrients into water bodies is the implementation of Beneficial Management Practices (BMPs). The main purpose of modeling agricultural BMPs is to evaluate their efficiency and estimate their impact on reducing nutrient transfer into bodies of water. In the Thames river basin and the Medway Creek sub-watershed, cover crops, crop rotation, Vegetative Filter Strip (VFS), fragile land retirement, conservation tillage, windbreaks, and erosion control structures are among the widespread types of BMPs implemented. The purpose of this modeling study is to simulate a set of scenarios to quantify the impact of BMPs on P loading and delivery into the Medway Creek. Crop rotation and VFS were explored to estimate the potential benefits of BMPs at the sub-watershed level by developing multiple scenarios based upon the "level-of-implementation" and "targeted/random" spatial distribution factors. The focus of this poster presentation is on illustrating the results of different scenarios for the crop rotation BMP only. The first run represents the random distribution (status quo) of crop rotation in the area (baseline scenario). The second run illustrates a targeted selection of sub-basins with the highest yield of P loads. For the second run, the sub-basins with the highest P loads are selected considering the results of the baseline scenario. This study uses a hydrological model (SWAT) to explore possible connections between crop rotation patterns and P loading. The study also explores how a simulation could be used to determine the target locations or critical source areas for BMP application. This, in turn, could maximize sediment and nutrient load reduction in the Medway Creek sub-watershed and increase the overall aquatic health across the basin.

Periphyton as a bioassessment tool for low-order streams in the Grand River Watershed

Lead Author: Alana Tedeschi, Department of Biology, McMaster University
Presenting Author: Alana Tedeschi, Department of Biology, McMaster University
Email address: tedescac@mcmaster.ca
Co-Authors:
Patricia Chow-Fraser, Department of Biology, McMaster University

Poster #: 51

Abstract:
Eutrophication in streams is a pressing global problem threatening aquatic habitat quality, especially in large agriculturally-dominated watersheds such as the Grand River Watershed (GRW). While there has been long-term nutrient monitoring in the GRW, most of the sites are located on larger tributaries, or the Grand River itself, rather than the low-order streams where single nutrient sources and effectiveness of best management practices can be measured. Also, recent studies have linked algal bloom biomass to rising soluble reactive phosphorus (SRP) levels in the western basin of Lake Erie, yet most existing monitoring programs do not monitor SRP. Biotic indicators of stream quality holistically provide accurate estimates of water quality in streams, eliminating the need for data on specific parameters while optimizing ecosystem-based monitoring initiatives. An example is periphytic algae that respond directly to increases of nutrients. We have created a volunteer-based monitoring program for low-order streams in the GRW using periphyton as a bioassessment tool, which is also statistically related to SRP in streams ($p = 0.0046$; $r2 = 0.425$). Further, we related the extracted chlorophyll content (□g/L) of periphytic algae to its true colour (measured in RGB values; $p < 0.0001$; $r2 = 0.92$) and created a CHL-RGB standard curve. As such, our program only requires an inexpensive colour sensor and the CHL-RGB standard curve to measure periphytic algae, replacing traditional costly equipment. Our pilot program will run this summer (2019), and participating volunteers from across the GRW will collect and process periphytic algae samples in this way. This volunteer-based monitoring initiative will be the first of its kind to collect standardized and comparable data indicative of SRP from low-order streams throughout the GRW.

Effects of pesticides on wetland aquatic invertebrate communities and strategies for mitigation using vegetated buffer zones

Lead Author: Andrea Wade, Toxicology Center, University of Saskatchewan
Presenting Author: Andrea Wade, Toxicology Center, University of Saskatchewan
Email address: andrea.wade.95@gmail.com
Co-Authors:
Karsten Liber, Toxicology Center, University of Saskatchewan
Christy Morrissey, Biology Department, University of Saskatchewan

Poster #: 52

Abstract:
Wetlands in the Prairie Pothole Region of North America are a valuable resource to humans and the environment alike. Intensive agriculture has led to the loss and degradation of wetlands in this region. Many wetlands are drained for conversion to agriculture and those that remain are often closely surrounded by crop with little to no natural vegetation buffer. These remaining Prairie Pothole wetlands are frequently contaminated by pesticides. This project investigates the potential effects of pesticides on Prairie Pothole wetland invertebrate communities and how pesticide contamination might be mitigated by restoring or maintaining perennial vegetation areas. In June 2018, 32 Saskatchewan wetlands in cereal or canola fields were sampled for aquatic invertebrates and pesticide contamination. Aquatic invertebrates were collected using the Canadian Aquatic Biomonitoring Network (CABIN) protocol for wetlands. Pesticide contamination was measured in water samples collected at the same time and analyzed by HPLC-MS for over a hundred different pesticides including herbicides, fungicides, and insecticides commonly used in the area. Pesticide concentrations were converted to toxicity indexes (PTIs) and modeled with other wetland and water quality metrics for their potential effect on aquatic invertebrate species abundances. All 32 wetlands sampled in 2018 were contaminated with one or more pesticides. The majority of wetlands contained a mixture of three or more pesticides with some wetlands containing as many as nine. Current work includes modeling data and examining how vegetated buffer zones (VBZs) can mitigate pesticide contamination of wetlands and their effects on aquatic invertebrates. VBZs are plantings of perennial vegetation cover around a body of water with the goal of reducing runoff from agriculture into the water. Although VBZs are used in many conservation easements, there is little scientific understanding of how to best implement VBZs to attain the greatest water quality, agronomic, and ecosystem service benefits of wetlands. In summer 2019, wetlands in canola and cereal fields that have planted VBZs in different configurations will be compared to assess effects on wetland health and agricultural productivity of the field. Wetland health will be evaluated based on the degree of pesticide contamination and on aquatic invertebrate biodiversity of the wetland. Invertebrate and water samples will be collected in June, following the same methods used in 2018. Quarter section crop yields standardized to area of crop will be used to determine agricultural productivity of individual fields. Identifying what VBZ implementation techniques have the greatest benefits to wetland water quality and ecosystem health will allow land owners and conservation organizations to design and prioritize incentive programs that best protect our wetland resources in working prairie landscapes.

In vitro-in vivo and cross-life stage extrapolation of uptake and biotransformation of benzo[a]pyrene in the fathead minnow

Lead Author: Chelsea Grimard, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Chelsea Grimard, School of Environment and Sustainability, University of Saskatchewan
Email address: chelsea.grimard@usask.ca
Co-Authors:
Annika Mangold-Döring, Insitute for Environmental Research, RWTH Aachen University, Germany
Markus Schmitz, Insitute for Environmental Research, RWTH Aachen University, Germany
Markus Hecker, School of Environment and Sustainability, University of Saskatchewan
Markus Brinkmann, School of Environment and Sustainability, University of Saskatchewan

Poster #: 53

Abstract:
An ever-increasing number of chemicals are used in our society that are eventually released into the environment. Current regulations to assess toxicological risks associated with these chemicals rely on extensive live-animal testing. Because of the costs and ethical concerns with regard to animal testing, the 3R principle (i.e., reduction, replacement, refinement) demands that animal experiments should be substituted with alternative test methods whenever possible. Computational models have been proposed as powerful in silico alternatives to animal experiments. Among these, toxicokinetic (TK) models have received particular attention because they can be used to predict the time course of a toxicant's concentration at the target site. Thus, they are not only useful to inform bioaccumulation assessments, but also help interpreting and extrapolating toxicological effect data. Current TK models are shown to be highly accurate for neutral organic chemicals if species specific chemical biotransformation is accounted for. Potential inter-species and life stage differences in biotransformation kinetics, however, are currently not well-understood. To bridge this gap, the goal of this study was: (a) to characterize in vitro transformation kinetics of the rapidly biotransformed model chemical benzo[a]pyrene (BaP) during different life stages of the fathead minnow (Pimephales promelas) using the S9 stability assay, (b) to develop and apply TK models for early life stage and adult fathead minnows to extrapolate biotransformation from in vitro to in vivo, and (c) to validate model predictions using data from in vivo flow-through exposures to graded concentrations of water-borne BaP. In addition to the study of substrate depletion, we will also account for life stage-dependent relative abundances of different BaP metabolites through ultra high-performance liquid chromatography and high resolution accurate mass mass spectrometry (UPLC-HRAM MS). Because different BaP metabolites have been shown to be associated with different toxicological effects, our models may also help to understand life stage-dependent differences in toxicological effects. In a next step, we will also characterize inter-species differences in biotransformation. Based on data acquired to date, we conclude that toxicokinetic models in combination with in vitro assays are a powerful alternative to in vivo experiments and can also account for life stage-specific differences in biotransformation.

Cross-species compartmental modeling of selenium in fishes exposed to selenomethionine via ingestion

Lead Author: Derek Green, Toxicology Centre, University of Saskatchewan
Presenting Author: Derek Green, Toxicology Centre, University of Saskatchewan
Email address: d.green@usask.ca
Co-Authors:
David Janz, Toxicology Centre, University of Saskatchewan
Karsten Liber, Toxicology Centre, University of Saskatchewan
Markus Brinkmann, School of Environment and Sustainability, University of Saskatchewan
Markus Hecker, School of Environment and Sustainability, University of Saskatchewan

Poster #: 54

Abstract:
Selenium (Se) is a trace element and essential nutrient for almost all forms of life. However, it is also a common component and/or contaminant in industrial and agricultural activities and effluents, and can be toxic when encountered in excess. Where aquatic environments are inundated with Se the biota show increased Se concentrations, presumably in the bioaccumulative form of selenomethionine (SeMet), a naturally occurring organic methionine analogue. Many organisms that ingest SeMet show increased risk of toxicity commensurate with exposure, and oviparous animals show increased maternal transfer of Se to their eggs, which can cause significant teratogenicity of exposed embryos. Though the primary mechanism identified for SeMet toxicity is the redox cycling of its metabolite methylselenol, not all fish species exposed to SeMet manifest symptoms of oxidative stress, suggesting alternate toxicity pathways may exist. The non-specific substitution of SeMet for methionine presents a vast number of ways in which SeMet might disrupt animal physiology, including an enhanced propensity of protein oxidation, disruption of methylation cycles, and alternative regulation of SeMet and methionine molecules and metabolites, including homocysteine, which could have broad ramifications for numerous animal systems. Cross-species systemic partitioning models can therefore be employed to characterize the relative organ sensitivities within and across species, which can then be compared with species specific SeMet pathologies to help identify the broader suite of mechanistic pathways affected by SeMet. This information can then be used to direct targeted explant and/or in vitro studies, which will enhance our mechanistic understanding of SeMet toxicity, and lead to better Se risk assessment while reducing expenditure of time, money, and animal life.

Ecological Risk Assessment of pesticides in wetlands of the Prairie Pothole Region

Lead Author: Egina Malaj, Toxicology Centre, University of Saskatchewan
Presenting Author: Egina Malaj, Toxicology Centre, University of Saskatchewan
Email address: egina.malaj@usask.ca
Co-Authors:
Karsten Liber, Toxicology Centre, University of Saskatchewan; School of Environment and Sustainability, University of Saskatchewan
Christy Morrissey, Department of Biology, University of Saskatchewan; School of Environment and Sustainability, University of Saskatchewan

Poster #: 55

Abstract:
Wetlands are important and complex freshwater ecosystems in the Canadian Prairie Pothole Region (PPR). This research project focuses in identifying the ecological threats related to the use of pesticides in the PPR. Firstly, a pesticide distribution model was developed to prioritize areas for large-scale pesticide sampling in wetlands. Secondly, a two-year Prairie wide monitoring campaign was conducted covering 300 individual wetlands and chemically analyzing for more than 170 pesticides (insecticides, fungicides and herbicides). The measured pesticide concentrations in the field were compared to the ecotoxicological relevant concentrations of pesticides in order to quantify the potential ecological risk for non-target aquatic species. Approximately 50% of the sites were chronically, long-term affected by insecticides and 10% were acutely, short-term affected by insecticides. The ecological risk was widespread throughout the Prairies with crops like wheat, canola and pulses contributing equally to the risk. Apart from being the first ecological risk assessment of pesticides performed in the PPR, this analysis introduces a comprehensive and systematic scheme for large-scale monitoring of wetlands.

Optimization of brook trout environmental DNA collection methods

Lead Author: Erika Burton, Biology, University of Waterloo
Presenting Author: Erika Burton, Biology, University of Waterloo
Email address: eaburton@edu.uwaterloo.ca
Co-Authors:
Dr. Patricija Marjan, Biology, University of Waterloo
Hadi Dhiyebi, Biology, University of Waterloo
Dr. John Giesy, Veterinary Biomedical Sciences and Toxicology, University of Saskatchewan
Dr. Mark Servos, Biology, University of Waterloo

Poster #: 56

Abstract:
Aquatic organisms continually shed cellular and extracellular DNA into their environs. By sampling their habitat for environmental DNA (eDNA) it is possible to detect and monitor aquatic multicellular organisms. This sensitive and non-invasive technique allows for species in low numbers to be detected in the environment. However, the newness of this field leaves areas of uncertainty with regards to best practices and potential biases in the methodology. The objective of this study was to identify and reduce uncertainties in eDNA methodology, primarily how physical disturbances such disruption of creek sediment influence the recovery of brook trout eDNA in lotic systems. DNA is known to adsorb to sediment in aquatic systems, therefore when the stream bed is disturbed, and sediments are mobilized there is the potential for an artificial inflation of eDNA concentration, leading to biases and/or inaccurate conclusions. This was completed in Washington Creek, a first order stream in the Grand River watershed with a characterized brook trout population. Water samples from the stream were collected before and after simulated disturbance events in stream areas upstream and downstream of the disturbance then filtered, extracted, and amplified via qPCR (for brook trout). The effects of physical disturbance on positive control field methodology were also evaluated by comparing disturbed and undisturbed water containing a known amount of brook trout biomass. Disturbed water showed decreased eDNA recovery due to inhibitors present in turbid water prevented DNA amplification, resulting in lower eDNA yield. Next steps for inhibitor evaluation and removal have been identified. Once biases and knowledge gaps in eDNA practices are addressed it can become a powerful tool for monitoring aquatic organisms, including species at risk.

Wastewater Effluent Effects on Metabolism of Darter Species (Etheostoma spp.) in the Grand River

Lead Author: Rhiannon Hodgson, Department of Biology, University of Waterloo
Presenting Author: Hadi Dhiyebi, Department of Biology, University of Waterloo
Email address: rmhodgso@uwaterloo.ca
Co-Authors:
Wayne Parker, Civil and Environmental Engineering, University of Waterloo
Mark R. Servos, Department of Biology, University of Waterloo
Paul M. Craig, Department of Biology, University of Waterloo

Poster #: 57

Abstract:
Effluent released from municipal wastewater treatment plants contains harmful contaminants that affect fish populations living in receiving waters. The physiological effects of effluents on common darter (Etheostoma spp.) species are largely understudied. Metabolism is a measure of total energy demand of the body, making it a useful bioindicator for physiological changes due to contaminant exposure. Additionally, the gills have major physiological functions such as respiration and osmoregulation. Impairment of these functions due to effluent contamination may be reflected in changes in energetic demand and gill physiology. In this experiment, the impacts of effluent exposure and seasonal variation on metabolism and gill physiology of three closely related species of darters (rainbow, greenside, and fantail) are investigated. Fish were collected from sites upstream and downstream of effluent-receiving waters. Metabolism, osmoregulatory activity, and gill histopathology were measured using closed-chamber respirometry, enzyme assays, and histological analysis, respectively. This study aims to link changes in metabolism and gill physiology to whole effluent toxicity in the Grand River to better understand physiological compensation occurring in contaminated environments.

Variation in the trophic ecology of walleye in the southern Grand River at the Lake Erie interface

Lead Author: Hillary Quinn-Austin, Biology, University of Waterloo
Presenting Author: Hillary Quinn-Austin, Biology, University of Waterloo
Email address: hillquinnaustin@gmail.com
Co-Authors:
Tom MacDougall, Ontario Ministry of Natural Resources and Forestry
Hadi Dhiyebi, Biology, University of Waterloo
Rebecca Rooney, Biology, University of Waterloo
Mark Servos, Biology, University of Waterloo

Poster #: 58

Abstract:
Ontario's inland fisheries are the largest in the world and are estimated to contribute $2.5 billion to the economy annually. Lake Erie supports the largest commercial and recreational walleye fishery of the Great Lakes, and requires a diverse mesotrophic environment to maintain stable populations. The walleye population of the southern Grand River in eastern Lake Erie is considered depressed due to the compounding impacts of habitat degradation and restricted access to spawning grounds by a low-head dam, making the Grand River a priority management area for walleye restoration. The Grand River walleye population provides an important source of recruitment and genetic diversity to eastern Lake Erie, making it crucial to investigate factors influencing year-class success. This study used stable isotope analyses of nitrogen and carbon to test for spatial changes in the trophic ecology of young-of-the-year (YOY) walleye between three habitat segments of the southern Grand River. Variation in trophic position and carbon source were observed between the lotic upper-river segment, the degraded Dunnville Dam reservoir, and the lake-effect zone at the river mouth. Primary consumers collected from each segment were used to account for spatial variability in the baseline organic matter sources, which can impact interpretation of stable isotope analyses. YOY trophic ecology was then compared to fish condition, an important factor in understanding year-class strength. Our next steps are to link our understanding of YOY walleye to mature walleye spawning activity using acoustic telemetry data, which can be used to determine the movement patterns and spawning habitat of mature walleye in the southern Grand River. This project will aid in advancing monitoring and management practices that protect and enhance both the health of the southern Grand River and the Lake Erie walleye fishery.

Comparing the Transport of Environmental DNA and Free DNA in a Fluvial System

Lead Author: Jacqueline Peters, Earth and Environmental Sciences, University of Waterloo
Presenting Author: Jacqueline Peters, Earth and Environmental Sciences, University of Waterloo
Email address: j29peters@uwaterloo.ca
Co-Authors:
Patricija Marjan, Biology, University of Waterloo
Mark Servos, Biology, University of Waterloo
David Rudolph, Earth and Environmental Sciences, University of Waterloo
John Giesy, Veterinary Biomedical Sciences and Toxicology Centre, University of Saskatchewan

Poster #: 59

Abstract:
The collection of environmental DNA (eDNA) is an affordable and non-invasive technique for aquatic species monitoring. However, there remain several knowledge gaps in terms of transport behaviour due to its complexity and polydisperse nature. Tracking eDNA through a medium and characterizing its transport allows for better understanding of its capture, isolation and its downstream applicability as a species monitoring tool. Existing literature shows that eDNA does not behave as a conservative tracer in the environment as it exists as a complex mixture of particles with different properties. However, its components may behave similarly to free DNA (fDNA) through a fluvial system. In such a system, eDNA may be transported through repeated sorption and resuspension events, where the eDNA properties and sediment characteristics are a controlling factor. To assess the differences in transport between fDNA (e.g., synthetic) and eDNA (e.g., from fish), a controlled tracer study will be conducted in Washington Creek, a tributary of the Grand River watershed in southern Ontario. Water samples containing an fDNA tracer and eDNA from caged fish species, that has not been previously detected in this stream, will be released simultaneously in the system. Following this, water samples will be collected at various distances from the source and at specific time points. Water samples will be filtered within 24 hours, extracted, and amplified using a quantitative polymerase chain reaction (qPCR). We suspect the behaviour of eDNA will differ from that of fDNA in a fluvial system. fDNA may favour sorption to clay minerals, but whether eDNA behaves the same way will be further explored. To further support our hypothesis and field-based results a series of laboratory experiments will be conducted involving the exposure of eDNA and fDNA to multiple substrate types. The sorptive behaviour of eDNA and fDNA will be contrasted using controlled flow-through columns and batch sorption experiments. Understanding the fate of different forms of eDNA relative to a conservative tracer will allow for mapping of hydrological pathways in streams and help to interpret eDNA signals. In addition, this will help optimize the standard operating procedure for isolation of various forms of eDNA present in aquatic systems.

Mercury sensing by DNA: Field-deployable routine detection of trace-level aqueous Hg2+

Lead Author: Kunfu Pi, Ecohydrology Research Group, University of Waterloo
Presenting Author: Kunfu Pi, Ecohydrology Research Group, University of Waterloo
Email address: kpi@uwaterloo.ca
Co-Authors:
Juewen Liu, Department of Chemistry, University of Waterloo
Fereidoun Rezanezhad, Ecohydrology Research Group, University of Waterloo
Philippe Van Cappellen, Ecohydrology Research Group, University of Waterloo

Poster #: 60

Abstract:
Water contamination by heavy metals has been a serious environmental problem, posing increasing threats to water security globally. In particular, mercury (Hg), due to its high neurotoxicity and bioaccumulation, causes severe health risks to human beings and wildlife even at very low concentrations. Concerns on Hg contamination of drinking water and other water resources have induced the routine monitoring of Hg in water as an essential part of water quality management around the world. However, the current methods sensitive and reliable enough to detect low levels of Hg are laboratory-based, time-consuming and expensive, making them inadaptable for routine use and field situations. In this study, we present an emerging biosensor based on deoxyribonucleic acid (DNA) molecules that can be specifically synthesized and modified to in-situ sense Hg2+ in water. The selected thymine-rich DNA sequence shows high binding specificity of Hg2+, and via integrating the DNA molecules into a hydrogel the environmental biosensor developed has a detection limit of ≤ 10 nmol/L Hg2+ by fluorescence signaling method. The Hg biosensor was found to maintain a consistently satisfactory performance under pH range of 4 - 10, temperature range of 5 - 50 ◦C, and in the presence of inorganic components typically for freshwater environments. Possible interferences include the complexation of Hg2+ by chloride and natural dissolved organic matter (NDOM) when they are present at moderate-high concentrations. To account for interferences caused by competitive binding, a hydrochemical model was developed based on the open access code CHEAQS Next which includes the Humic Ion-Binding Model VII. The modeling results confirm that a single complexation reaction between Hg2+ and the DNA molecule could reproduce the results from the entire set of experimental conditions, from simple electrolyte solutions to complex aqueous compositions simulating those found in the Laurentian Great Lakes. We further demonstrate that the DNA-based biosensor can be combined with the diffusive gradients in thin films (DGT) technique to achieve simultaneous sampling and sensing of ultra-low Hg2+, thereby expanding its application prospect in other field situations including soil and sediment environments. This Hg biosensor exhibits the potential to provide instrument-free, fast, flexible and routine detection methods for aqueous Hg2+. Similar DNA-based biosensors can be developed for the routine monitoring of other toxic metals in natural aquatic environments.

A Novel Multi-Species Physiology-Based Toxicokinetic Modelling Approach in Support of Ecological Risk Assessment

Lead Author: Markus Brinkmann, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Markus Brinkmann, School of Environment and Sustainability, University of Saskatchewan
Email address: markus.brinkmann@usask.ca
Co-Authors:
Annika Mangold-Döring, Institute for Environmental Research, RWTH Aachen University, Germany
Chelsea Grimard, Toxicology Centre, University of Saskatchewan
Henner Hollert, Institute for Environmental Research, RWTH Aachen University, Germany
Markus Hecker, School of Environment and Sustainability, University of Saskatchewan

Poster #: 61

Abstract:
The production and release of chemicals by our society has been described as one of the greatest threats to the sustainability of human activities on this planet. Chemical legislations of varying rigor have been implemented globally which seek to minimize impacts of chemicals on the environment through environmental risk assessments (ERA). The foundation of ERA are standardized toxicity data which are generated in laboratory experiments with model species. These species, however, might not necessarily be most representative of environmentally relevant native species in an ecosystem. Furthermore, a wealth of data from non-model species is available in the scientific literature but cannot be utilized in ERA because of the non-compliance with test guidelines. In context of the 3R concept (replacement, reduction, and refinement of animal testing), it would be ideal to use, e.g., models to transpose these datasets into a format that is useful in ERA and help avoid unnecessary animal experiments. Physiologically based toxicokinetic (PBTK) models are powerful tools that facilitate extrapolation between levels of biological organization, exposure conditions, and among species.
In our previous research we successfully re-parameterized a single-species PBTK model for multiple species and combined these models into a multispecies modeling framework. In contrast to this “top-down” approach, we here present a “bottom-up” multispecies PBTK modeling framework which will be based on data from the 222 freshwater species of fishes found in Canada. This approach – unlike all previous models – does not require full sets of model parameters to define individual species fully but will rather make use of a database of all available data to describe the statistical distributions of model parameters. These distributions are then used to feed into random number generators in stochastic Monte Carlo simulations to make probabilistic cross-species toxicokinetic predictions.
In addition to cross-species extrapolations in ERA, our novel stochastic multispecies PBTK model provides a framework that will support addressing various questions of environmental relevance, such as providing predictions for specific taxonomic, ecological, or geographic groups of fishes. In this way, our new model will potentially enable more environmentally relevant predictions without the need for additional animal experiments, and could ultimately pave the way towards more sustainable use of existing data.

Forecasting cyanobacteria blooms using high frequency lake data

Lead Author: Michael Kehoe, SENS, GIWS
Presenting Author: Michael Kehoe, SENS, GIWS
Email address: kehoe.michael@gmail.com
Co-Authors:
Helen Baulch
Brian Ingalls
Jason J. Venkiteswaran

Poster #: 62

Abstract:
Blooms of harmful cyanobacteria species are a growing problem worldwide and an annual problem in many Canadian lakes during summer. Monitoring has commonly been carried out on weekly to fortnightly intervals in many lakes. Recent technological advances mean a growing number of lakes now contain floating buoy systems that collect high frequency data on water quality and other environmental conditions. This has created new opportunities for understanding and forecasting blooms. Most previous models for forecasting harmful cyanobacteria blooms have been developed using the traditional low frequency data with little exploration of how new high frequency data might be used to forecast blooms. Here we present a collection of statistical and machine learning models that forecast cyanobacteria (as phycocyanin fluorescence) over 1, 4, and 7 day forecast horizons in the shallow polymictic Buffalo Pound Lake. We compared the performance of these models to a naïve model that assumes perfect correlation between current and future values of fluorescence. Because phycocyanin fluorescence is very highly temporally correlated, all models, including the naïve model, provided highly accurate forecasts. The more complex models provided a modest but notable improvement. These results suggest that simple approaches can be applied to bloom forecasting with useful results, and provide a baseline against which more complex approaches, such as mechanistic-models with data assimilation can be compared.

Identification of Secreted microRNA from Acutely Stressed Rainbow Trout (Oncorhynchus mykiss)

Lead Author: Heather Ikert, Biology, University of Waterloo
Presenting Author: Nathanael Harper, Biology, University of Waterloo
Email address: heather.ikert@uwaterloo.ca
Co-Authors:
Michael Lynch, Biology, University of Waterloo
Andrew Doxey, Biology, University of Waterloo
Mark Servos, Biology, University of Waterloo
John Giesy, Veterinary Biomedical Sciences, University of Saskatchewan
Barb Katzenback, Biology, University of Waterloo
Paul Craig, Biology, University of Waterloo

Poster #: 63

Abstract:
Measurements of waterborne environmental DNA are currently being employed to monitor both invasive and endangered fish species in Canadian waterways. However, few studies have examined environmental RNA within the water as a marker of the health status of a local community. MicroRNA (miRNA) are stable, targeted, post-transcriptional regulators of mRNA, and are therefore useful markers that can be linked to phenotypic responses. Changes in miRNA levels in tissues and circulation have previously been measured in fish due to acute and chronic stress. Additionally, miRNA have been measured in water samples; however, changes to specific miRNA in response to stress have never been identified in water. This study examines all miRNA present in blood plasma, mucus, and water samples before and after an acute stressor in order to identify environmental markers of stress. Samples were collected before (control) and one hour following (stressed) a three-minute air stressor. From these samples, all miRNA were sequenced using NGS technology. Differentially expressed miRNA were identified and validated via RT-qPCR. This study identifies novel candidates for non-invasive biomonitoring using waterborne miRNA. These altered miRNA can be linked to altered phenotypes in organisms and indicate the overall health status of fish in the environment.

Can seasonal changes in brook trout (Salvelinus fontinalis) abundance be detected using environmental DNA (eDNA)? - A case study in a small headwater stream in southern Ontario, Canada

Lead Author: Patricija Marjan, Department of Biology, University of Waterloo
Presenting Author: Patricija Marjan, Department of Biology, University of Waterloo
Email address: patricija.marjan@gmail.com
Co-Authors:
Mark Servos, Department of Biology, University of Waterloo
Paul Craig, Department of Biology, University of Waterloo
Barb Katzenback, Department of Biology, University of Waterloo
John Giesy, Department of Veterinary, Biomedical Sciences and Toxicology Centre, University of Saskatchewan

Poster #: 64

Abstract:
Environmental DNA (eDNA) is a non-invasive tool that uses genetic material from the surrounding area to indirectly infer the current status of species present. The eDNA approach was compared to traditional capture-based sampling to detect brook trout (Salvelinus fontinalis) in Washington Creek in southern Ontario. This headwater stream was selected as the study site that was surveyed on monthly bases from March to December (2018) combining traditional electrofishing, eDNA water sampling, and stream hydrology measurements. The goal was to determine temporal variations in eDNA signal intensity and relate it to the brook trout population characteristics and seasonal dynamics. Our preliminary results suggest that eDNA can be used to routinely detect brook trout presence in the stream. Further, our results indicate an increase in the eDNA signal in the summer months that corresponds with the increased fish density. Interpretation of eDNA results is complex due to seasonal changes in the biological and physical parameters of the stream. These parameters can affect eDNA shading rates, degradation, its fate, and therefore detection. Studying the dynamics of eDNA over time and in conjunction with quantitative methods can further improve the reliability of this approach and help to determine the most suitable time and locations for designing eDNA-based brook trout biomonitoring/detection. Moreover, it can help us understand how this method can be used on its own or to compliment traditional bioassessment methods.

Growth of rainbow darter (Etheostoma caeruleum) increases downstream of a municipal wastewater treatment plant (WWTP)

Lead Author: Samina Hayat
Presenting Author: Samina Hayat
Email address: s3hayat@uwaterloo.ca
Co-Authors:
Hadi Dhiyebi
Leslie Bragg
Mark McMaster
Mark Servos

Poster #: 65

Abstract:
Municipal wastewater treatment effluent (MWWE) is a major concern for aquatic organisms due to a variety of contaminants that have been linked to adverse effects. In the Grand River watershed, ON (Canada), rainbow darter (Etheostoma caeruleum) are a small-bodied fish species that are used extensively to study impacts of MWWE exposure. In recent years, contaminants of emerging concern (CEC) have been linked to increased intersex in fish in the Grand River, and major investments have been made in infrastructure upgrades to the Waterloo treatment plant in 2017 to improve treatment. Fish exposed to wastewater effluent are impacted at every level of biological organization (gene expression, histology, physiology, somatic indices) but little is known about potential growth impacts. Growth is an important indicator of fish health and is used by the Canadian Environmental Effects Monitoring (EEM) program to understand impacts of metal mining and paper and pulp effluent on fish health.
This study aims to understand the impact of MWWE on growth of rainbow darter in the Grand River. Growth rates upstream and downstream of the Waterloo wastewater discharge will be compared before and after major infrastructure upgrades were completed in 2017. Fish growth estimates require an age estimate, which in small bodied fish often includes otolith measurements. von Bertalanffy growth curves will be compared to assess whether fish downstream grew significantly different from fish upstream. Understanding and quantifying potential differences in growth attributed to wastewater effluent can allow for detection of subtle impacts. Use of these small bodied fish and growth as an endpoint can be used in regional monitoring programs to provide another indicator of fish health and allow linkages between exposure concentrations and biological responses.

Modelling of multiple stressors, their interactions and impact on aquatic life in the Grand River Watershed

Lead Author: Sondus Jamal, Civil and Environmental Engineering, University of Waterloo
Presenting Author: Sondus Jamal, Civil and Environmental Engineering, University of Waterloo
Email address: sondus.jamal@uwaterloo.ca
Co-Authors:
Eli Zeeb, Civil and Environmental Engineering, University of Waterloo

Poster #: 66

Abstract:
Contaminants along with other factors (e.g. temperature) act as stressors on aquatic life. These stressors can be human-induced or natural, and their effects are further magnified by changes in urban environments and climate. Trace contaminants such as pharmaceuticals, endocrine disrupting compounds (e.g. estrogen), and microplastics are being increasingly reported in effluents from wastewater treatment plants (Arlos et al., 2014; Ternes et al., 2004).
Models and tools, which can reliably predict the impact of these stressors, would contribute greatly to the improvement of monitoring and risk assessment programmes. They would also inform planning decisions for major infrastructure investments and/or remedial actions.
A key challenge with typical predictive models is that they are not linked to nor validated by actual observations; even models linked to measured data tend to have smaller data sets, and rarely consider interactivity and cumulative effects. This is mainly due to the reliance on limited site-specific information, the lack of an inter-disciplinary approach and the resource intensity of such efforts.
Our research focuses on developing linked exposure and effect models which can predict the impact of key stressors on sentinel fish species (i.e. fish species able to detect risks to humans) in the Grand River Watershed (GRW). The models are split into key components: source model, treatment model, fate model by studying exposure, and toxicology by looking at response. The outputs of these components will then be contrasted to actual field data both temporal and spatial. Our future work will focus on variability and interactivity between stressors along with the consideration of different endpoints such as metabolism. The modelling efforts are being carried out in collaboration with the GWF modelling group at the University of Saskatchewan, and it will be extended to include the water intake at Ohsweken, which is in the Six Nations reserve in Ontario.
The GRW is a great case study since it is the largest Canadian watershed upstream of Lake Erie. It supports intensive agricultural production in Ontario and a growing urban population in Guelph, Kitchener, Waterloo, Cambridge, and Brantford.
Drs. Parker and Servos have done extensive research in the GRW with over a decade in collected data. Our research group is inter-disciplinary bringing together diverse water professionals (e.g. engineers, biologists, chemists and toxicologists), and is also well connected to the key stakeholders (e.g. Grand River Conservation Authority and the Waste Water treatment plants).
The long-term goal of this research will be to contribute to the development of a robust “multi-stressor modelling platform” transferable to different watersheds across Canada. This is key in supporting informed future management decisions, especially for municipalities with minimal financial resources.
References
Arlos, M. J., Bragg, L. M., Servos, M. R., & Parker, W. J. (2014). Simulation of the fate of selected pharmaceuticals and personal care products in a highly impacted reach of a canadian watershed. Science of the Total Environment, 485-486(Complete), 193-204. doi:10.1016/j.scitotenv.2014.03.092

Ternes, T., Joss, A., & Siegrist, H. (2004). Scrutinizing pharmaceuticals and personal care products in wastewater treatment. Environmental Science & Technology, 38(20), 392A-399A

Impact of Forest Fire on Aquatic Invertebrates in Subarctic Lakes of the Taiga Plains.

Lead Author: Thomas Pretty, Intergrated Biology, Wilfrid Laurier
Presenting Author: Thomas Pretty
Email address: pret9680@mylaurier.ca
Co-Authors:
Derek Gray, Biology, Wilfrid Laurier

Poster #: 67

Abstract:
Fires represent a major natural disturbance in the Boreal region, and their frequency is increasing in response to climate change. In 2014, severe megafires spread throughout the Taiga Plains in Canada's Northwest Territories (NWT), denuding watersheds for hundreds of small lakes. Lakes found in burned areas often experience large increases in nutrients and metals which can have impacts on aquatic communities. To examine the impact of the 2014 fires on lakes in the NWT, we collected biological and water chemistry data from nine burned, and six reference lakes during August 2018. Our objectives were to compare the following between fire-impacted and reference lakes: 1) surface water chemistry; 2) abundance, richness, and diversity of zooplankton and benthic invertebrates; and 3) mercury levels in water/biota. Preliminary analyses failed to detect a significant difference in any of the major surface water chemistry variables measured, with the exception of nitrates. In addition, our analyses show no difference in water mercury concentrations. Analyses of biological data is ongoing. These preliminary results suggest that lakes within the Taiga plains might be surprisingly resilient in the face of wildfires.

The Application of Sensor Technology to Delineate Selenium Exposure and Trophic Transfer Downstream of a Saskatchewan Uranium Mine

Lead Author: Maira Peixoto Mendes, Toxicology Centre, University of Saskatchewan
Presenting Author: Maira Peixoto Mendes, Toxicology Centre, University of Saskatchewan
Email address: maira.mendes@usask.ca
Co-Authors:
Beatriz Cupe Flores
Karsten Liber

Poster #: 68

Abstract:
The application of sensor technology to monitor water quality parameters in real-time is growing worldwide. Sensor technology is being applied mostly in commercial activities (e.g., aquaculture) and in the marine environment, but limited information is available for freshwater ecosystems. In the context of water pollution, selenium (Se) is known to bioaccumulate and biomagnify in the trophic chain at relatively low aqueous concentrations. The major step for Se accumulation is the uptake of inorganic Se forms and their subsequent conversion into organic forms by primary producers, such as periphyton. In northern Saskatchewan, effluent discharges from uranium mining activity can increase Se releases into boreal lakes, potentially affecting aquatic biota. Therefore, the aim of this study was to apply sensor technology at the McClean Lake uranium mining operation to delineate Se exposure from a treated uranium milling effluent and to investigate Se bioaccumulation in periphyton. To address these aims, 10 Smart Water sensor units measuring temperature, pH, dissolved oxygen, oxidation-reduction potential, conductivity and turbidity were acquired from Libelium®, a Spanish sensor manufacturer. In the laboratory, sensors were calibrated using standard solutions and tests performed to validate results by comparing field meter readings with the ones reported by the sensor. An acrylic box and platform were designed to protect sensor units from field conditions and allow them to float. To delineate Se exposure downstream of the effluent discharge, sensors were deployed in the field for four weeks (Aug-Sept 2018) at 10 different stations. At each station, probes were submerged and fixed at 50 cm below the water's surface so that all measurements were taken at the same depth. During sensors deployment in the field, artificial substrate samplers for periphyton colonization were placed at each station (n=4). In parallel, conductivity was measured with hand-held field meters and water samples were collected (n=3) for Se concentrations analysis. After 4 weeks, the sensors and artificial substrates were retrieved from the field and once again water samples and conductivity values were collected. Sensors results from all probes except for temperature were affected by biofilm growth after approx. 20 days submerged in water. Results from this preliminary study indicate that to have consistent sensor readings, regular probe cleaning (~ every 15 days) should be conducted for the next field seasons. Conductivity values obtained with field meters were plotted against Se aqueous concentrations and a positive correlation was observed ($R^2 = 0.98$), suggesting that conductivity can be a good surrogate for estimating Se exposure from the effluent. It is expected that future sensor conductivity data can use this relationship to predict Se exposure levels at different locations and times in McClean Lake, and subsequently those data can be used to estimate Se in periphyton. In terms of observed Se bioaccumulation in periphyton, the highest Se concentrations in water (0.47 - 2.40 µg/L) were accompanied by higher Se concentrations in periphyton tissue (10.56 - 15.70 µg/g d.w.).

Trophic & biogeochemical dynamics of mercury in fishery lakes in the Northwest Territories

Lead Author: Ari Yamaguchi, Integrative Biology, Wilfrid Laurier University
Presenting Author: Ari Yamaguchi, Integrative Biology, Wilfrid Laurier University
Email address: yama0010@mylaurier.ca
Co-Authors:
Heidi Swanson, Biology, University of Waterloo
Deb MacLatchy, Biology, Wilfrid Laurier University

Poster #: 69

Abstract:
Kakisa Lake and Tathlina Lake, located in the Dehcho Region of the Northwest Territories, support commercially and culturally significant fisheries for the local Ka'a'gee Tu First Nation. Presently, Walleye (Sander vitreus) in Tathlina Lake have mercury (Hg) concentrations that are above the 0.5 mg/kg limit for commercial sale set by Health Canada. Elevated Hg concentrations ([Hg]) in food fishes pose neurological, developmental, and reproductive health risks to the humans who consume these fishes, depending on consumption levels and vulnerability; vulnerability is highest in children, pregnant women, and the elderly. Mercury-related health risks are greater for Dehcho residents than for southern and westernized populations because subsistence fishing contributes significantly to their diets. Separated by 23 km of land, Tathlina Lake drains into Kakisa Lake via Kakisa River. They vary widely in many physical properties, including depth (Tathlina: ~1.5 m; Kakisa: max. 7 m) and area (Tathlina: 570 km2; Kakisa: 331 km2). Additionally, Tathlina Lake's food fishes generally have higher [Hg] than those in Kakisa Lake. Differences in physicochemical dynamics and their related ecological processes could contribute to differences in fish [Hg] between the two lakes. Initial data do not satisfactorily identify the root cause for the differences in fish [Hg] between lakes. The purpose of this study is to relate analyses of food web structure, fish growth rates, and lake physicochemistry to [Hg], and attempt to determine why fish [Hg] are different between the lake systems. I predict that a difference in productivity of the lakes may explain the different Hg burdens. I expect that chlorophyll a, as a proxy for algal biomass, will be higher in Kakisa Lake than in Tathlina Lake, resulting in a lower [Hg] per unit of algal biomass in Kakisa Lake than in Tathlina Lake. This would demonstrate a bloom dilution effect, which can be verified by comparing [Hg] in the same taxa across lakes. I further expect that growth dilution contributes to the [Hg] disparity, which I will verify with age and fork length data. I predict that growth rates will be faster in Kakisa Lake than in Tathlina Lake. Finally, I predict that the rates of Hg biomagnification between the two lakes will be different. Stable isotope analysis will provide the basis for constructing a model of the food webs in each lake, and I will match that trophic information with [Hg] to quantify biomagnification rates.

Arsenic levels from a human biomonitoring project in the Northwest Territories

Lead Author: Mylene Ratelle, School of Public Health and Health Systems, University of Waterloo
Presenting Author: Mylene Ratelle, School of Public Health and Health Systems, University of Waterloo
Email address: mratelle@uwaterloo.ca
Co-Authors:
Brian Laird, School of Public Health and Health Systems, University of Waterloo

Poster #: 70

Abstract:
Small amounts of arsenic are found naturally in water. However, gold mining activities from the Giant Mine (1948-2004) have resulted in elevated levels of arsenic being released around the City of Yellowknife, Northwest Territories (NWT), located near the Great Slave Lake. Particular forms of arsenic are classified as carcinogenic and elevated exposure can be a challenge for population health. A human contaminant biomonitoring project funded by the Northern Contaminants Program was implemented in the Dehcho and Sahtú regions of the NWT to investigate the current levels of contaminant exposure (including arsenic) in participating Indigenous communities.
In the Sahtú and the Dehcho region of the Northwest Territories, nine Indigenous communities accepted to take part in the project. Total arsenic levels were measured in 198 urine samples and 276 blood samples, while a subset of hair samples (n=19) was analyzed for total arsenic and a subset of urine samples (n=26) was analysed for arsenic speciation. The total arsenic was quantified at University of Montréal (Michèle Bouchard) using an inductively coupled plasma mass spectrometry (ICP-MS), while the speciation was done at the Institut National de Santé Publique du Québec (INSPQ) using ion exchange chromatography and ICP-MS.
Arsenic in urine was detected for all the participants (age: 6 to 88 years), while the detection rate in blood was lower (23%). At the group level, the total arsenic concentration in urine (n=198) had a GM of 5.5 µg/L (6.3 µg/g creatinine) and a 95th percentile of 34 µg/L (27 µg/g creatinine), which are below the national values from the Canadian Health Measure Survey cycle 2 (CHMS). The small number of samples from the Dehcho region along the Great Slave Lake and the Mackenzie River analysed for arsenic speciation show that the 95th percentiles of dimethylarsinic acid (DMA), monomethylarsonic acid (MMA), arsenite (AsIII), arsenate (AsV) were all below the CHMS. All these participants had inorganic arsenic levels below the health-based guidance value of 35 ug/L of urine (MMA, DMA, AsIII and AsV). These results indicate that arsenic emissions from historic gold-mining activities in other parts of the territory have not translated to increased exposures in the Dehcho and Sahtú regions. Overall, these findings will increase the knowledge of the contaminant exposure levels in the north and help to prioritize environmental health issues for these regions. This information may also help contextualize results from the Health Effects Monitoring Program happening around Yellowknife.

FIShNET: Healthy Water, Healthy Fish, Healthy People

Lead Author: Kelly Skinner, School of Public Health and Health Systems, University of Waterloo
Presenting Author: Kelly Skinner, School of Public Health and Health Systems, University of Waterloo
Email address: kskinner@uwaterloo.ca
Co-Authors:
Brian Laird, School of Public Health and Health Systems, University of Waterloo
Vern Cheechoo, Mushkegowuk Council
Heidi Swanson, Department of Biology, University of Waterloo
Breanna Phillipps, School of Public Health and Health Systems, University of Waterloo

Poster #: 71

Abstract:
Environmental change in aquatic ecosystems can impact fish health in many ways, including effects on metabolism and bioenergetics, trophic ecology, immune responses to pathogens and parasites, and exposure to contaminants, such as mercury. Mercury is of particular concern in aquatic ecosystems because the methylated form (methylmercury; MeHg) bioaccumulates and biomagnifies, and elevated methylmercury concentrations have been documented in several of the predatory fish species regularly harvested across Canada. To address the health risks posed by mercury and other contaminants, provincial and territorial governments regularly provide advice on how people can best include fish as part of a healthy diet. However, this advice is generally based primarily on fish contaminant levels, without fully accounting for the benefits of traditional food consumption. Through this proposed work, we are characterizing the links between environmental change, water quantity and quality, fish health, food safety, and food security in one subarctic First Nations community (Fort Albany) in northern Ontario.
The main outcomes of this work include: i) describing the fish health concerns of local partners; ii) strengthening relationships for engagement and tailoring tools for risk communication according to local preferences and priorities; iii) improving abilities to detect and predict changes in the safety and sustainability of fish stocks in the face of changing climate and resource development; iv) filling site-specific data gaps related to levels and sources of mercury exposure; v) understanding the relationships between fish and food security; vi) designing a platform for future data visualization tools. The team is currently completing ethics applications and will start data collection in summer 2019.

Health and Risk Communication of Contaminants in the Dehcho and Sahtú Regions of the Northwest Territories, Canada

Lead Author: Kelly Skinner, School of Public Health and Health Systems, University of Waterloo
Presenting Author: Kelly Skinner, School of Public Health and Health Systems, University of Waterloo
Email address: kskinner@uwaterloo.ca
Co-Authors:
Mylene Ratelle, School of Public Health and Health Systems, University of Waterloo
Danielle Brandow, School of Public Health and Health Systems, University of Waterloo
Brian Laird, School of Public Health and Health Systems, University of Waterloo

Poster #: 72

Abstract:
Public health strategies related to contaminant exposures in Indigenous communities in northern Canada need to balance the risks and benefits of consuming country foods. Elevated mercury concentrations in some fish species in some lakes in the Dehcho region of the Mackenzie Valley in the Northwest Territories (NWT) resulted in a series of fish consumption notices that suggested people limit their consumption of specific fish species, including walleye, northern pike, and lake trout, from specific lakes. It is not known what the level of awareness is and understanding of these consumption notices, whether they resulted in altered food behaviours, or the risks perceived with country food consumption. As part of a larger human biomonitoring study in nine Indigenous communities in the Dehcho and Sahtú Regions of the NWT, participants were invited to respond to a Health Messages Survey on health and risk communication for contaminants, with a focus on mercury and cadmium. Questions included the awareness and understanding of current health messages on country foods and contaminants, questions on risk perception related to contaminants, perspectives on health and country foods, how people usually heard about consumption notices and other information on health, foods and/or contaminants, and preferences for receiving messaging. Participants (n=87) indicated a high consumption of country foods (99%), preference to eat only country foods (38%), and heard that country foods had beneficial nutrients (90%). Seventy percent of respondents had heard or seen messages about fish with high levels of mercury and had heard this from researchers or scientists (52%), radio (44%), or a friend (44%). Since hearing the messages on mercury in fish in specific lakes, respondents reported that they: were more concerned about the fish they ate (46%); decreased the amount of fish they ate (32%); and changed the location where they usually fish (29%). Most participants had access to the internet (68%), cell phone or land line (61%), and listened daily to local radio as a source of news (74%). Doctors were the most trusted source of information about contaminants (51% trusted “a lot”), followed by friends or relatives (45%), Elders (44%), and university researchers (43%).
Collaboration between researchers, government, trusted sources and communities in the NWT, Canada is critical to develop cross-cultural, co-created communication strategies and build more knowledge around the complexity of risk perception and health messaging. The priority should continue to be carefully planned communication strategies, built through engagement with communities, which promote country food consumption while lowering contaminant exposures to maintain and improve health and well-being.

Human Biomonitoring Research in the Northwest Territories and Yukon: An Evaluation of Manganese Preliminary Results

Lead Author: Mallory Drysdale
Presenting Author: Mallory Drysdale
Email address: mebdrysdale@uwaterloo.ca
Co-Authors:
Sara Packull-McCormick
Mylene Ratelle
Brian Laird

Poster #: 73

Abstract:
Traditional food is an important part of the diet for many residents of the Yukon and Northwest Territories who traditionally harvest foods including fish, caribou, moose, waterfowl, small game and many plants. Traditional food consumption among First Nations peoples is associated with improved nutrition, food security, and lower rates of chronic diseases; however, these foods can also pose potential risks via exposure to some contaminants, including mercury and cadmium. To help address questions and concerns regarding contaminant exposures, a multi-year contaminant biomonitoring study has been initiated in participating First Nations communities in the Yukon and Northwest Territories. To better understand the balance between risks and benefits from various food options, this has included several nutrient biomarkers as well. The biomonitoring studies have included human hair, urine, and blood sampling in communities and laboratory analysis of these samples. In addition to the biomonitoring samples collected, participants responded to questionnaires designed to investigate exposure sources, risk perceptions, as well as trusted sources of information within participating communities. The biomonitoring study has been conducted in close collaboration with partner communities, and as of May 2019, ten communities across the Northwest Territories and Yukon, including 614 participants.
As part of this work, one objective is to measure trace mineral concentrations, including manganese, in biomonitoring samples. Manganese is an essential trace mineral and low levels are required to promote bone growth. However, excess manganese can cause toxic effects and has been associated with long-term neurological disorders. No health-based guidance value are available for manganese biomarkers; however, comparisons can be made to nationally-representative studies (e.g., the Canadian Health Measures Survey or the CHMS) and population reference values. Preliminary results from participating communities in the Northwest Territories report a geometric mean blood manganese concentration of 10 µg/L and a 95th percentile value of 19 µg/L. Manganese concentrations in urine in participating communities had a geometric mean of 0.21 µg/L and a 95th percentile of 0.66 µg/L. Manganese biomarkers were elevated at the 95th percentile in both blood and urine in comparison to CHMS values. Additionally, the geometric mean manganese concentration in urine was approximately two-fold higher than observed in the CHMS. Approximately 96 – 98% of samples had manganese biomarker concentrations below the available population reference values. Manganese biomarkers reflect recent exposure and levels above the reference values do not necessarily indicate an adverse effect will occur. Ongoing work is being conducted to determine potential sources of manganese exposure in the eleven communities based on dietary surveys, drinking water quality monitoring, and lifestyle risk factors, including smoking.

Will Onkwehón:we have access to clean water in the future?

Lead Author: Dawn Martin-Hill, Indigenous Studies, McMaster University
Presenting Author: Dawn Martin-Hill, Indigenous Studies, McMaster University
Email address: beaudilm@mcmaster.ca
Co-Authors:
Tina Moffat, Anthropology, McMaster University
Patricia Chow-Fraser, Biology, McMaster University
Ravi Selvaganapathy, Mechanical Engineering, McMaster University

Poster #: 74

Abstract:
National attention to water security and climate change in Indigenous communities highlights diverse challenges identified by Indigenous Peoples in obtaining potable water supplies. The analysis shows that up to 72,000 people could have been affected by drinking water advisories (DWAs) in First Nations at the start of 2017. In 2016 alone, 133 boil water advisories in 90 indigenous communities were issued that affected over 50,000 people across the country.
This research project focuses on two distinct communities to capture the range of challenges: (1) Six Nations of the Grand River (Ontario), largest Canadian reserve with 25,000+ members, within 30-minute drive of major cities; Lubicon Cree northern Alberta. Both communities have had limited access to clean water and endured generations of human health disparities not encountered in mainstream society. Both have experienced enteric infections, and other related health impacts suspected cause related to contaminated drinking water sources. The primary concerns for the two communities are: (i) the quality of their drinking water, (ii) the ecological integrity of their source, and (iii) governance of these waters framed within an Indigenous knowledge analysis.
Co-creation of Indigenous Water Quality Tools is a transdisciplinary, community-led project incorporating traditional knowledge and is using an innovative mixed method approach to facilitate sharing and integration of western science and Indigenous/Local Knowledge in response to water-quality threats. The project combines four research teams, working synergistically, to monitor all source waters with continuous environmental sensors, accessible via mobile devices & translated into different Indigenous languages; investigate the cause of health issues related to contaminated water and explore mitigation options; examine the socio-economic, health and food security impacts of climate change based on local climate trends; contribute to development of tools for appropriate community-based safe water solutions, including source water protection, customize source-based treatment, and co-develop a youth culturally-land based training program in water monitoring. The co-creation of sensors, data analysis and culturally relevant tools will build long-term and sustained community capacity to address current and future uncertainties in water quality.

Water Well Told: Stories and their part in source water protection

Lead Author: Ashleigh Duffy, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Ashleigh Duffy, School of Environment and Sustainability, University of Saskatchewan
Email address: asd854@usask.ca
Co-Authors:
Dr. Graham Strickert, School of Environment and Sustainability, University of Saskatchewan

Poster #: 75

Abstract:
Multiple stakeholders and Indigenous rights holders are addressing threats to rural drinking water on the Canadian Prairies. Local water knowledge and values have been explored through stories, but story has yet to be officially recognized within processes of technical community water solutions. This study collected personal accounts of stories shared during source water protection planning (SWPP) in the North Saskatchewan River Basin (NSRB) to explore the role of stories in SWPP. Interviews with SWPP contributors and water champions in the NSRB were analysed for themes using narrative inquiry and the results were validated through member-checking. Central themes supported the use of stories for network support, context-based decision making, empathizing different meanings for water, and sharing knowledge to protect future generations. Results are presented in a mosaic SWPP story to illustrate that dedicating a step to story sharing in the SWPP process could make it more effective, Indigenize it, and set the stage for similar community work.

"Water is Something To Be Respected": Exploring Water Insecurity and It's Impact on Holistic Health with Six Nations of the Grand River

Lead Author: Sarah Duignan, Anthropology, McMaster University
Presenting Author: Sarah Duignan, Anthropology, McMaster
Email address: duignase@mcmaster.ca
Co-Authors:
Tina Moffat, Dept of Anthropology, McMaster U
Dawn Martin Hill, Dept of Anthropology, Indigenous Studies, McMaster U

Denise McQueen, Indigenous Studies, McMaster U

Poster #: 76

Abstract:
Water security's impact on physical health is well known, but connections between access to water and other elements of health is under-explored, particularly as it relates to Indigenous Knowledge. As part of a project that is co-creating knowledge around water quality and health, this research investigates the ways in which lack of access or lack of quality in household water impacts health across multiple dimensions. Interviews with Six Nations community members reveal the emotional, social, environmental, and mental dimensions of health that are influenced by access to good quality water. These interviews and feedback helped to inform the development of a water quality and health survey that would be used in connection with tap water testing for households within the community, to build health assessments that are more holistic and rooted in Indigenous Knowledge.

Water for Life = Water for All? First Nation inclusion in Alberta's watershed planning framework

Lead Author: Juliane Schultz, Geography and Planning, University of Saskatchewan
Presenting Author: Juliane Schultz, Geography and Planning, University of Saskatchewan
Email address: juliane.schultz87@gmail.com
Co-Authors:
Robert Patrick, Department of Geography and Planning, University of Saskatchewan

Poster #: 77

Abstract:
Canada is one of the most decentralized water governance countries in the world. Federal and provincial water policy and regulations are fragmented resulting in uncertainty and at times conflict over accountability and responsibility issues. Increasingly, provincial governments have taken to the devolution of water management authority to local watershed organizations. Watershed planning is a holistic water resource management approach that includes a complex assessment of risks and concerns and their possible impacts on different watershed areas and their stakeholders. One example of a watershed management approach is Alberta's Water for Life Strategy. This initiative has received international recognition and was the first of its kind in North America. In this research, I wish to examine the presence of Indigenous engagement with provincial–scale watershed plans.
Water resources planning and the inclusion of Indigenous peoples adds various challenges. The Indian Act (1876) gave the federal government full authority of First Nations reserves, but provinces set their own water regulations which are not applicable to reserves. Effective watershed planning requires participation not only from industry partners and multi-stakeholders but also from Indigenous communities living in a watershed. This is strengthened by the fact that the Trudeau government accepted the Truth and Reconciliation Commission's report in 2015 which defines reconciliation as "... establishing and maintaining a mutually respectful relationship between Aboriginal and non-Aboriginal peoples in this country. " (p. 113).
Therefore, my research aims to explore opportunities to support reconciliation through the watershed planning process. First, I will assess whether First Nations are included in watershed plans; second, I will identify why or why not First Nations were included in the plan-making process; and third, I will identify how the planning process can engage with First Nations more effectively (benefits of/advantages of/opportunities for). My strategy is to review Alberta's watershed plans for evidence of First Nations inclusion using latent and manifest analysis. This will be followed up by telephone interviews with watershed authorities to gain a deeper understanding of the plan-making process. My results will provide insights for watershed planners on how to better engage with Indigenous populations and possibly enhancing the Reconciliation process in Canada.
GEOG 803 Thesis Proposal: Reconciliation through Watershed Planning 28
Keywords: Watershed planning; Alberta; Indigenous; First Nations;

Ohneganos: Indigenous Ecological Knowledge, Training & Co-Creation of Mixed Method Tools

Lead Author: Dawn Martin-Hill, Paul R. McPherson Indigenous Studies Chair, McMaster University
Presenting Author: Karissa John, Indigenous Studies Program, McMaster University
Email address: karissajohn42@gmail.com
Co-Authors:

Poster #: 78

Abstract:
From the perspective of the traditional Haudenosaunee, we speak in terms of responsibilities with respect to water, not in terms of water rights. From time immemorial, we have held the view that the "law of the land" is not man-made law, but a greater natural law, the Great Law of Peace ….the root words for "rain" in Mohawk means expensive, or precious or holy. Culturally, we would not abuse this resource (King, 2007).
Indigenous com UNESCO Resolution XXIII-8, IHP support sustainable goal indicator 6.a.2 water education affirms intergovernmental programme devoted to fostering water research, water resources management, education and capacity building.." Ohneganos, a Global Water Futures Indigenous-led scientific transdisciplinary team with Haudenosaunee community observes the UNESCO target, that the Agenda 2030 aims to achieve gender equality and empowerment of women and girls (SDG 5). With Mohawk women academic/community leads a primary innovation of this project is co-development of research design and analyses complementary knowledge systems of Indigenous Knowledge (IK/TEK) and western science (WS). IK has a multiplicity of sources, including traditional, spiritual, and empirical; it engages a holistic paradigm that acknowledges the emotional, spiritual, physical, and mental well-being nested in the culture and language of a people. Our work exemplifies "The Value of Traditional Ecological Knowledge for the Environmental Health Sciences and Biomedical Research" by Symma Finn,1 Mose Herne,2 and Dorothy Castille3
Support collaborations between Western scientists and Tribal researchers and between biomedical, environmental, and social scientists. The development of conceptual models for integrating cultural understanding bet The Value of Traditional Ecological Knowledge for the Environmental Health Sciences and Biomedical Research TEK and Western science is achievable through multidisciplinary team-based science and through promoting mixed-methods research that blends qualitative and quantitative investigative approaches.
Globally, IK/TEK has been shown to strengthen socio-ecological community resilience within the multiple stressors of global environmental changes, encourages accredited water management training of youth. Our project will create bilingual texts/resources will build communities' capacity to monitor future environmental challenges [training] water management (2) building youth health resilience related to water security [wellness], and (3) training youth/assisting community in water governance, rights, responses inclusive of Indigenous laws [governance] in accordance with UNDRIP and TRC call to action.4) sensor development, training, monitoring and accreditation and geolinguistic heritage mapping and establishment of a Nation supported Haudenosaunee Environmental Health Task Force and Grandmothers Council ensures gender equity outlined in the Great Law.
The environmental philosophy as instructed by the Oheniton Karihwatehkwen and the political philosophy as governed by the Kahswenhtha would establish a relationship based upon peace, power and righteousness and would restore harmony, strength and balance to our natural world and to the Kaniatarowanenne.

Collaborative Water Governance: A Holistic Perspective Towards Mistawasis Nêhiyawak Well-being

Lead Author: María F. Mora, Ph.D (c), School of Environment & Sustainability, University of Saskatchewan
Presenting Author: María F. Mora, Ph.D (c), School of Environment & Sustainability, University of Saskatchewan
Email address: mariafer.mora@usask.ca
Co-Authors:
Michelle Watson, Climate Change Project Leader, Mistawasis Nêhiyawak
Anthony Blair Dreaver Johnston, Special Projects Coordinator, Mistawasis Nêhiyawak
Lalita Bharadwaj, PhD., School of Public Health, University of Saskatchewan

Poster #: 79

Abstract:
Water issues on First Nations in Saskatchewan represent a challenge from both a technical standpoint and a decision-making perspective. Strategies applied to water problems on reserves have not been able to guarantee the holistic and integrated well-being. Questions have therefore been raised around the current Canadian water governance framework. The purpose of this research is to co-construct a water governance framework with the Mistawasis Nêhiyawak through developing deeper understanding of the context, and complex problems involved in water governance with this community. This research integrates the principles of community-based participatory research where engagement and relationships with Mistawasis Nêhiyawak are built on ethical principles and a participative, proactive, decolonial, and integrative research approach is applied. Interviews and focus groups were conducted with Elders, women, leaders and youth to co-construct the meaning of, and framework for water governance. Mistawasis experiences demonstrate that water governance should be pursued and practiced from a 'partners' perspective, where collaboration promotes crucial opportunities to more efficiently address various water issues in the community. At the same time, collaboration should be set on intercultural relationships, opening equitable dialogue spaces that recognize the cultural differences and water ontologies present in Saskatchewan. The framework envisioned could represent the basis of an alternative, holistic, and collaborative water governance perspective in the province, inclusive of Indigenous knowledge, people's needs, and aspirations.

Integration of Western Science and Traditional Ecological Knowledge to better evaluate the social impacts of climate change in the Six Nations of the Grand River community in Southern Ontario

Lead Author: Tariq A. Deen, School of Geography and Earth Sciences, McMaster University
Presenting Author: Tariq A. Deen, School of Geography and Earth Sciences, McMaster University
Email address: deenta@mcmaster.ca
Co-Authors:
M. Altaf Arain, School of Geography and Earth Sciences, McMaster University
Patricia Chow-Fraser, Department of Biology, McMaster University
Olivier Champagne, School of Geography and Earth Sciences, McMaster University

Poster #: 80

Abstract:
Research indicates that all regions in Ontario will experience impacts of climate change in the future. With respect to Southern Ontario, these impacts include increase in temperature and precipitation as well as more intense and frequent extreme events such as heatwaves, droughts or flooding due to extreme precipitation or early spring snowmelt. While these impacts will affect all Ontarians, certain social groups within society will be more affected than others. Indigenous communities within Ontario have historically been more affected by climate change and other environmental events than non-Indigenous communities due to a number of geographical and socio-economic reasons. Because of historic and current differences in capacities and preparedness in dealing with climate change and extreme weather events, it is imperative that climate change and extreme events vulnerability studies be conducted and data be generated that is specific to Indigenous communities like the Six Nations of the Grand River in Southern Ontario. Climate change information and data are fundamental to accessing climate change impacts and vulnerability. Traditionally, this information was collected using techniques developed through Western Science (WS) philosophies. These techniques have primarily relied on the use of technologies (such as, hypothesis, gauges, sensors, computational models, etc.) to measure, and analyze climate change information. While WS methods are useful to physical and social studies, the integration of Traditional Ecological Knowledge (TEK) philosophies, which is a system of human observations and narratives used exclusively by Indigenous populations to help describe and understand the functioning of local environmental systems, into WS based community vulnerability frameworks can provide additional insight into climate change impact studies, while also highlighting keys areas of community vulnerability. In this poster, results will be presented from an ongoing WS-TEK integrated vulnerability assessment of the social impacts to climate change in the Six Nations of the Grand River community in Southern Ontario. This research falls within the objective of the Ecosystem Health's sub-group of the Co-Creation of Indigenous Water Quality Tools project of the Global Water Futures (GWF) program.

Indigenous engagement in Manitoba water governance

Lead Author: Warrick Baijius, Geography and Planning, University of Saskatchewan
Presenting Author: Warrick Baijius, Geography and Planning, University of Saskatchewan
Email address: warrick.baijius@usask.ca
Co-Authors:
Community of Wuskwi Sipihk First Nation, MB
Robert Patrick, University of Saskatchewan
Chris Furgal, Trent University

Poster #: 81

Abstract:
Globally, the rights of indigenous peoples to participate in, benefit from, and control development in their territory has become entrenched in legal systems. Often, the term 'indigenous engagement' is used to describe this new wave of participation. As a subset of resource governance in general, indigenous engagement in water governance within Canada, is mediated by a number of social institutions. Modern treaties often include negotiated settlements, legislation, and co-management authority over traditional territory, whereas numbered treaties articulate principles to guide and structure the relationship between the Dominion government and indigenous peoples. Given contemporary social norms that emphasize justice for indigenous peoples in the context of resource management and development, how are indigenous peoples to be engaged in prairie water governance? I answer this question through a case study of a First Nation in Manitoba.
First, I conducted a systematic literature review of 'indigenous engagement in water governance' to answer: what does it mean to 'be engaged' by state-based water governance? Preliminary results indicate a diversity of engagement mechanisms and rationales, with limited comparability in the methods and purposes of assessment of engagement, where they exist. Most literature on indigenous engagement in water governance speaks to the importance of inclusion and the resource constraints that limit it, as well as the normative and practical roles of indigenous knowledge and voice in decision-making, but do not address the more fundamental issues of politics that plague full participation beyond mere 'management'.
Second, I analyzed existing watershed plans for evidence of indigenous engagement, and conducted interviews to identify sources of variation in the extent and degree of indigenous representation in watershed plans. Integrated watershed management plans in Manitoba show variation in the extent and degree of indigenous representation, and by inference, of participation in planning. This variation was tested for correlation with extent of reserve land in a watershed, as well as the number of reserves within a watershed. Findings are inconclusive, and the variation requires further investigation.
Third, I facilitated a community-based watershed planning process to develop an action plan for a First Nation community in Manitoba experiencing significant water quality and quantity issues. Work with the community included piloting a number of participatory mapping technologies and techniques, in order to test their potential for use in a study of traditional water use: a large-format satellite image print where community members use coloured dots to indicate use, observations of quality and quantity change, and designate areas for protection from logging; digital mapping of the same, combined with qualitative interviews; and site tours, with photographs and field notes used to provide context. Using the interviews and mapping data, this action plan will 'tell the story' of environmental change at a landscape scale, and will reveal not only the realities of 'indigenous engagement with water', but also the complexities of engaging indigenous peoples in water governance in Manitoba.

Water Spirituality: An Indigenous Perspective on Laitu Khyeng Indigenous Community, Chittagong Hill Tracts (CHT), Bangladesh

Lead Author: Ranjan Datta, Johnson Shoyama Graduate School of Public Policy
Presenting Author: Ranjan Datta, Johnson Shoyama Graduate School of Public Policy
Email address: rda027@gmail.com
Co-Authors:

Poster #: 82

Abstract:
We (researcher and four co-researcher participants, Elders, and knowledge-holders) were interested in exploring how identity and meanings of sustainability were framed in relation to the politics of water management. Combining theory from political ecology, postcolonial theory, and science studies, especially the work of Ingold, Deleuze, Bhabha, Said, Latour, Whatmore, Haraway, and Levi-Strauss (Bhabha, 1985; Deleuze, 2004; Ingold, 2011; Haraway, 1991, 1998; Latour, 2004; Levi-Strauss, 1966; Whatmore, 2002), we have examined two main questions. First, how did Indigenous peoples of the Chittagong Hill Tracts (CHT), Bangladesh, view sustainability in relation to their own knowledge about the meanings of water and water management? Second, how were governmental and transnational policies constructed within the contested social and ecological landscapes of the CHT? Our research addressed questions using interdisciplinary approaches for understanding sustainability in relation to conceptions and practices of water management, and asking how those of us who invoked this term might most effectively address Indigenous ecological, economic, and social challenges. In accordance with research questions specified above, this study guided by the critical concerns of identifying the problems of existing forest/land management in relation to the everyday water practices and traditional experiences in Indigenous regions. This study followed a relational research framing with a focus on the researcher's relational accountability and obligations to study participants and site. Four methods of data collection were used, including traditional sharing circles, individual stories, commonplace book and photovoice. This study situated itself within this context and took a significant step in exploring identity and justice in relation to Indigenous understandings of sustainability and water management.

Towards Eco-centric Water Governance: Principles for the interaction between international, domestic and indigenous water governance systems

Lead Author: Jorge Luis Fabra-Zamora
Presenting Author: Jorge Luis Fabra-Zamora
Email address: fabrajl@mcmaster.ca
Co-Authors:

Poster #: 83

Abstract:
Water flows between many different nations and regions crosses boundaries between International, Western, Indigenous Governance Frameworks. This paper explores the relationships and interactions between these frameworks in order to generate an understanding of the right relationship. Here, I will argue that an eco-centric perspective that accommodates the co-existence of multiple regulations and that illuminates feasible, responsive, and appropriate institutional and governance arrangements. This model will contribute to dialogue at multiple scales, serving Indigenous communities, states, and the international community, and promoting the process of co-creation of new co-governance relationships and institutions.

Water-Related Health in Global Water Futures

Lead Author: Corinne Schuster-Wallace, University of Saskatchewan
Presenting Author: Corinne Schuster-Wallace, University of Saskatchewan
Email address: cschuster.wallace@usask.ca
Co-Authors:
Lalita Bharadwaj, University of Saskatchewan

Poster #: 84

Abstract:
Human health is impacted directly and indirectly by water in many inter-related ways. Global environmental change, and climate change in particular, is affecting the incidence and distribution of these health impacts. Water is a direct vector, transmitting waterborne diseases from human and animal-sourced pathogens including E. coli and Giardia lamblia. Water provides the breeding habitat for vectorborne diseases, such as dengue, West Nile virus, and schistosomiasis. Water resources are a key driver of food security and green water is a mechanism through which water can be redistributed around the world. Agriculture and industry are also sources of water pollution, causing eutrophication that can lead to harmful algal blooms and elevated presence of chemicals, metals, and radionuclides in drinking water supplies. Floods and droughts (leading to fire hazards and crop shortage) exacerbate water contamination and have indirect impacts on health, such as disrupting access to healthcare services, injury, malnutrition, and subsequent financial and psychological trauma. Compromised ecosystem services further contribute to negative health impacts through loss of habitat and food supplies as well as water stress.
Research findings, approaches (including citizen science and Traditional Knowledge), and models in Global Water Futures provide multiple opportunities through which members affect the changing public health landscape. GWF responses to health include advanced warning systems, scenario development, adaptation and resilience, as well as balancing social, economic, and environmental systems. However, in order to realise these benefits, we need to i) expand research to include investigation of associated potential health impacts; and, ii) develop risk communication tools designed specifically for public health professionals and the general public.
This interactive poster provides an opportunity to catalogue collective GWF contributions to human health and explore new opportunities to engage in human health research.

Utilizing Global Water Futures Data to Support Rural Landscape Resilience

Lead Author: Harvey Hill PhD., Johnson-Shoyama Graduate School of Public Policy, The University of Saskatchewan
Presenting Author: Harvey Hill PhD., Johnson-Shoyama Graduate School of Public Policy, The University of Saskatchewan
Email address: concan1@sasktel.net
Co-Authors:

Poster #: 85

Abstract:
Scientists based on the Canadian Prairies now associated with the Global Water Futures Research Initiative have played a key role in the development of water transportation models appropriate for "pothole" landscapes observed in Alberta, Manitoba and Saskatchewan. Their work was critical to ensuring the landscape and Infrastructure Resilience Assessment methodology could actually be applied in Western Canada to support community and local government water related risk mitigation.
Current research by Global Water Futures researchers in the areas of GIS, LIDAR Data gathering, hydrology modelling and the socio-economic aspects of water management are opening up more opportunities to cost effectively proactively identify and mitigate water related risks on rural agricultural landscapes.
This presentation will illustrate how GWF research can support vulnerable landscapes practically. In terms of social and economic metrics.

A Modest Step to Estimating the Value of Formal Drought Planning

Lead Author: Harvey Hill, Adjunct Professor , Johnson-Shoyama Graduate School of Public Policy.
Presenting Author: Harvey Hill, Adjunct Professor , Johnson-Shoyama Graduate School of Public Policy.
Email address: concan1@sasktel.net
Co-Authors:
Dr. Rolf Olsen, Institute for Water Resources, US Army Corps of Engineers.

Poster #: 86

Abstract:
The World Meteorological Organization, the United States National Integrated Drought Information System and many other organizations have promoted the development and implementation of drought planning processes and drought plans. Interestingly, it is difficult in the literature to find estimates of the potential economic value of such plans. This presentation describes an estimate of the economic value of the City of Cedar Rapids. Lessons learned from this study may provide insights for policy makers, technical experts and economists regarding factors to consider in the design and implementation of drought plans in their jurisdictions.

From Drought Tournaments To Multi-Hazard Tournaments, An Update

Lead Author: Harvey Hill, PhD., Johnson-Shoyama Graduate School of Public Policy, The University of Saskatchewan
Presenting Author: Harvey Hill, PhD., Johnson-Shoyama Graduate School of Public Policy, The University of Saskatchewan
Email address: concan1@sasktel.net
Co-Authors:
Dr. Rolf Olsen, PhD., The Institute for Water Resources, The US Army Corps of Engineers
Andrea Carson, MSc., Community Planner, Pittsburgh District, The US Army Corps of Engineers
Aarin Teague PhD. , Senior Engineer at San Antonio River Authority, Texas
Jason Smith P.Eng., Rock Island District, The US Army Corps of Engineers.

Poster #: 87

Abstract:
A forerunner to the Global Water Futures, The Drought Research Initiative (DRI), played a key role in the Invitational Drought Tournament (IDT). Has proven to be very successful having been applied to a range of risk management issues in Canada, North America, the Caribbean, Central America, Africa and Asia. The concept has evolved to include multiple hazards, a range of hydro-meteorological information combined with socio-economic information to address an increasingly sophisticated number of issues facing water managers and their stakeholders.
This presentation will describe how the methodology has evolved both technically and in terms of its practical application. It will provide information regarding the factors to consider when determining if the approach can support researchers, policy makers and decision makers address water related risk assessment, mitigation and adaptation.
Examples of training materials will also be provided.

Modelling Agricultural Landowners' Demand for Monetary Compensation to Take Up Best Management Practices in Ontario

Lead Author: Haiyan Liu, Economics, University of Waterloo
Presenting Author: Haiyan Liu, Economics, University of Waterloo
Email address: h445liu@uwaterloo.ca
Co-Authors:
Roy Brouwer, Economics, University of Waterloo

Poster #: 88

Abstract:
Severe algal blooms have been a recurring phenomenon in Lake Erie in the past few decades. Excess nutrients runoff from agricultural lands is a major contributor and various best management practices (BMPs) have been promoted to resolve this issue. However, BMP adoption rates are still far below expected after more than 20 years' introduction into the market. In this study, we first investigate farmers' current BMP adoption status and then elicit their demand for monetary compensation to increase their take-up. We pay particular attention to the factors and conditions that incentive farmers' adoption. The core part of the project is to design an online survey with a discrete choice experiment which specifies a couple of hypothetical BMP options for pre-identified attributes. Choice experiment, as a stated preference method, along with other socio-demographic characteristics of the farmer and farm operation data, can recover estimates of farmers' willingness-to-accept for using BMPs. The survey will collect information on agricultural operations (e.g. farm size, main field-based agricultural crops, experience and perception with BMPs), choice experiment (BMP programs with hypothetical BMP type, duration, participation mode, technical support source, inspection type, and compensation level), environmental attitude (e.g. level of concern about drinking water pollution and climate change, and knowledge of local water quality), and socio-economics (e.g. age, gender, education and income). When designing the survey, we sought advice from various practitioners of agricultural policies, to ensure the survey questions are easily understood by farmers and the hypothetical scenarios are realistic. The survey has been distributed to all farmers who are members of Ontario Soil and Crop Improvement Association (OSCIA). We will analyze the data with proper economic and econometric models.

Changing cyanobacteria blooms despite constant nutrient loads

Lead Author: Megan L. Larsen, Department of Geography and Environmental Studies, Wilfrid Laurier University
Presenting Author: Jason J. Venkiteswaran, Department of Geography and Environmental Studies, Wilfrid Laurier University
Email address: jvenkiteswaran@wlu.ca
Co-Authors:
Jason J. Venkiteswaran, Department of Geography and Environmental Studies, Wilfrid Laurier University
Helen M. Baulch, School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan
Sherry L. Schiff, Department of Earth and Environmental Sciences, University of Waterloo
Scott N. Higgins, IISD Experimental Lakes Area

Poster #: 89

Abstract:
Nuisance and harmful algal blooms impair water quality and threaten our use of lakes for recreation, fisheries, and drinking water. Managing and preventing blooms requires understanding their multiple drivers in order to develop site-specific mitigation strategies. We used environmental and climatic forcings as external drivers that change the pattern of bloom growth and cessation in Lake 227, a small, softwater, experimentally eutrophied lake at the IISD Experimental Lakes Area. Since 1990, only phosphorus has been added to the lake during the open-water season, making this a multi-decadal replicated experiment in time. We observed a gradual transition from a single, long mid-season bloom of the nitrogen-fixing cyanobacteria, Aphanizomenon, into two shorter blooms. The early bloom is heavily dominated by Aphanizomenon whereas the later bloom is more diverse. Nevertheless, the total phytoplankton biomass has remained relatively consistent over the last 27 years. This pattern may be partially driven by earlier stratification and/or a nearly two-week increase in the number of ice-free days that increased the length of the stratified season. Together, the results demonstrate that even within a strictly controlled nutrient-addition experiment, bloom topology and composition will change. This means that managing freshwaters with varying external nutrient loads requires recognizing that recovery targets are constantly moving.

Phosphorus Legacies in Ontario Watersheds

Lead Author: Tamara Van Staden, Earth & Environmental Science, University of Waterloo
Presenting Author: Tamara Van Staden, Earth & Environmental Science, University of Waterloo
Email address: tamara94@shaw.ca
Co-Authors:
Kim Van Meter, Earth and Environmental Science, University of Illinois
Nandita Basu, Earth & Environmental Science, University of Waterloo
Philippe Van Cappellen, Earth & Environmental Science, University of Waterloo

Poster #: 90

Abstract:
Excess phosphorus (P) loading increases the frequency of harmful algal blooms (HABs), posing severe threats to drinking water security and aquatic ecosystems. Efforts to reduce the inputs of P to Canadian agricultural soils started in the late 1970s-early 1980s, and were initially successful, but surface water P loading became persistent again in the 2000s. HABs were a problem in the southern Laurentian Great Lakes (LGL) before the initial nutrient mitigation efforts, and the re-emergence of HABs in Lake Erie in the 2000s was likely a result of legacy P that had accumulated in soils and groundwater in agricultural watersheds. Legacy P exists as a result of historical inputs of P, typically fertilizer used in excess of crop needs. Consequentially, even after reducing P inputs, legacy P continues to be exported from soils after several decades. A large-scale mass balance was conducted for the Ontario watersheds to locate and quantify agricultural and other anthropogenic legacy P inputs from 1961 – 2016, utilizing existing datasets as well as historical reconstructions of P inputs to the landscape. This scale of P mass-balance has not been completed before in Ontario. The mass balance model was implemented into a Geographical Information System (GIS) platform to delineate areas of legacy P accumulation and depletion within the landscape. These maps identified areas with high P inputs and large stores of legacy P. Notably, southwestern Ontario has historically been the densest agricultural area, and has had high P inputs over time. County-scale trends such as shifts to livestock or crop-based agriculture, or increasing urbanization were also identified. Additionally, as P export is influenced by redox conditions in soil, and more clay in the soil can increase attenuation of P transport, there is spatial variance in the likelihood that P will leach or accumulate in soils. The total cumulative legacy P accumulation map was used to construct a soil vulnerability map. Soil data such as clay and iron content in conjunction with drainage data such as topography, drainage, and proximity to surface water were used to identify vulnerable areas with a high risk of P leaching to surface water. The results inform nutrient management and abatement strategies and the implementation of conservation practices.

Modification of global riverine nitrogen fluxes by river damming

Lead Author: Zahra Akbarzadeh, Earth and Environmental Sciences, University of Waterloo
Presenting Author: Zahra Akbarzadeh, Earth and Environmental Sciences, University of Waterloo
Email address: zakbarza@uwaterloo.ca
Co-Authors:
Taylor Maavara, Earth and Environmental Sciences Area, Lawrence Berkeley National Laboratory
Stephanie Slowinski, Earth and Environmental Sciences, University of Waterloo
Philippe Van Cappellen, Earth and Environmental Sciences, University of Waterloo

Poster #: 91

Abstract:
River damming, accelerating significantly after the Second World War, shows no sign of abating in the coming decades. Dams are known to promote N elimination by burial in sediments accumulating in reservoirs and through the emission of gaseous products of denitrification to the atmosphere. However, few studies have investigated the global N fixation in dam reservoirs. We quantify the role of damming in regulating global riverine nitrogen (N) fluxes using a reservoir N mass balance model. In-reservoir processes represented in the model include primary production, mineralization of organic N, denitrification and sedimentary burial. Additionally, N fixation is considered as a source of new N to reservoirs, and estimated based on the N to phosphorus (P) ratio of the riverine inflow. Using Monte Carlo analysis, we upscaled the N mass balance and created a virtual global dataset of dams. In this dataset, two global relationships between N elimination in reservoirs, either by denitrification or burial, and the hydraulic residence time are derived. These relationships are then combined with N loads to the world's dam reservoirs generated by the Global-NEWS model and the estimated N fixation fluxes. The results demonstrate that, globally, denitrification and burial in dam reservoirs exceed N fixation, and as a result, dam reservoirs act as a sink of N. We quantify that denitrification and burial in reservoirs eliminated 7% of N loading to the global river network in the year 2000, yet this percentage could rise to 15% by 2050 in consequence of the rapid building of new dams. Our results further imply that dams increase the N:P ratio of riverine discharge, thereby reducing the magnitude of N limitation of primary production in receiving lentic and coastal marine environments. The latter should inform management strategies to lessen the impacts of cultural eutrophication.

Hydrodynamic modelling of snowmelt flooding events and nutrient transport in the Canadian Prairies using the FLUXOS model

Lead Author: Diogo Costa, Global Institute for Water Security, University of Saskatchewan
Presenting Author: Diogo Costa, Global Institute for Water Security, University of Saskatchewan
Email address: diogo.costa@usask.ca
Co-Authors:
John Pomeroy, Global Institute for Water Security, University of Saskatchewan

Poster #: 92

Abstract:
Agricultural runoff is a key source of nutrients, contributing to widespread eutrophication, which is generally considered the most significant stressor affecting water quality worldwide. In many cold regions, snowmelt causes temporary flooding of agricultural fields and is a major period of nutrient transport. For example, in the Canadian Prairies and Northern US Great Plains, snowmelt is normally the dominant runoff event of the year and is generally responsible for soil losses of N and P exceeding those from rainfall-induced runoff in the summer. Large snowmelt runoff volumes and reduced infiltration during snowmelt over seasonally frozen soils are some of the factors contributing to this phenomenon. The ability to predict nutrient transport during snowmelt is important to support the development of effective land management practices, but it remains a major scientific challenge. Snowmelt occurs during a short period but often causes extensive flooding of agricultural fields and has a major impact on the annual nutrient export. This suggests that hydrodynamic simulations at high temporal and spatial resolution may be helpful to improve the prediction of field-scale streamflow and nutrient export during snowmelt events and help advance theory on the dominant processes affecting nutrient release. In this study, the FLUXOS model for hydrodynamic modelling was repurposed to simulate snowmelt events in the Canadian Prairies where extensive flooding of agricultural fields is common. The model was originally developed for river reach flood simulations, and therefore it was repurposed here to allow for field and catchment-scale simulations and snowmelt forcing through new T-index and snow energy balance modules. A module for drop inlet spillways and culverts was also included. The prototype model has been tested in the South Tobacco Creek (MB) and Smith Creek (SK) Watersheds and shows promising results. This presentation will focus on the advances and future perspectives with this modelling approach. Plans for coupling FLUXOS to The Canadian Hydrological Model (CHM) will also be discussed.

Contribution of Point Source Inputs from a Bunker Silo to Phosphorus Loads from a Small Agricultural Watershed in Ontario, Canada

Lead Author: Dylan Price, Geography & Environmental Management, University of Waterloo
Presenting Author: Dylan Price, Geography & Environmental Management, University of Waterloo
Email address: d2price@uwaterloo.ca
Co-Authors:
Merrin Macrae, Geography & Environmental Management, University of Waterloo
Janina Plach, Geography & Environmental Management, University of Waterloo
Will Pluer, Geography & Environmental Management, University of Waterloo

Poster #: 93

Abstract:
Phosphorus (P) loads from agricultural sources contribute to feshwater eutrophication. In agricultural watersheds, most attention has been given to diffuse sources such as fertilizers and manure applied to fields, as non-point sources are difficult to manage. However, the role of small point sources is poorly understood and has not been quantified relative to non-point sources. On livestock farms, nutrient-rich, acidic effluent from bunker silos can contribute to the degradation of surface waters. The objectives of the study are to: 1) quantify P concentrations, species and loads from the bunker silo effluent and farm yard, and compare these to P from non-point sources in the same watershed; and 2) to quantify the legacy P stored in a riparian wetland adjacent to the bunker silos, and determine if the riparian wetland is acting as a P source. Stream discharge and concentrations of soluble reactive P, total dissolved P and total P were monitored over a one-year period, to quantify P loads from diffuse inputs from agricultural fields and inputs from the bunker silo and farm yard of a small dairy farm. Groundwater fluxes and P concentrations were monitored from the impacted and non-impacted sections of the riparian wetlands under a range of antecedent conditions. Results demonstrate significant contributions of P both directly from the bunker silo, and the riparian wetland located adjacent to the bunker silo. These data provide insight into the significance of critical source areas, and the role of point sources in the landscape to P loads to freshwater ecosystems.

Using land-use, catchment classifications and nutrient regimes to understand nutrient retention in prairie wetlands

Lead Author: Emily Cavaliere, GIWS, University of Saskatchewan
Presenting Author: Emily Cavaliere, GIWS, University of Saskatchewan
Email address: emily.cavaliere@gmail.com
Co-Authors:
Amy Hergott, GIWS, University of Saskatchewan
Helen Baulch, GIWS, University of Saskatchewan
Nandita Basu, Earth and Environmental Sciences, University of Waterloo

Poster #: 94

Abstract:
The Canadian Prairies are a changing landscape. The hydrology has changed due to shifts in precipitation patterns, a warming climate and changing water management. Biogeochemical cycles are also changing. For example, agriculture nutrient inputs have altered aquatic ecosystem function. Wetlands are important sites that alter flow and nutrient regimes. Within the Prairies, wetlands still number in the millions. However, a large proportion of historic wetlands have been lost to human activity, and wetland drainage is ongoing. This research aims to understand the varied role of diverse wetlands in the prairie landscape – understanding factors that affect whether wetlands are functioning as nutrient sources, sinks, or transformers. We combine field-based data collection with a meta-analysis of flow-nutrient relationships across the Prairies to better understand spatial variation in wetland and watershed function. Data presented within this poster are a first step towards developing modelling approaches to better understand the functionality of prairie wetlands in the landscape. The next steps will be to integrate this understanding into predicting the effects of changing climate, and wetland management in the transport of nutrients from agricultural landscapes of the Prairies.

Understanding the influence of ice barrier on the mobility of carbon, nitrogen and phosphorus in agricultural soils

Lead Author: H. Townsend, Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada
Presenting Author: H. Townsend, Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada
Email address: hrtownse@uwaterloo.ca
Co-Authors:
F. Rezanezhad, Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada
P. Van Cappellen, Ecohydrology Research Group, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada
M. Macrae, Biogeochemistry Lab, Department of Geography and Environmental Management, University of Waterloo, Waterloo, Canada

Poster #: 95

Abstract:
Agroecosystems serve as a major non-point source of nutrients, contributing to the eutrophication of downstream waters and the proliferation of harmful algal blooms. Understanding the seasonal availability, transformation and speciation of carbon (C), nitrogen (N), and phosphorus (P) in agricultural soils is key to creating accurate nutrient budgets and models. In existing models, the impacts of winter soil processes are often ignored or under-developed. Current climatic trends and associated winter warming are altering the timing of snow cover and spring snowmelt, implicating biological, physical and chemical processes occurring in soils. Eruptions of greenhouse gases (GHG) such as carbon dioxide (CO2) and nitrous oxide (N2O) from agricultural soils have been associated with the thawing of soil, where the length of freezing has been linked to the magnitude of GHG release. This study explores ice as a barrier to gas exchange by comparing soils under a simulated ice layer with samples experiencing open gas exchange with the atmosphere in a laboratory-controlled setting. The results demonstrated that the presence of ice increases the concentrations of dissolved inorganic carbon and total nitrogen in porewaters below the soil surface. Time series data collected in this experiment will be used to model how changes in the duration of soil freezing may impact water quality in future climate scenarios and help to shape best management practices related to the application of fertilizer in the fall.

Modified Chitosan Beads for the Removal of Phosphate from Aqueous Solution

Lead Author: Lee Wilson, Chemistry Department, University of Saskacthewan
Presenting Author: Inimfon Udoetok, Chemistry Department, University of Saskacthewan
Email address: inimfon.udoetok@usask.ca
Co-Authors:

Poster #: 96

Abstract:
Chitosan was modified through bead formation by two methods of cross-linking; before and after bead formation, along with imbibition of copper ions. Characterization of the bead materials via spectroscopic (FTIR and 13C solids NMR) and thermal analyses (TGA) confirm variable level of cross-linking in the beads according to the cross-linking method. SEM, XPS and equilibrium solvent swelling results further affirm the variable level of cross-linking and copper imbibition in the beads. ICLCu (cross-linked before bead formation) exhibited the greatest pillaring of chitosan fibrils, lowest concentration of copper ions and percentage swelling. Equilibrium and kinetic uptake of phosphate ions at pH 8.5 and 295 K reveal that NCLCu (non-crosslinked copper imbibed bead) displays the highest affinity with phosphate ions (Qm = 133 ± 45 mg/g), in agreement with the highest Cu2+ content of the beads. Regeneration studies affirmed the recyclability and cost effectiveness of the beads in line with consistent orthophosphate removal efficiency after four cycles of adsorption/desorption. This study reveals the role of cross-linking method on the extent of copper complexation with chitosan and the resulting phosphate sorption capacity of modified chitosan beads. The “green” materials design strategy herein provides support for the use of such low-cost and effective sorbents for a practical solution to address phosphate contamination in aquatic environments.

Legacy soil P in agricultural landscapes of Manitoba Prairies and Lower Great Lakes region of Ontario

Lead Author: Janina Plach, Geography and Environmental Management, University of Waterloo
Presenting Author: Janina Plach, Geography and Environmental Management, University of Waterloo
Email address: jplach@uwaterloo.ca
Co-Authors:
Merrin Macrae, Geography and Environmental Management, University of Waterloo
Henry Wilson, Agriculture and Agri-Food Canada

Poster #: 97

Abstract:
Phosphorus storage and release in agricultural soils is controlled by the interaction between hydrology and soil biogeochemistry, reflecting dynamic environmental and soil conditions (e.g., pH, water table, redox), and abundance and reactivity of soil organic matter (e.g., plant residue) and minerals (e.g., clay, metal-oxides, carbonates). Agricultural soils of the Canadian Prairies and the lower Great Lakes region are naturally calcareous, but differ in texture (clay to loams) and topography (flat to hummocky). Establishing soil biogeochemistry and solid-phase partitioning of Legacy Pi can help predict the timing of Pi re-release under changing soil conditions (e.g., flooding) and associated Pi availability to crops and runoff. This is essential to provide insight for farmers into more effective and customized P management strategies based on soil type, landscape position, geographic region and according to risk of soil Pi loss. As such, the objectives of this study were to determine; 1) legacy Pi concentrations, and 2) important solid-phase Pi partitioning in agricultural soils of Manitoba (3 fields) and Ontario (2 fields, 1 riparian buffer). Soil (0-5, 5-15 and 15-30 cm) was collected in 2018 along contrasting landscape positions (high to low slope) at each site. Landscape position was used as a proxy for differing soil conditions i.e., low slope having greater occurrence of flooding. Porewater (pH, O2, Fe, Ca and Pi concentrations) were collected along a landscape position at one Ontario site. Characterizing soil biogeochemistry linked to soil Pi availability, and implications for predicting risk of soil Pi to downstream water quality will be presented.

Characterizing Watershed-scale Responses in Water Quality to Changes in Anthropogenic Nutrient Inputs in The Laurentian Great Lakes Drainage Basins

Lead Author: John Dony
Presenting Author: John Dony
Email address: jwldony@uwaterloo.ca
Co-Authors:
Nandita Basu
Kim Van Meter
Qualbe Shadman T. Chowdhury

Poster #: 98

Abstract:
Anthropogenic nutrient inputs into water bodies pose serious challenges to our water resources. Cultural eutrophication resulting from excessive nitrogen and phosphorus loading into ground- and surface waters can lead to deteriorating water quality and associated ecological and public health concerns. The Laurentian Great Lakes drainage basin is particularly vulnerable to water quality threats due to its highly populated urban areas and the substantial amount of agricultural land use. Past initiatives have been successfully implemented to reduce point source nutrient loadings into the Great Lakes and its tributaries to improve water quality. Despite these nutrient reduction efforts, eutrophication problems persist in the Great Lakes, in part due to continued nutrient loadings from non-point sources. To address non-point nutrient pollution, Best Management Practices (BMPs) are implemented at the watershed scale to reduce nutrient export to waterways. Assessing the effectiveness of various BMPs presents a challenge due to the diversity and variation of anthropogenic and natural landscapes. This is further complicated by extended response times between the implementation of BMPs and changes in water quality; improvements are often not immediate and instead occur decades after BMPs are implemented depending on local biogeochemical and hydrological processes. Delays in watershed responses from nutrient inputs pose challenges for policy makers and watershed managers addressing eutrophication, since improvements in water quality will not be demonstrated until well after mitigation strategies are implemented. Furthermore, the temporal scale of watershed responses is locally dependant, so delays will vary by watershed.
Through my research I aim to improve our understanding of the responses and behaviours of watersheds the Great Lakes to changes in anthropogenic nutrient inputs. I am investigating and quantifying trends in historical water quality records to determine spatial and temporal factors that affect nutrient loadings into water bodies. I am using time series water quality data and spatial data for the Great Lakes Watersheds to determine trends related to anthropogenic nutrient loadings using stochastic and numerical methods. This includes methods such as cross correlation, regression and clustering techniques, spatial interpolation and model development. Currently, my research is in the early stages and results are a work-in progress.
By applying a stochastic approach to investigate trends in water quality, my objective is to improve our understanding of the behaviour and response of the Great Lakes watersheds to anthropogenic nutrient inputs. Understanding the spatial factors influencing nutrient dynamics and time lags in watersheds is critical for implementing effective management strategies over appropriate time scales and managing expectations with regards to delays in observing the outcomes. This research will directly benefit water managers and policy makers operating in these watersheds and lead to more effective watershed management for improved water quality and solutions to Southern Ontario's eutrophication concerns.

Influence of urban landscape on Lake Wilcox' water quality

Lead Author: Jovana Radosavljevic, Earth and Environmental Science, University of Waterloo
Presenting Author: Jovana Radosavljevic, Earth and Environmental Science, University of Waterloo
Email address: jradosav@uwaterloo.ca
Co-Authors:
Mahyar Shafii, Earth and Environmental Science, University of Waterloo
Philippe Van Cappellen, Earth and Environmental Science, University of Waterloo
Melissa Turcotte, Earth and Environmental Science, University of Waterloo

Poster #: 99

Abstract:
Excess of phosphorus (P) in freshwater aquatic ecosystems can result in eutrophication and emergence of harmful algae. To establish best management practices for P control, sources and the composition of P exported to water bodies need to be determined. In this research, we focus on Lake Wilcox located in Ontario (45 km north of Toronto) and analyze historical water quality data (with a special focus on the last three years 2016–2018) to understand seasonality in water quality variables, as well as the effects of urban landscapes on physical processes in the lake. Lake Wilcox is dimictic (i.e., mixes in the spring and fall and stratifies in the summer and winter), and its P loadings are either external (via runoff) or internal (from lake sediment). Long term data indicates Lake Wilcox is anoxic below the depth of 6 m in the time window of June to August. However, recent data show that anoxia has been longer in the past three years (i.e., from June to mid-October in 2016 and 2017, and from June to September in 2018). This can be partially attributed to high concentrations of chloride, which have been significantly high in the past years due to road salt application in urban areas during winter. Decreasing dissolved oxygen and variable concentrations in total phosphorus between the seasons indicate that internal load has a significant contribution to water quality. Data also demonstrates seasonality in P loading that is associated with temporal variations in runoff dynamics. Because Lake Wilcox is surrounded by urban areas, export and speciation of P is controlled by stormwater management infrastructure (e.g., sewers, ponds and/or green technologies such as bioretention cells). This highlights the need for proper stormwater management aiming to minimize P loss from urban areas, especially during extreme hydrologic events.

How are Fall Fertilizer Amendments Affected by Winter Soil Conditions?

Lead Author: Konrad Krogstad, Earth and Environmental Sciences, University of Waterloo
Presenting Author: Konrad Krogstad, Earth and Environmental Sciences, University of Waterloo
Email address: kjkrogst@uwaterloo.ca
Co-Authors:
Grant Jensen, Biology, University of Waterloo
Laura Hug, Biology, University of Waterloo
Fereidoun Rezanezhad, Earth and Environmental Sciences, University of Waterloo

Poster #: 100

Abstract:
Agricultural soils in cold regions are critical in governing water flows and quality within agriculture catchments. Increased winter temperatures caused by climate warming may expose soils to colder temperatures and more freeze-thaw events. Freeze-thaw cycles influence chemical, biological, and physical soil properties that control carbon and nutrient cycling as well as microbial activity in soils. Changes to these processes may impact nutrient export from affected soils, possibly altering soil health and nearby water quality. Determining these impacts will improve our conceptual and quantitative understanding of shallow subsurface biogeochemical processes in agricultural soils of cold climate regions. In this study, a soil column experiment was conducted using agricultural soil to assess the leaching of carbon and nutrients during the fall-winter and winter-spring transitions and during the non-growing season. The soil columns were exposed to a non-growing season temperature and precipitation model and fertilizer amendments were made to the experimental columns to determine the efficacy of Fall-applied fertilizers, which is relevant for current 4R fertilization guidelines (right source, right rate, right time, right place). Leachates from the columns were collected and analyzed for dissolved organic and inorganic carbon (DOC, DIC), total nitrogen (TN), and major cations and anions. Findings from this experiment will ultimately be used to bolster winter soil biogeochemical models by elucidating carbon and nutrient fluxes over changing winter conditions and refine the best management practices for fertilizer application.

Effect of stormwater ponds on phosphorus dynamics in urban catchments: insights from a modeling approach

Lead Author: Mahyar Shafii, Earth and Env Sci, UW
Presenting Author: Mahyar Shafii, Earth and Env Sci, UW
Email address: mshafiih@uwaterloo.ca
Co-Authors:
Melissa Turcotte, Earth and Env Sci, UW
Chris Parsons, Earth and Env Sci, UW
Nandita Basu, Earth and Env Sci, UW
Philippe Van Cappellen, Earth and Env Sci, UW

Poster #: 101

Abstract:
Stormwater (SW) runoff in urban areas serves as an important pathway for exporting nutrients and contaminants to downstream ecosystems. As a SW management practice for flood control and water quality improvement, several SW ponds have been put in place all across the world. In Ontario, improved pond designs (such as hybrid extended detention ponds) have become a common practice for addressing the emerging flood, water quality, and sediment erosion concerns under climate change. Despite the implementation of a large number of SW ponds, understanding about their storage, export and internal cycling of nutrients is very limited. Phosphorus (P) is a key macro nutrient that limits or co-limits many freshwater ecosystems. A number of previous studies have suggested internal P transformations through SW ponds. However, the effect of P cycling in these ponds on the downstream flowing water bodies has not been properly quantified. Our research involves developing and calibrating a parsimonious process-based model of P based on existing knowledge and data on P cycling in SW ponds. The model will be then employed to get quantitative insight into the effect of SW ponds on P export and speciation at the watershed scale. Upon such quantitative characterization of P forms and transformation rates within urban landscapes, we will conduct scenario analysis to assess the risk of increases in P export in the presence of extreme hydrologic events.

Diffusive Phosphorus Fluxes at the Sediment-Water Interface from Eastern Canadian Lakes

Lead Author: Mauro de Toledo, SENS, University of Saskatchewan
Presenting Author: Mauro de Toledo, SENS, University of Saskatchewan
Email address: m.b.detoledo@usask.ca
Co-Authors:
Helen Baulch, SENS, University of Saskatchewan

Poster #: 102

Abstract:
Although phosphorus (P) is an important nutrient for plants and algae, increased phosphorus availability can cause adverse effects. High phosphorus loads increase the growth of algae, contributing to lake eutrophication and its many negative effects such as cyanobacterial blooms, water turbidity, anoxia, and fish kills. A portion of the phosphorus that enters a lake may be deposited in the bottom sediments. However, certain environmental conditions cause the release of the deposited phosphorus into the sediment porewater. From there, the dissolved phosphorus can diffuse deeper into the sediments or move up to the water column (i.e. internal phosphorus loading) and maintain eutrophic conditions for several years, even after external sources of phosphorus have been controlled. The amount of phosphorus released from sediments to the water column is a function of various environmental conditions (e.g. redox state, pH, temperature, and phosphorus concentration in the porewater and water column). The abundance of different phosphorus fractions in the sediment pool (e.g. Fe-bound P, Al-bound P, Ca-bound P, and organic P) also plays a significant role. I measured the concentration of dissolved phosphorus and metals in the sediment porewater to better understand controls on phosphorus concentration in the water column, estimating the potential importance of sediment-water fluxes in nutrient supply. Predicted phosphorus fluxes for all the studied lakes were from the sediments to the water column and are broadly reflective of the range shown in other Canadian lakes. Preliminary data analysis suggests geospatial patterns related to ecozones, geology, and human impact.

Updated Lake Erie nutrient mass balance: Integrating new information into a body of existing knowledge.

Lead Author: Serghei Bocaniov, Department of Earth and Environmental Sciences, University of Waterloo
Presenting Author: Serghei Bocaniov, Department of Earth and Environmental Sciences, University of Waterloo
Email address: sbocaniov@uwaterloo.ca
Co-Authors:
Igor Markelov, Department of Earth and Environmental Sciences, University of Waterloo
Homa Kheyrollah Pour, Department of Earth and Environmental Sciences, University of Waterloo
Alice Dove, Water Quality Monitoring & Surveillance, Sean M. Backus, Environment and Climate Change Canada
Department of Earth and Environmental Sciences, University of Waterloo; Water Institute, University of Waterloo

Poster #: 103

Abstract:
Lake Erie is one of the economically foremost lakes of North America where despite significant reductions in external nutrient loads in the past few decades the water quality has not improved and is in serious decline right now. After periods of eutrophication (1950s to 1970s), followed by a period of oligotrophication due to reduced external loads (1980s to 1990s), lake is currently entering a new re-eutrophication stage as manifested by increasing frequency, spatial extent and severity of observed episodes of harmful algal blooms in its western basin, hypoxia or low dissolved oxygen concentration in the central basin, and filamentous green algae Cladophora in the east basin. This may suggest that increase in lake's internal loading and cycling of nutrients is larger in magnitude and importance compared to the observed reduction in external loadings.
Nutrient mass balance analysis studies have been shown to be crucial for understanding of eutrophication processes and estimates of internal loading in lakes. In light of recent improvements in estimates of nutrient fluxes due to both higher temporal resolution of measurements of water quality constituents and acquired more accurate load estimation techniques, an integrated mass balance of total phosphorus (TP) has been constructed for the St. Clair – Niagara River system to estimate basin-specific external and internal loads from 2003 through 2013. Mass balance components included estimation of TP inputs from the direct and indirect sub-watersheds, point sources (industrial and municipal discharges), atmospheric loads, allochthonous inputs from the upstream watershed (Lake Huron), and losses via the major outflow (Niagara River) and a ship canal (Welland Canal).

Phosphorus retention in a Southern Ontario reservoir: Seasonal and annual mass balance

Lead Author: Tung Kao, Environmental and Earth Sciences, University of Waterloo
Presenting Author: Tung Kao, Environmental and Earth Sciences, University of Waterloo
Email address: nadykao@gmail.com
Co-Authors:
Amanda Niederkorn, Environmental and Earth Sciences, University of Waterloo
Mohamed Mohamed, Environment and Climate Change Canada
Chris Parsons, Environmental and Earth Sciences, University of Waterloo

Poster #: 104

Abstract:
The increasing frequency and severity of harmful algal blooms (HABs) in Lakes Erie and St Clair have been troubling developments in the past few decades, and excess loads of phosphorus (P) are considered to be a primary driver to this re-eutrophication. The Thames River, in southern Ontario, is the largest tributary P input to Lake Erie's western basin from the Canadian side. Dammed reservoirs are known to attenuate P fluxes, however, the reservoir retention efficiencies for P reported in the literature are highly variable. The influence of three large reservoirs (Fanshawe, Pittock, and Wildwood) on P loads of the Upper Thames River are currently poorly constrained both seasonally and annually due to a lack of primary data. P mass balance approaches were attempted in the past. However, these studies were hampered by a lack of primary chemistry data spanning all seasons and were never subjected to peer-review.
Here I will present the results from a P mass balance model we developed to assess whether Fanshawe Reservoir acts as a net P sink or source to downstream Thames River on an annual and seasonal time scale. For a complete one-year duration (March, 2018 – March, 2019), we collected water samples every two weeks on the Thames River upstream and downstream of Fanshawe Reservoir, in addition to ECCC's data collected at the same upstream location (January, 2018 – June, 2018). DRP, TDP, and TP were analysed and were used, in combination with discharge values provides by WSC, to calculate seasonal loads for each fraction using the Beale Ratio Estimator method. Our results show that a drastic variation of P loading and retention efficiency exists seasonally. Inflowing TP loads range from over 110 metric tons (Winter 2018) to 6.4 metric tons (Summer 2018). Outflowing total P loads range from 22.9 metric tons (Winter 2019) to 7.5 metric tons (Summer 2018). The reservoir acted as a strong sink during Fall 2018 (70.19% retained) and Winter 2019 (66.24% retained), a moderate sink during Spring 2018 (35.16% retained), and a relatively weak source during Summer 2018 (-17.83% retained). DRP and TDP loads followed comparable seasonal trends. Our results demonstrate the large variation in P loading, retention efficiency and bioavailability of the P load between seasons. Furthermore, our findings provide insight on the potential importance of sampling throughout the entire year for accurate estimations on tributary P loads and reservoirs' retention efficiencies on an annual scale.

Impacts of freeze thaw cycle duration and magnitude on phosphorus release from agricultural soils

Lead Author: Stephanie Higgins, Geography and Environmental Management, University of Waterloo
Presenting Author: Stephanie Higgins, Geography and Environmental Management, University of Waterloo
Email address: smhiggins@uwaterloo.ca
Co-Authors:
Merrin Macrae, Geography and Environmental Management, University of Waterloo

Poster #: 105

Abstract:
Biogeochemical processes in winter agricultural landscapes are poorly understood. Freeze-thaw (FT) processes have been shown to increase phosphorus (P) supply from plants, microorganisms, and decrease soil aggregate stability, making soils more vulnerable to erosion. Climate change will increase the number of melt events in winters, leaving soils more susceptible to an increased number of FT cycles. In the laboratory, soil cores (10 cm depth, 5 cm diameter) from an agricultural field in Southern Ontario were subjected to three FT cycles of variable temperature magnitude (-18°C, -4°C and 4°C) and variable length of time (1 day or 1 week per cycle) to determine the impacts of frost magnitude and duration on soil extractable P (water extractable and sodium bicarbonate extractable), microbial biomass P, aggregate stability, and, P concentrations and forms in leachate. At each time step, half of the cores were flushed with artificial rainwater, and leachate was collected and analyzed for three forms of P: total P, total dissolved P and soluble reactive P. Triplicate soils cores were used for temperature magnitude, duration of FT cycle, and rain condition. Results showed strong variability within the samples. As expected, FT impacted both the forms and concentrations of P in soil and leachate; however, this differed with both frost duration and magnitude, patterns will be discussed. This research provides an improved understanding of the role of frost in P supply from agricultural soils and can shed insight into the potential impacts of a changing climate on soil P dynamics in winter.

Long Term Trend of Total Phosphorus Concentration of Lake Erie Watersheds

Lead Author: Lamisa Malik, Civil & Environmental Engg., University of Waterloo
Presenting Author: Lamisa Malik, Civil & Environmental Engg., University of Waterloo
Email address: l6malik@uwaterloo.ca
Co-Authors:
Dr. Nandita Basu

Poster #: 106

Abstract:
Eutrophication has been observed in Lake Erie since 1960's due to presence of excess nutrient in the lake water. It leads to massive algal bloom and anoxic condition posing threat to drinking water quality and aquatic ecosystem. Phosphorus (P) is a limiting nutrient in water body and its concentration has been increasing over the last century, especially in human-impacted watersheds. Main source of Phosphorus pollution is due to increasing use of fertilizers, detergents, animal feed etc. To reduce phosphorus loads to lakes and rivers first agreement was signed in 1972 with banned in use of P in laundry detergent. Despite of ongoing effort to reduce the phosphorus loads to Lake Erie by 50%, toxic and nuisance algal blooms began increasing in 1990s. To understand the reasoning behind this, a study has been conducted by analyzing the trend of long-term Total Phosphorus (TP) concentration for all the watersheds that drains into Lake Erie. For simplification, Lake Erie algae problem has been described in relation to the three main basins i.e. western, central and eastern basin. Different time spectrum of TP has also been analyzed for each of the watershed to see the change of trend due to phosphorus reduction program over the time frame. It is observed that western basin receives most of the total phosphorus load when compared to other basins. To observe the main drivers to Lake Eutrophication, Phosphorus mass balance of most human impacted watershed contributing to Lake Erie- Maumee River Watershed has also been studied. It is hoped that this study will give some insight of nutrient enrichment within the Lake Erie basin as well future opportunities to assess the legacy P accumulation.

A Comparative Study of Lumped Model GR4J and Distributed Hydrological Model VIC at 49 Catchments in the Lake Erie Basin

Lead Author: Hongren Shen, Dept. Civil and Environmental Engineering, University of Waterloo
Presenting Author: Hongren Shen, Dept. Civil and Environmental Engineering, University of Waterloo
Email address: hongren.shen@uwaterloo.ca
Co-Authors:
Juliane Mai, Dept. Civil and Environmental Engineering, University of Waterloo
Ming Han, Dept. Civil and Environmental Engineering, University of Waterloo
Bryan A Tolson, Dept. Civil and Environmental Engineering, University of Waterloo
Nicolas Gasset and Vincent Fortin, Dept. Recherche en prévision numérique environnementale, Environment and Climate Change Canada

Poster #: 107

Abstract:
Hydrologic models provide people with the extrapolations and predictions of key hydrologic variables, such as evapotranspiration, soil moisture, and runoff in both space and time, thus making these models helpful in water resources management and decision-making. However, choosing an appropriate model in terms of model complexity is a crucial step for both operational and research purposes. This study presents a comparative analysis of a simple lumped rainfall-runoff model (GR4J) and a complex distributed model Variable Infiltration Capacity (VIC) at 49 catchments in the Lake Erie Basin to improve our understanding of the difference in model performance due to different model complexity. GR4J model comprise six parameters (four parameters from the original GR4J model and two parameters from the Cema-Neige snow module) for each lumped catchment and it requires minimum meteorological data, i.e. precipitation and air temperature, while VIC model needs more forcing variables to simulate water-energy balance and it considers distributed information about the catchment, such as land cover, vegetation, and soil properties, both making it naturally bounded with many parameters for each grid cell. This study applied the same input data and consistent calibration protocol for the two models. The Regional Deterministic Reforecast System (RDRS) forcing data is used to drive GR4J and VIC during the period from 2010 to 2014. Gauges chosen for calibrating the two models are comprised of both regulated and natural ones and the drainage areas range from 200 km2 to 2,000 km2. Afterwards, model efficacy in runoff simulation at multi-site is evaluated by testing the conventional model performance statistics such as Nash-Sutcliff Efficiency, percent of bias, and linear correlation coefficient, and model run time. The results will shed light upon how one can select an appropriate hydrologic model in terms of simulation and computational efficiency in the Lake Erie Basin.

Revisiting Water Budget of Lake Erie

Lead Author: Igor Markelov, Ecohydrology Group, University of Waterloo
Presenting Author: Igor Markelov, Ecohydrology Group, University of Waterloo
Email address: is.markelov@gmail.com
Co-Authors:
Serghei Bacaniov, Ecohydrology Group, University of Waterloo
Homa Kheyrollah Pour, Ecohydrology Group, University of Waterloo
Philippe Van Cappellen, Ecohydrology Group, University of Waterloo

Poster #: 108

Abstract:
In this work, we focus on historical (1917-2017) trends of individual hydrological components and the water level of Lake Erie as well as on the recent (2003-2017) basin-wide water balance. Along with strong seasonal and annual patterns, precipitation and runoff have 30 years cycles which could be best seen in the 10-year moving averages. These cycles correlate well with the water level of Lake Erie. During the last 40 years, the precipitation occurs more often during the early fall and produces higher runoffs. From 2003 to 2013, the water level fluctuated around its average values. The year 2011 was the record year by many parameters.
It delivered the record volumes of waters through the rains and runoffs.
However, it has not increased the water level of Lake Erie due to they constitute only a small portion of the water budget. To a large extent, the water level in Lake Erie is regulated by the water supply from the upper Laurentians Great Lakes via St. Clair River.

Vulnerability of the world's cold regions large lakes to global environmental pressures: A unified research strategy

Lead Author: Philippe Van Cappellen, Department of Earth and Environmental Sciences, University of Waterloo; Water Institute, University of Waterloo
Presenting Author: Philippe Van Cappellen, Department of Earth and Environmental Sciences, University of Waterloo; Water Institute, University of Waterloo
Email address: pvc@uwaterloo.ca
Co-Authors:
Kevin G. Lamb, Department of Applied Mathematics, University of Waterloo; Water Institute, University of Waterloo
Homa Kheyrollah Pour, Department of Earth and Environmental Sciences, University of Waterloo
Serghei A. Bocaniov, Department of Earth and Environmental Sciences, University of Waterloo
Igor Markelov, Department of Earth and Environmental Sciences, University of Waterloo

Poster #: 109

Abstract:
Large lakes, particularly those in cold regions, are vulnerable to a range of environmental pressures that are being exacerbated by climate change. A clear understanding of the future trajectories of these lakes is of crucial importance to the communities that depend on them for their livelihood, but in many cases meaningful predictions are constrained by limited spatial and temporal coverage of field observations and monitoring programs, and by inadequate knowledge of in-lake processes and their resilience to changing external drivers. Many lakes possess a number of common characteristics and function in similar ways, however. Therefore, the responses to external and internal perturbations of data-poor lakes could be delineated by developing a generalized cold regions' lake typology. In the GWF Lake Futures project, we are currently studying the physical and biogeochemical processes and dynamics in two well monitored Laurentian Great Lakes: Erie and Ontario. Our ultimate goal, however, is to develop transferable approaches for predicting the sensitivity and vulnerability of cold regions' lakes to changes in climate and nutrient inputs. Using a combination of field observational and remote sensing data series, and statistical and mechanistic modeling, we capitalize on our ongoing work in Lake Erie and Ontario to develop a roadmap for predictively assessing the coupled hydrodynamic-biogeochemical evolution of large cold regions' lakes worldwide.

Towards reduced prediction uncertainty for hydro-biogeochemical modelling – an evaluation of the HYPE model for nutrient simulation and management in Canada

Lead Author: Befekadu Taddesse Woldegiorgis
Presenting Author: Befekadu Taddesse Woldegiorgis,School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan
Email address: taddessebefekadu@gmail.com
Co-Authors:
Helen Baulch, School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan
Howard Wheater, School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan

Poster #: 110

Abstract:
Nutrient pollution is widely acknowledged as the most pervasive threat to water quality worldwide. The modelling of nutrients is needed to support field, catchment and regional-scale analyses and the evaluation of management strategies, but is associated with high levels of uncertainty. In our research we address strategies to improve parameter identifiability and reduce model uncertainty, as a basis for addressing nutrient management under Canadian conditions. The predominant practice in calibrating a hydro-biogeochemical model for catchment water quality simulation is to fit a hydrological model, and then fit the biogeochemistry parameters, which reduces the dimensionality of the parameter space for each of these stages, when considered individually. However, literature suggests that this sequential approach gives priority to the hydrologic model, and can compromise the biogeochemical model performance. This paper focuses on the comparison of the prediction uncertainty of sequential vs. simultaneous calibration approaches for nutrient modelling using a formal Bayesian uncertainty analysis. The HYPE model was used to simulate total phosphorus in the Beaver River watershed, Ontario. The DREAMzs sampler was used to identify the hydrologic and water quality parameters, and the predictive uncertainty accounted for model residual heteroscedasticity and serial correlation. Equal weight was given to the hydrologic and water quality likelihood functions for the simultaneous approach. The findings of this research shows that serial fitting of the hydrologic model followed by biogeochemical model fitting seriously degrades the predictive power of the biogeochemical model. The serial approach yields substantively higher predictive uncertainty while the simultaneous approach reduces the width of the 95 percent uncertainty band by three fold while increasing the percentage of observations enclosed in the uncertainty band as compared to the serial fitting approach. Consequently, simultaneous calibration is highly recommended, despite the associated increase in dimensionality of the parameter space for single step calibration. The HYPE results are encouraging and, while more extensive evaluation on a broader range of catchments is needed, they provide provisional support for the model's wider application for nutrient management in Canada.

Simulation of Tile Flow with the Cold Regions Hydrological Model in a Temperate Region: an Ontario Case Study

Lead Author: Merrin Macrae, Department of Geography and Environmental Management, University of Waterloo
Presenting Author: Mazda Kompanizare, Department of Geography and Environmental Management, University of Waterloo
Email address: mkompani@uwaterloo.ca
Co-Authors:
Diogo Costa, Global Institute for Water Security, University of Saskatchewan
Rich Petrone, Department of Geography and Environmental Management, University of Waterloo
John Pomeroy, Global Institute for Water Security, University of Saskatchewan

Poster #: 111

Abstract:
Tile drain networks beneath farm fields can quickly remove excess water from the upper crop root zone following heavy precipitation and snowmelt events, improving the overall field trafficability and crop success. However, tile drains can also create water quality issues by increasing nutrient export to surface water bodies, particularly in soils where macropores enhance preferential flow. There is great interest in assessing and predicting the role of tile drainage on field hydrology and nutrient transfer under both current and future climates. The Cold Regions Hydrological Model (CRHM) platform has been developed based on over 50 years of research in Canadian hydrology, which makes it ideal for addressing the problem of nutrient transport in winter, but the lack of a tile drainage module has limited its use in certain regions. The goal of this work is to develop a tile drainage component for CRHM that includes both flow and nutrient losses. As a first step, the objectives of the current project are to simulate hourly flow through tile drains with CRHM. Although there are other physically-based and empirical hydrological models able to simulate flow rates through tile networks, most of them are unable to operate at sub-daily time intervals, a time scale that is important to capture the dynamics of nutrient loss through tiles. This poster describes recent developments towards a tile drainage module for CRHM. Comparison between observed and simulated data shows good model predictability. The implications of modelled tile flow for nutrient transfer in tiles will also be discussed.

Interoperability between a Hydrologic and Hydraulic Computer Model

Lead Author: Sayed Abedin,Civil & Environmental Engineering, University of Waterloo
Presenting Author: Sayed Abedin,Civil & Environmental Engineering, University of Waterloo
Email address: sjhabedin@uwaterloo.ca
Co-Authors:
Dr. Bruce MacVicar,Civil & Environmental Engineering, University of Waterloo

Poster #: 112

Abstract:
In this research, we aim to exploit the scope of interoperability between a commonly used and widely recognized hydrologic and hydraulic computer model in order to develop an efficient and user-friendly land-use based spatial decision support system. Storm Water Management Model (SWMM) developed and managed by US Environment Protection Agency (EPA) is used as the hydrologic simulation model while Hydrologic Engineering Center's River Analysis System (HEC-RAS) is utilized as the hydraulic simulation model. There are mainly three processes involved to integrate these two models: i) to run SWMM, ii) to feed the output from SWMM into HEC-RAS, and iii) to run the HEC-RAS model. An open source programming language, Python is used to run and integrate these processes under one framework with automation. Wilket Creek watershed located in Toronto, Ontario is used as the study site where the Wilket Creek represents the stream. SWMM produces runoff for a given rainfall event in the watershed that flows into the creek, and HEC-RAS routes the flow through the creek to the downstream end of it. This research is innovative in the sense that it exploits scope of interoperability between SWMM and HEC-RAS through automation, i.e., through running a single Python script. This research will help to integrate SWMM and HEC-RAS models within a larger decision support system, and allow for model run and uncertainty analysis automation.

Improving hydrological simulations in the Prairies using in-situ soil moisture information

Lead Author: Sujata Budhathoki, Global Institute for Water Security, University of Saskatchewan
Presenting Author: Sujata Budhathoki, Global Institute for Water Security, University of Saskatchewan
Email address: sujata.budhathoki@usask.ca
Co-Authors:
Karl E. Lindenschmidt, Global Institute for Water Security and School of Environment and Sustainability, University of Saskatchewan
Bruce Davison, National Hydrology Research Centre, Environment Canada, Saskatoon

Poster #: 113

Abstract:
Traditionally, hydrological models are only trained to accurately reproduce the streamflow regime without considering other hydrological state variables such as soil moisture and evapotranspiration. Limited studies have been performed on constraining the model parameters, which may provide large degree of freedom, resulting in equifinality and poor model performance. In this study, a multi-objective optimization approach is adopted, and both the streamflow and soil moisture data are calibrated simultaneously for an experiment study basin, i.e. Brightwater Creek Basin (BWC) in the Saskatchewan Prairies in western Canada. The results of this study show that multi-objective calibration improves model fidelity compared to the single objective calibration. Moreover, the study demonstrates that, single objective calibration performed against only streamflow can fairly mimic the streamflow hydrograph but does not yield realistic estimation of other fluxes such as evapotranspiration and soil moisture (especially in deeper soil layers) which can be addressed by multi-objective calibration using the in-situ soil moisture data. The study was performed on a small experimental basin in the Prairies using MESH-PDMROF but the work can be transferred to other model applications. Further experiments and studies are required to upscale the study to other large Prairie basins.

A Multi-method Generalized Approach to Assess Dynamical Sensitivity of Complex Watershed Models

Lead Author: Amin Haghnegahdar, Global Institute for Water Security
Presenting Author: Amin Haghnegahdar, Global Institute for Water Security
Email address: amin.haghnegahdar@usask.ca
Co-Authors:
Saman Razavi, Global Institute for Water Security

Poster #: 114

Abstract:
Distributed dynamical physically-based watershed models are being increasingly used as the primary tool for water resources planning and management due to advances in computational power and data availability. For an enhanced and efficient development and application of these complex models, it is critical to understand the dynamical behavior of these models and identify the most influential factors (e.g., parameters) controlling it. Global Sensitivity Analysis (GSA) techniques can be used for this purpose.
The challenge here is that GSA results depend on the GSA approach (e.g., derivative-based, variance-based, or variogram-based), and the type of model response considered. They can also vary with time. To address these challenges a new approach called Generalized Global Sensitivity Matrix (GGSM) is proposed by Razavi and Gupta (2018). When implemented within the STAR-VARS framework, GGSM can use any GSA approach to generate time-aggregated or time-varying sensitivity indices with only a single GSA experiment.
In this study, we aim to illustrate how the STAR-VARS algorithm coupled with the GGSM approach facilitates a computationally-efficient comprehensive GSA using different methods, and how it enables learning about the temporal variability of dominant factors in response of distributed watershed models. For this purpose, we use the VARS-TOOL software toolbox, a comprehensive GSA toolbox, developed based on the VARS (variogram analysis of response surfaces) approach.
For our case study, we use Modélisation Environmentale–Surface et Hydrologie (MESH) as applied to Nottawasaga river basin in Canada. MESH is a semi-distributed physically-based coupled land surface-hydrology modelling system developed by Environment and Climate Change Canada (ECCC) for various water resources management purposes in Canada. MESH couples the Canadian land surface scheme (CLASS) with a routing module, WATROUTE. We will consider multiple model responses such as streamflow and evapotranspiration to assess how the influence of various parameters differs across various model responses.

Pan-Canadian lake and river routing products for hydrologic and land-surface hydrologic models

Lead Author: Ming Han, Civil and Environmental Engineering, University of Waterloo
Presenting Author: Bryan A. Tolson, Civil and Environmental Engineering, University of Waterloo
Email address: btolson@uwaterloo.ca
Co-Authors:
Juliane Mai, Civil and Environmental Engineering, University of Waterloo
Bryan A. Tolson, Civil and Environmental Engineering, University of Waterloo
James R. Craig, Civil and Environmental Engineering, University of Waterloo
Etienne Gaborit, Environment Canada and Climate Change

Poster #: 115

Abstract:
Lakes and reservoirs have critical impacts on hydrological, biogeochemical, and ecological process, and they should be one of the essential components in our hydrological and eco-hydrological models. However, limited research has explicitly included lakes in the hydrologic routing of streamflow through a drainage network. Lakes can greatly reduce flows and delay streamflow delivery downstream and the impacts of ignoring lakes of different sizes still requires more research. In this study, lake and river characteristics, as well as detailed sub-basin delineation products, were compiled from the HydroLAKES database and the HydroSHEDS database and were subsequently used to develop a hydrologic routing network including both lakes and river channels for all of Canada. All lakes in the database (including those as small as 10 ha) were explicitly included in the developed routing network provided and were directly connected to the HydroSHEDS drainage network. The routing network products are developed so they can be ingested into any routing software. As a demonstration, we use these networks to develop hydrologic routing model in the Raven hydrological modelling framework software which has a variety of different process models available for hydrologic routing. As a case study, a subregion of the Hudson Bay drainage basin (61621 km2) was utilized to route 8 years of GEM-HYDRO land surface model simulated flows through thousands of lakes. The HydroLAKES database supplied lake volume, average depth, pour point elevations and lake areas. The impact on streamflow of small lakes (< 40 km2) compared to larger lakes (> 40 km2).

Recent development of the Raven Hydrological Modelling Framework

Lead Author: James Craig, Civil and Environmental Engineering, University of Waterloo
Presenting Author: James Craig, Civil and Environmental Engineering, University of Waterloo
Email address: jrcraig@uwaterloo.ca
Co-Authors:

Poster #: 116

Abstract:
This talk summarizes recent improvements to the Raven hydrological modelling framework and presents applications of the framework to a variety of Canadian watersheds. Raven is used across Canada for both research and flow forecasting, and supports the management of more than 10 GW of hydroelectricity generating capacity. Recent process improvements support simulation of lakes, wetlands, reservoir management, cold regions processes (including blowing snow, frozen ground, lake ice, and permafrost). The framework has also been improved in its ability to support practical forecasting and prediction needs through (1) integration into the PAVICS climate analysis system developed by Ouranos (2) integration into the McMaster University CAFFEWS system in support of FloodNet, (3) additions to the RavenR R library for visualization and postprocessing, and (4) improved netCDF file support for gridded climate inputs and outputs. Improvements to vegetation growth and contaminant transport algorithms are ongoing.

Model flexibility and performance is briefly demonstrated for a range of research and operational applications, including methods for model structure identification and mega-scale routing through systems with thousands of lakes.

Effects of resolution on modelled Prairie depressional storage

Lead Author: Kevin Shook, Geography and Planning, University of Saskatchewan
Presenting Author: Kevin Shook, Geography and Planning, University of Saskatchewan
Email address: kevin.shook@usask.ca
Co-Authors:
John Pomeroy, Geography and Planning, University of Saskatchewan
Jefferson Wong, School of Environment and Sustainability, University of Saskatchewan
Li Xu, GIWS, University of Saskatchewan

Poster #: 117

Abstract:
Although progress has been made on the modelling of depressional storage in the Canadian Prairies, the effects of the resolution of a model on the results obtained have not been widely addressed. Models such as the Wetland DEM Ponding Model (WDPM) which use digital elevation models (DEMs), explicitly incorporate the DEM resolution in their results. Models such as the Pothole Cascade Model (PCM) which use discrete models of depressions also incorporate a resolution, through the minimum pond size represented in the model.
In this study we conducted WDPM simulations using DEMs of varying resolutions in two Prairie basins (Smith Creek and St. Denis). The results indicate that model outputs, including the spatial distribution of water, the total wetted area, and the frequency distributions of ponded water areas and depths may be influenced by the DEM resolutions.
The model results are also compared to those obtained from data sets based on remote sensing, and the implications for modelling are discussed.

Advances and future perspectives in water quality modelling in large -scale catchments

Lead Author: Luis Morales-Marin, Global Institute for Water Security (GIWS), University of Saskatchewan
Presenting Author: Luis Morales-Marin, Global Institute for Water Security (GIWS), University of Saskatchewan
Email address: lmoralesma@gmail.com
Co-Authors:
Prabin Rokaya, Global Institute for Water Security (GIWS), University of Saskatchewan
Karl Lindenschmidt, Global Institute for Water Security (GIWS), University of Saskatchewan

Poster #: 118

Abstract:
In cold regions, large-scale catchments are characterized by high heterogeneity in climate conditions, land-use, soil types and anthropogenic changes imposing many challenges in water quality modelling. New modelling approaches are thus needed in order to understand and simulate the transport of solutes at the catchment scale. Here, we present an overview of our work on two different topics related with water quality modelling in large-scale catchments. The first one is related to stream temperature modelling in river systems in which we coupled the River Model Basin (RBM) and the hydrological model MESH (MESH-RBM), to investigate the effects of climate change scenarios on future stream water temperatures and fish habitat in large river basins. Our second and current work relates to the development of a new physically-based solute transport model to estimate overland and in-stream solute transport for large scale cold region catchments. The new model performs on the MESH computational grid and estimates solute concentrations and erosion/deposition depths at every cell and at every time step. The model (MESH-SOL) resolves the advection-diffusion equation on the hillslopes and in-streams for different sediment grain sizes based on the hydrological and hydraulic information computed in MESH and based on information related to soil and land use properties. The model is loosely coupled with MESH and currently we are testing its performance in the Athabasca River Basin. Our future work includes the incorporation of transport of dissolved nutrients and the implementation of both MESH-RBM and MESH-SOL to other large-scale catchment in Canada.

Does the agility of land models allow for proper hydrograph simulation?

Lead Author: Shervan Gharari, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Shervan Gharari, School of Environment and Sustainability, University of Saskatchewan
Email address: shervan.gharari@usask.ca
Co-Authors:
Martyn Clark, University of Saskatchewan at Canmore

Poster #: 119

Abstract:
Land models are increasingly used in terrestrial hydrological modeling as they encompass a variety of processes. Despite the growing use of the land models in hydrological prediction and projection, extensive diagnostics of land models are limited due to their complexity and data-intensive nature. In this study, we look into the agility of the land model in reproducing the hydrograph and partitioning the flow into fast and slow responses. We base our analyses on a simplified toy model as well as the Variable Infiltration Capacity model, VIC. We focus attention on the representation of Macro/Micropore water movement in the soil and their representation in the models and their effect for hydrograph simulation and partitioning. We demonstrate that introducing macropores into land models substantially improves simulations of strteamflow. Our findings have significant implications for the use of land models for flood prediction and hyper resolution simulation of the terrestrial component of the water cycle.

Dynamic Surface Soil Moisture Content and Contributing Drainage Area Mapping

Lead Author: Zhaoqin Li, GIWS, U of S
Presenting Author: Zhaoqin Li, GIWS, U of S
Email address: zhaoqin.li@usask.ca
Co-Authors:
Karl-Erich Lindenschmidt, GIWS, U of S
Luis Morales, GIWS, U of S
Brandon Williams, GIWS, U of S
Sujata Budhathoki, GIWS, U of S

Poster #: 120

Abstract:
Dynamic hydrographic connections (Contributing Drainage Area, CDA) in the Prairie Pothole Region pose a challenge for hydrological modelling and irrigation management. It is very difficult to directly quantify CDA. Remote sensing data can provide an opportunity to indirectly estimate CDA through delineating saturated soil moisture content. Global soil moisture products, such as Soil Moisture Active Passive (SMAP, 3 days), have provided temporal and spatial dynamic soil moisture data for studies and applications dealing with interactions within the land surface and atmospheric boundary layer. However, these global products typically have a spatial resolution larger than 3km which is too coarse to be used for CDA delineation. We propose a new method by applying Bayesian deep learning to decomposed time series Synthetic Aperture Radar (SAR) data to retrieve surface soil moisture and map CDA in vegetated agricultural fields at a spatial resolution finer than 1km. The algorithm is still being optimization and the results will be reported during the meeting. This research is expected to contribute to large-scale hydrological modeling of Prairie regions.

Hydrological responses in a boreal forest basin to climate and land cover change

Lead Author: Zhihua He, GIWS, University of Saskatchewan
Presenting Author: Zhihua He, GIWS, University of Saskatchewan
Email address: zhihua.he@usask.ca
Co-Authors:
John W. Pomeroy, GIWS, University of Saskatchewan
Xing Fang, GIWS, University of Saskatchewan
Amber Peterson, GIWS, University of Saskatchewan

Poster #: 121

Abstract:
In the boreal forest, the canopy generally controls the dynamics of the snow processes on the sub-canopy surface, such as snow accumulation and snowmelt, thus regulating the runoff processes in the basin. In this study, snow interception and sublimation, sub-canopy energy balance snowmelt, infiltration, evapotranspiration and runoff processes over and through frozen and unfrozen ground were simulated in the boreal forest of Whitegull Creek Basin, Saskatchewan, using a model created using the flexible Cold Regions Hydrological Modelling Platform (CRHM). Hydrological responses to the changes in atmospheric driving data and forest cover were investigated in the period from 1998 to 2016. The CRHM-created model generally produced good performance for the simulations of streamflow, snow water equivalent (SWE), soil liquid water content and evapotranspiration after parameter adjustment, when compared to flux tower observations of evapotranspiration, snow surveys and streamflow discharge measurements. To examine the sensitivity of the basin hydrology to variations in inputs, temperature change scenarios were set up by linear increments in perturbations of observed temperature of up to +5 ℃, and precipitation change scenarios were generated by multiplying observed precipitation from 80% to 120%. The forest change scenarios were designed to simulate clear-cutting of specific forest types in the model. The model results for the water balance show that: 1) as the temperature warmed by 5 ℃ above current observations, runoff declined by 28 mm and peak SWE in spring by 48 mm; 2) as precipitation varied from 80% to 120% of currently observations, runoff varied by 120 mm and peak SWE in spring by 46 mm; 3) clear-cutting spruce increased runoff by 22 mm, whilst clear-cutting jack pine had little impact on runoff. Peak SWE in spring at the spruce and jack pine sites increased by 38 mm when the corresponding forests were cleared in the model. The results show strong sensitivity to precipitation changes, and milder sensitivity to air temperature change and forest cover change for this southern boreal forest basin.

Rethinking how we interpret the 'cascade of uncertainty' in scenario-led hydrological impacts assessment to climate change

Lead Author: Zilefac Elvis Asong, Global Institute for Water Security and School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Zilefac Elvis Asong, Global Institute for Water Security and School of Environment and Sustainability, University of Saskatchewan
Email address: elvis.asong@usask.ca
Co-Authors:
Saman Razavi, Global Institute for Water Security and School of Environment and Sustainability, University of Saskatchewan
John Pomeroy, Global Institute for Water Security and School of Environment and Sustainability, University of Saskatchewan, Centre for Hydrology, University of Saskatchewan
Alain Pietroniro,Environment and Climate Change Canada
Elshamy Mohamed,Global Institute for Water Security and School of Environment and Sustainability, University of Saskatchewan

Poster #: 122

Abstract:
Earth System Models (ESMs) are the major source of knowledge for developing quantitative hydrologic storylines of future change for the water sector. Climate projections have demonstrated the need to adapt to a changing climate, but have been less helpful in guiding how to effectively adapt. Part of the reason is the 'cascade of uncertainty' going from emission scenarios, ESMs, internal climate variability, impact models, to an adaptation response at the local scale. Many studies of climate change impacts on water resource systems have adopted the 'top down' approach which makes use of the IPCC climate scenarios. This scenario-led approach is associated with a myriad of uncertainties such that they often constrain the formulation of informed adaptation measures. A possible limitation is how this 'uncertainty cascade' has been represented and interpreted conventionally—where it symbolizes an ever expanding envelope of uncertainty, and that all uncertainties are equally important irrespective of timescale, location, impact, and climate variables. In this study, we illustrate an approach for representing the cascade using quantitative data. The approach is demonstrated using the CMIP5 projections of precipitation and 2 m air temperature over eight major river basins in Canada. Through this visualization, the following conclusions are drawn. First, there is a large intermodel spread in projected basin-scale precipitation relative to the historical period. Secondly, the relative importance of each source of uncertainty is river basin and variable specific. Based on the results, we recommend that climate impact studies do not rely on a single climate model or just a few realizations. These findings can help impact assessors to tailor resources towards addressing from onset, the major sources of uncertainty over a basin rather trying to accommodate all sources of uncertainty or making a 'guess' based on available resources. Focusing resources on addressing the pertinent uncertainties can lead to a better-informed adaptation response and communication of uncertainties to stakeholders and policymakers.

Modeling ice growth in Marginal Ice Zones using a coupled hydrodynamic-ice model

Lead Author: Andrew Grace, Applied Mathematics, University of Waterloo
Presenting Author: Andrew Grace, Applied Mathematics, University of Waterloo
Email address: a2grace@uwaterloo.ca
Co-Authors:
Marek Stastna, Applied Mathematics, University of Waterloo
Kevin Lamb, Applied Mathematics, University of Waterloo
Andrea Scott, Systems Design Engineering, University of Waterloo

Poster #: 123

Abstract:
Modeling of long term inter-annual variability of ice growth on small lakes is usually done without concern for the hydrodynamics beneath the ice. This is usually a safe assumption, but when horizontal expanse of the lake is large enough such that total ice cover is unlikely, then hydrodynamics and ice movement must be taken into account. Areas of a body of water with partial cover are known as Marginal Ice Zones (MIZ). Understanding and modeling the formation of MIZ's is imperative to understanding their impact on a lake ecosystem. Modeling all the important characteristics of MIZ's is a complicated endeavor, thus warranting a "process study" approach. Here, we present some basic studies of the growth of surface ice on a lake with non-uniform topography under varying atmospheric forcing conditions. Lastly, we address the limitations of the external forcing package in terms of being able to resolve motion of interest on small scales.

Understanding a Legacy System by Clustering Call-graphs Hierarchically and Automatically using a Machine Learning Model: A Case Study with CRHM

Lead Author: Avijit Bhattacharjee, Computer Science, University of Saskatchewan
Presenting Author: Avijit Bhattacharjee, Computer Science, University of Saskatchewan
Email address: avijit.bhattacharjee@usask.ca
Co-Authors:
Banani Roy, Computer Science, University of Saskatchewan
Chanchal Roy, Computer Science, University of Saskatchewan
Kevin Schneider, Computer Science, University of Saskatchewan

Poster #: 124

Abstract:
Many legacy systems like CRHM(The Cold Regions Hydrological Model) needs to be upgraded in a modern platform to cope up with the growing requirements of users and adopting to new technologies. However, most of the legacy systems code base is not well-documented. So, for a new developer it becomes very challenging to catch up with the functionalities and source code. By generating a call graph from caller-callee relationships and visualizing graphically, developers can understand the flow of legacy system but call graph can be abstruse for large systems. To solve this problem, we have designed a modified concept to organize call graphs in hierarchical level so that developers can see the part of call graph for which they are interested. First, we created a call graph from existing legacy system by using caller-callee relationship of methods. Next, we extracted all entry and exit points of the call graph to obtain a list of execution paths. In addition, we have clustered the execution paths and labeled the clusters with topic-modelling technique. This hierarchical view of clusters with label is higher level abstraction of the whole project. Now, if a developer want to observe call graph of a cluster, he can see the most dominating execution path which is simple and easy to understand and makes sense about the behavior of the specific cluster.

Support for new formats of basin and site delineations in the MESH modelling framework

Lead Author: Daniel Princz, Environment and Climate Change Canada
Presenting Author: Daniel Princz, Environment and Climate Change Canada
Email address: daniel.princz@canada.ca
Co-Authors:

Poster #: 125

Abstract:
MESH is a flexible framework for building hydrological land surface models. It contains a number of integrated models, including multiple land surface and routing schemes, supports reading input and writing outputs using various file formats, and supports the discretization of parameters and variables using uniform, semi-distributed, and/or fully distributed datasets across a domain. Spatial domains have been traditionally delineated for MESH to a square-grid geospatial fabric of uniform resolution. However, recent advances have been made to the framework to support additional types of basin and site delineations. These include a point mode, useful for diagnosing process methodology at small scales – for example, over a meteorological station or observatory; a hybrid square-grid domain of mixed resolutions – for example to run the land surface and routing schemes at two different resolutions inside the same model timestep; and an irregular subbasin domain – for example, delineated to watershed boundaries when the square-grid approach is not suitable for a particular application. Applications of each of the different approaches over a common domain is presented, and the differences between the various MESH configurations is noted. In each of the applications, the exact same driving data, parameters and variables, are used to run the exact same workflow of models inside the framework. Between the applications, only the method of delineation of the domain is changed. The demonstration of these applications serves as an example of new alternatives to the traditional format for providing basin and site delineations to MESH, and to illustrate the flexibility of the 'MESH model' as a framework. No performance assessment of the respective applications is presented, as the most appropriate format for basin or site delineation should be application driven.

Testing new generation of CRHM automatically

Lead Author: Hamid Khodabandehloo, Computer Science, U of S
Presenting Author: Hamid Khodabandehloo, Computer Science, U of S
Email address: hak335@usask.ca
Co-Authors:
Dr. Banani Roy, Computer Science, U of S
Dr. Monishankar Mondal, Computer Science, U of S
Dr. Chanchal Roy, Computer Science, U of S
Dr. Kevin Schneider, Kevin Schenider

Poster #: 126

Abstract:
Testing is one of the most crucial disciplines in software production lifecycle. Having a proper testing method will result in a high quality software system. Testing is extremely important when modernizing a legacy system which is still being used by many users. When the users will use the new system (the one that is migrated from the legacy system) they will expect exactly the same behaviour as of the old system. Therefore, testing an application which is being migrated is more difficult and should be more accurate. For this purpose, we designed a model to make sure that the development during migration will produce fewer bugs and bugs will be identified and fixed in shorter period of times. In this model, we test every method in the development time using Google test unit tests. Having unit tests contribute to ensure our current changes are not affecting the other parts of the code-base. On the other hand, we mimic user behaviour using automated UI tests after each release on both the old version and the migrated version and compare the results to make sure the migrated version is working accordingly. We are planning to gather data from the old application to investigate how users are using it to make more usable test cases. Under this circumstance we can ensure we have tested almost all the usages of the application. This process will enhance a more reliable, accurate, and faster testing.

Hydrological modelling in the Lake Erie and the Nelson-Churchill river basins using HYPE

Lead Author: Tricia Stadnyk, Department of Civil Engineering (Water Resources), University of Manitoba
Presenting Author: Hervé Awoye, Department of Civil Engineering (Water Resources), University of Manitoba
Email address: oyemonbade.awoye@umanitoba.ca
Co-Authors:
Ajay Bajracharya, Department of Civil Engineering (Water Resources), University of Manitoba
Masoud Asadzadeh, Department of Civil Engineering (Water Resources), University of Manitoba

Poster #: 127

Abstract:
In the frame of our contribution to the IMPC project, the University of Manitoba (UofM) is performing hydrologic simulations with the Swedish semi-distributed hydrologic model HYPE. For the IMPC A5 theme, we adapted the latest native version of HYPE (HYPE v.5.6.3) to the Lake Erie Basin. The model performed satisfactorily on this catchment and we are planning to continue its deployment on the Nelson-Churchill river basin (NCRB). Currently, a modified HYPE version is being used on NCRB. The modified version includes specific modifications to improve simulation and model performance, including addition of lakes, calibration of lake releases, frozen soils functionality, Prairie pothole and non-contributing areas, diversions, and flow regulations in partnership with Manitoba Hydro. The frozen soil algorithm in HYPE is being tested by validating the simulated temperature and soil moisture content at varying depth with the ground measurements obtained from several locations within NRCB. In addition, a time-varying sensitivity analysis of the model parameters in HYPE, in which the frozen soil parameters are also incorporated, was performed using several evaluation criteria including selective flow signatures. By using moving window period of 30 days, 60 days, 90 days, 180 days, and 360 days, the sensitivity analysis using VARS (Variogram Analysis of Response Surfaces) was able to capture the variation in the sensitivity of the model parameters throughout different time periods and seasons. The use of small window size and flow signatures were particularly crucial in identifying the time-varying sensitivity characteristics of the model parameters.

Technical advancements in the Canadian Hydrological Model

Lead Author: Kevin R. Green, Department of Computer Science, University of Saskatchewan
Presenting Author: Kevin R. Green, Department of Computer Science, University of Saskatchewan
Email address: kevin.green@usask.ca
Co-Authors:
Chris Marsh, Department of Geography and Planning, University of Saskatchewan
Raymond J. Spiteri, Department of Computer Science, University of Saskatchewan

Poster #: 128

Abstract:
The Canadian Hydrological Model (CHM) is a novel C++ simulation code designed to increase our future capacity for hydrological simulations over a variety of spatial extents. CHM combines multi-scale unstructured spatial meshes with a plug-in architecture of modular process representations for developing and simulating hydrological processes. The use of multi-scale unstructured meshes is particularly important for simulations over large spatial extents.
We present recent technical advancements aimed at improving the efficiency and scalability of CHM. These advancements include: 1) Mesh organization for simplified element coupling, 2) Extension to distributed computing environments through use of the Message Passing Interface, and 3) Updated linear algebra solvers to efficiently deal with advection-diffusion differential equation modules at large spatial extents.
Preliminary results have shown that these advancements have: 1) Significantly decreased the simulation run time for a fixed simulation size, and 2) Vastly increased the spatial domain of a simulation without increasing simulation run time. Using the Snowcast domain (www.snowcast.ca) with a drift-resolving mesh (~100 m ridge scale) as a test, we found an increase in the speed of simulation by more than an order of magnitude.
These results show great promise for the future application of CHM to simulations encompassing all of Western Canada and ensuring inclusion of hydrologically important processes at a variety of scales.

Developing a flexible vegetation growth library for hydrological models

Lead Author: Ming Han, Department of Civil and Environmental Engineering, University of Waterloo
Presenting Author: Ming Han, Department of Civil and Environmental Engineering, University of Waterloo
Email address: m43han@uwaterloo.ca
Co-Authors:
Juliane Mai, Department of Civil and Environmental Engineering, University of Waterloo
J. R. Craig, Department of Civil and Environmental Engineering, University of Waterloo
B. A. Tolson, Department of Civil and Environmental Engineering, University of Waterloo
Nandita Basu, Department of Civil and Environmental Engineering, University of Waterloo

Poster #: 129

Abstract:
Modelling of vegetation growth and agriculture practices are essential to understand the eco-hydrological processes in a watershed. Response of vegetation growth and nutrient uptake and losses to different agriculture management scenarios is critical information for sustainable watershed land management. Currently, vegetation growth procedures (including the nitrogen (N) uptake procedure) from soil and water assessment tool (SWAT) were recoded into a vegetation growth library, Robin. The vegetation growth model in Robin can be easily coupled to basically any hydrologic or land-surface model to add the functionality of crop and vegetation growth. The flexible nature of the Robin library is demonstrated by coupling it with both the HYPE hydrological model and the Raven hydrological modelling framework. The two coupled models were set up in Grand River basin in Ontario and calibrated with MODIS LAI product and county level yield measurement. Result shows that the Robin can reasonably simulate the dynamics of LAI for each of the crop types. The simulated yield for maize and soybean were also reasonable compared with observation data. Further work will: 1) explore reasonable ways to regionalize the crop parameters to make the Robin suitable for large scale studies; 2) explore the benefits to hydrologic model predictions of including an explicit vegetation growth model along with the corresponding remote sensing products such as (LAI and evapotranspiration) ; 3) add more advanced vegetation growth process descriptions into Robin.

Coping with deep uncertainty: Exploratory modeling in support of robust decision making in the Saskatchewan water resources system

Lead Author: Nhu Cuong Do, Global Institute for Water Security, University of Saskatchewan
Presenting Author: Nhu Cuong Do, Global Institute for Water Security, University of Saskatchewan
Email address: nhu.do@usask.ca
Co-Authors:
Saman Razavi, Global Institute for Water Security & School of Environment and Sustainability, University of Saskatchewan
Syed Mustakim Ali Shah, Global Institute for Water Security & Department of Civil, Geological and Environmental Engineering, University of Saskatchewan

Poster #: 130

Abstract:
The Saskatchewan River Basin that spans the three Canadian provinces of Alberta, Saskatchewan, and Manitoba is one of the world's largest and most complex river systems. Increasing demands from population growth, agricultural and industrial developments put further pressure on the sustainability of the river basin. These problems have raised significant challenges for water science and management, pointing to the need for a decision-making tool that can be used for long-term water resources planning of the Saskatchewan River Basin, thereby securing water under deep uncertainty and facilitating discussion with stakeholders about investment priorities and goals.
This study formulates a modeling framework to explore the water system robustness under a wide variety of plausible future conditions. We use the MODSIM-DSS software package, developed for river basin water management and decision support, to emulate the Saskatchewan River system. Different robustness metrics are also established to evaluate the river system performance. The modeling framework uses sensitivity analyses to classify appropriate strategies, those that perform reasonably well under a given future condition. This study aims to facilitate decision and policy making, by ranking the importance of policy decisions based on the system sensitivity to alternative decision options.

Comparison of a 1D lake ice model and the MITgcm ice model

Lead Author: Sarah Walsh, Applied Mathematics, University of Waterloo
Presenting Author: Sarah Walsh, Applied Mathematics, University of Waterloo
Email address: sawalsh@uwaterloo.ca
Co-Authors:
Tim Hill, Applied Mathematics, University of Waterloo
Kevin Lamb, Applied Mathematics, University of Waterloo
Marek Stastna, Applied Mathematics, University of Waterloo
Andrea Scott, Systems Design Engineering, University of Waterloo

Poster #: 131

Abstract:
The MITgcm (Massachusetts Institute of Technology General Circulation Model) is a 3D ocean model with the ability to model sea ice. Using this model, we are interested in modelling the evolving ice cover of Lake Erie. The MITgcm has been validated at large scales, but because Lake Erie simulations will be at a much higher resolution, and deal with fresh water instead of salt water, further validation is required. CLIMo (Canadian Lake Ice Model) is a 1D lake ice model. The recent research is focused on comparing the MITgcm ice model with CLIMo. Since CLIMo is well validated for small lakes and computing costs are very low for running simulations, CLIMo is a good candidate to be compared with the MITgcm. The MITgcm and CLIMo were developed for different purposes. By understanding the differences between the models we can identify which parameters in the MITgcm may need to be altered. Once the appropriate parameters have been identified, the MITgcm can be run to simulate ice and active hydrodynamics.
One output variable we investigated in the model comparison is the temporal growth of the ice thickness. To determine which parameters the models are most sensitive to, several cases have been designed in which we varied parameters related to ice thickness such as ice albedo and the sensitivity of ice growth to a number of factors including downward shortwave and longwave radiation. The MITgcm and CLIMo have very different ice albedo values. In this work, we will discuss why this may be the case.

Modelling of water, vapor, heat and stress fields in variably saturated freezing soil

Lead Author: Xiang Huang (Department of Earth and Environmental Sciences, University of Waterloo)
Presenting Author: Xiang Huang (Department of Earth and Environmental Sciences, University of Waterloo)
Email address: xiang.huang@uwaterloo.ca
Co-Authors:
David L. Rudolph (Department of Earth and Environmental Sciences, University of Waterloo)

Poster #: 132

Abstract:
As climate change intensifies, it is imperative to quantify the freezing-thaw processes in permafrost and seasonally frozen soils. Although many frost heave and freezing soil models were developed in past decades, saturated condition is commonly assumed and/or only pore ice behavior is conventionally predicted. This study presents a fully coupled thermal-hydraulic-mechanical model for variably saturated freezing soil, which examines a number of processes, including the heat conduction and convection, phase change with non-equilibrium ice-water interfaces, soil water movement and groundwater flow, vapor migration, and the development of ice lenses. Instead of directly solving for the pore pressure distributions, the void ratio is considered as a dependent variable related to the degree of saturation of unfrozen water. Both the stress-deformation and ice lenses segregation are inextricably linked to the evolution of void ratio as well. The performance of the model is verified by an empirical formula and results of laboratory column experiments obtained from the literature. Two freezing scenarios are present for consideration: (a) top-down freezing (one-sided) representative of seasonally freezing soils, and (b) top-down and bottom-top freezing (two-sided) representative of freezing soil in permafrost areas. The results show that (i) moisture, vapor, temperature and stress fields interact highly with each other, (ii) moisture is drawn toward the freezing front at a relatively high rate, and (iii) the high effective stress ahead of the freezing front causes considerable downward compaction.

Analysis and Prediction of Land Cover Changes Using Remote Sensing and GIS Techniques in Hable-Rud river basin, Iran

Lead Author: Sajad khoshnoodmotlagh-GORGAN UNIVERSITY IRAN
Presenting Author: Sajad khoshnoodmotlagh-GORGAN UNIVERSITY IRAN
Email address: khoshnod.sajad@gmail.com
Co-Authors:
Sajad khoshnoodmotlagh-GORGAN UNIVERSITY IRAN
Saman Razavi-Global inistitute for water security
Amin Haghnegadar-Global inistitute for water security
Amir Sadoddin-GORGAN UNIVERSITY IRAN

Poster #: 133

Abstract:
Abstract
The Prediction of future land cover changes is an important step in proper planning and management of watershed systems. Various methods exist for this purpose. In this study, land cover changes are investigated using Remote Sensing (RS) and Geographic Information Systems (GIS). For this purpose, first a supervised classification technique is applied to Landsat images acquired for 1986, 2000 and 2017. The classification of Landsat images is carried out using maximum likelihood method. Then, using a pixel-by-pixel change detection, the land cover changes are predicted for 2017 and 2040 using the CA-Markov model in IDRISI 18.31. The descriptive variables used include slope, aspect, elevation, and calculated distances from various land features such as river, road, industrial area, residential area, salty land, and agriculture. The predictions for the year 2017 were validated (standard Kappa index = 0.74) using the derived map from Landsat image of 2017. According to the predicted results for 2040, the areas of rangeland and salty land will increase by ~6.5% and 2%, while the areas of bare land and agricultural land will decrease by ~6% and 2%, respectively. The analysis of the results indicates a need for a more effective design, planning, and development of land use policies for ecosystem protection.
Keywords: CA-Markov model, land use, GIS, Hable-Rud River basin

A virtual basin modelling approach to understand the roles of wetlands and climate on Prairie streamflow

Lead Author: Balew A. Mekonnen, Centre for Hydrology, Department of Geography, Univeristy of Saskatchewan
Presenting Author: Balew A. Mekonnen, Centre for Hydrology, Department of Geography, Univeristy of Saskatchewan
Email address: balew.mekonnen@usask.ca
Co-Authors:
John Pomeroy, Centre for Hydrology, Department of Geography, Univeristy of Saskatchewan
Chris Spence, National Hydrology Research Centre, Environment and Climate Change Canada
Kevin R. SHook, Centre for Hydrology, Department of Geography, Univeristy of Saskatchewan
Colin J. Whitfield, School of Environment and Sustainability, University of Saskatchewan

Poster #: 134

Abstract:
Climate and land management changes are two major challenges facing the Canadian Prairie. Understanding controls on water cycling across the Prairie is useful to make informed decisions and improve resilience. The surface hydrology theme is part the Prairie Water programme; and it aims to determine how the water cycle is partitioned across the diversity of Canadian Prairie watersheds under a range of land management and climate scenarios. To achieve the objectives, the following work is being done: (1) classifying watersheds within the Prairie; (2) modelling each watershed class in a virtual manner using a modular simulation platform called the Cold Regions Hydrological Model (CRHM); and (3) assessing effects of climate change and wetland management such as wetland drainage and consolidation on prairie hydrology. The current work specifically focuses on implementing a virtual basin modelling approach and assessing wetland and climate change effects on the prairie water system. We demonstrated capability of the virtual basin modelling approach in simulating various elements of the hydrological cycle.
Results indicate that combination of warmer and drought conditions reduce peak as well as annual flow volume. Results also indicate that wetland consolidation may be a promising way to offset wetland drainage effects on streamflows of the Prairie.

CoSMoS - Complete Stochastic Modelling Solution

Lead Author: Filip Strnad, Czech University of Life Sciences Prague (CULS)
Presenting Author: Filip Strnad, Czech University of Life Sciences Prague (CULS)
Email address: strnadf@fzp.czu.cz
Co-Authors:
Simon Papalexiou, University of Saskatchewan
Yanis Markonis, Czech University of Life Sciences Prague (CULS)

Poster #: 135

Abstract:
CoSMoS is an R package that allows for time series generation with desired properties. The package simulates processes by precisely reproducing their marginal distribution and linear correlation structure, including intermittency. After the choice of characteristics of the time series you want to generate, the package will perform necessary correlation transformations of the Gaussian process and generate the desired timeseries. Users can generate as many and as long time series from processes such as precipitation, wind, temperature, relative humidity etc. It is based on a framework that unifies, extends, and improves a modelling strategy that generates time series by transforming “parent” Gaussian time series having specific characteristics.

Watershed Classification of the Canadian Prairies

Lead Author: Jared D. Wolfe, Prairie Water, Global Institute for Water Security
Presenting Author: Jared D. Wolfe, Prairie Water, Global Institute for Water Security
Email address: jared.wolfe@usask.ca
Co-Authors:
Kevin R. Shook, Centre for Hydrology
Chris Spence, National Hydrology Research Centre, Environment and Climate Change Canada
Colin J. Whitfield, School of Environment and Sustainability, University of Saskatchewan

Poster #: 136

Abstract:
Understanding climatic and physical similarities of watersheds can aid in predicting how processes, including hydrology, nutrient cycling, and ecology, are expected to respond to future environmental change. Classification methods offer a means of grouping watersheds according to landscape features, and thus may identify which types of watersheds behave similarly. The Canadian Prairie has a distinct hydrological behaviour that is heavily influenced by wetlands. Current knowledge is based on relatively few, well-studied research sites, and the ability from which to extrapolate to ungauged basins is unclear. We compiled data relating to climate, geography, and land cover from watersheds of approximately 100 km2 as a means of comprehensively evaluating the factors that may control watershed behaviour. From this emerged a classification that identified seven broad classes, including those distinguishing southern Manitoba, the pothole region, river valleys, and grasslands. Important defining attributes of classes were climate, elevation, surficial geology, wetland distribution, and land cover. Differences in key characteristics across the classes emphasize the importance of developing management strategies that target sub-regions expected to exhibit similar behaviour. Our results suggest different pressures on water security of watersheds distributed across the Prairies. We provide the first classification of watersheds for the Canadian Prairies, and our findings provide a foundation that will be used to address questions related to water resources and ecology at a regional level.

Building an integrated virtual Prairie watershed to support decision-making

Lead Author: Jared D. Wolfe, Prairie Water, Global Institute for Water Security
Presenting Author: Jared D. Wolfe, Prairie Water, Global Institute for Water Security
Email address: jared.wolfe@usask.ca
Co-Authors:
Colin J. Whitfield, School of Environment and Sustainability, University of Saskatchewan
Chris Spence, National Hydrology Research Centre, Environment and Climate Change Canada
John Pomeroy, Centre for Hydrology, Global Water Futures, University of Saskatchewan
et al.

Poster #: 137

Abstract:
Evaluation of the cumulative effects of water management decisions and environmental change requires an integrated understanding of multiple ecosystem components. Agricultural water management can have important consequences for hydrological regimes, and will in turn impact water quality, biological diversity, and the resilience of ecosystems, humans and the economy to additional environmental stressors. Understanding the consequences of complex, multi-faceted decisions in a changing environment is imperative to community resilience in the Prairies. We outline our approach to linking models of surface and sub-surface hydrology, aquatic biogeochemistry, biodiversity, and socio-economics to evaluate changes in response to agricultural land management and climate change scenarios. Our focus is on small (~100 km2) watersheds that we anticipate can capture linkages between local decision-making and potential outcomes of these decisions at scales relevant to landowners and rightsholder. These watersheds are modelled in a virtual manner wherein a typical watershed is constructed and parameterized according to a Prairie watershed classification. Using a scenario analysis approach informed by our partners, modelled (CRHM) predictions of surface hydrology will be integrated with emerging understanding of groundwater recharge, nutrient retention, invertebrate and bird communities, and socio-economic factors linked to wetland drainage. The outcome of these efforts will be a decision-making tool for those tasked with overseeing the resilience of Prairie communities and ecosystems.

Observation of Crop, Climate, and Hydrology Interactions on the Canadian Prairies

Lead Author: Phillip Harder, Centre for Hydrology, University of Saskatchewan
Presenting Author: Phillip Harder, Centre for Hydrology, University of Saskatchewan
Email address: phillip.harder@usask.ca
Co-Authors:
Warren Helgason, Department of Civil, Geological and Environmental Engineering, University of Saskatchewan
Ander Hunter, Department of Civil, Geological and Environmental Engineering, University of Saskatchewan
Bruce Johnson, Global Institute for Water Security, University of Saskatchewan
John Pomeroy, Centre for Hydrology, University of Saskatchewan

Poster #: 138

Abstract:
The Canadian Prairie land surface is a large-scale dynamic mosaic of annual cropped fields, intermixed with perennial pastures and forages. The heterogeneity of these surface features complicates the expression of interactions between the land surface, agriculture practices, hydrology, and the atmosphere. To quantify the land-atmosphere interactions and the implications of agricultural management, an extensive field campaign is gathering the necessary observations to guide land-surface and hydrological model development. For the 2018 growing season point-scale energy balance, meteorological, soil, and vegetation data was collected from perennial forage, pasture, barley, lentil, and field pea crops near Saskatoon, Saskatchewan. The spatial variability of these crops was quantified with distributed modeling of modeling of energy fluxes driven with high resolution unmanned aerial vehicle observations of crop height and structure from lidar, vegetation indices from multispectral imagery and surface temperatures from thermal infrared imagery. Preliminary results demonstrated large differences in land-atmosphere interactions between, and within, crop types. A similar field campaign is planned in 2019 that will extend the observations to other crops common to this region. Preliminary modeling efforts to validate the crop representation of NOAH-MP with this novel dataset will be presented. Testing and validation of models of coupled crop-atmosphere interactions improves our ability to understand and predict land-atmosphere response to changes in agricultural practice and climate on the Canadian Prairies.

Mapping sub-canopy snow depth: Challenges and opportunities with unmanned aerial vehicles

Lead Author: Phillip Harder, Centre for Hydrology, University of Saskatchewan
Presenting Author: Phillip Harder, Centre for Hydrology, University of Saskatchewan
Email address: phillip.harder@usask.ca
Co-Authors:
John Pomeroy, Centre for Hydrology, University of Saskatchewan
Warren Helgason, Department of Civil, Geological and Environmental Engineering, University of Saskatchewan
Cob Staines, Centre for Hydrology, University of Saskatchewan

Poster #: 139

Abstract:
Accumulation of the seasonal snowpack is critical to cold regions hydrology. High-resolution maps of snow depth in and around vegetation would improve the understanding of how snow-vegetation interactions affect the spatial variation of snow accumulation. Optical imagery from cameras mounted on unmanned aerial vehicles (UAVs) has been used to successfully measure the depth of open snowfields at high resolutions using Structure from Motion (SfM) techniques. Airborne-LiDAR has been used to map snow depth in alpine terrain and in sparse forest canopies but is challenged to penetrate dense forest canopies because it generally produces low-density point clouds. In contrast, UAV-LiDAR systems have high-density point clouds, measure returns from a wide range of scan angles, and so have a greater likelihood of successfully measuring sub-canopy snow depth. The effectiveness of UAV-LiDAR and SfM in mapping snow depth in both open and forested terrain was tested in a 2019 field campaign in the Canadian Rockies Hydrological Observatory, Alberta and at Canadian Prairie sites near Saskatoon, Saskatchewan. Concomitant snow surveys quantified the errors. Both methods demonstrated similar capabilities in alpine and open prairie terrain, whilst only UAV-LiDAR could successfully measure the sub-canopy snow surface. SfM, even at close proximity to the snow surface could not resolve mixed surfaces of vegetation and snow. UAV-LiDAR measured exceptionally deep snowdrifts in treeline forests and wetland tree rings, and shallow snow under dense needleleaf forest canopies, which emphasises that accounting for the impact of multiscale snow redistribution processes is critical for basin-scale snow accumulation estimation.

Groundwater - Surface Water - Atmosphere Interactions of a Terminal Wetland on the Canadian Prairies

Lead Author: Anders Hunter, Civil,Geological, and Environmental Engineering, University of Saskatchewan
Presenting Author: Anders Hunter, Civil,Geological, and Environmental Engineering, University of Saskatchewan
Email address: anders.hunter@usask.ca
Co-Authors:
Phillip Harder, Centre of Hydrology, University of Saskatchewan
Warren Helgason, Civil,Geological, and Environmental Engineering, University of Saskatchewan

Poster #: 140

Abstract:
The Canadian Prairie landscape is characterized by relatively flat, but often hummocky terrain, which can result in poorly developed surface drainage over large areas. In these poorly drained regions, terminal water bodies offer insight into the state of the regional water balance, integrating short term exchanges of water (precipitation and evaporation) as well as longer term groundwater-wetland exchanges. Recent observations of water fluxes to and from a terminal wetland complex near Saskatoon, SK have been used to investigate seasonal groundwater-surface water-atmosphere exchanges. A buoy-mounted eddy covariance system, regular salinity measurements, and high resolution topographic mapping with a UAV mounted lidar system provide a novel dataset to observe the evaporation and groundwater exchanges from volumetric, depth and solute balance perspectives. The water balance observations estimate that, of the 740 mm of evaporation occurring from the surface of the wetland (between June 19 and October 11, 2018), 14 % was derived from rainfall, 58 % was derived from groundwater recharge to the wetland, and 28% from a decline in wetland storage. Estimation of the groundwater input from the solute balance provides an independent validation of the volumetric estimates. This dataset provides a unique opportunity to quantify the groundwater-surface water and surface water-atmosphere exchanges for the Canadian Prairies and will be used to improve the representation of wetland features in hydrological and land-atmosphere models.

Identifying Groundwater Discharge Zones in Northern Canada Using Remotely Sensed Optical and Thermal Imagery

Lead Author: Brittney Glass, Dept. of Earth and Environmental Science, University of Waterloo
Presenting Author: Brittney Glass, Dept. of Earth and Environmental Science, University of Waterloo
Email address: bglass@uwaterloo.ca
Co-Authors:
David Rudolph, Dept. of Earth and Environmental Science, University of Waterloo

Poster #: 141

Abstract:
Landsat 4-5 TM and RapidEye-3 datasets were used to identify groundwater discharge zones in the Central Mackenzie Valley (CMV) of the Northwest Territories. Given that this area is undergoing active shale oil exploration and climatic changes, identification of groundwater discharge zones is of great importance both for pin-pointing potential contaminant transport pathways, and for characterizing the hydrologic system. Following the works of Morse and Wolfe (2015), a series of image algorithms were applied to imagery for the entire Central Mackenzie Valley, and for the Bogg Creek Watershed (a sub watershed of the CMV) for selected years between 2004 and 2017. The algorithm series extracted 'icings' from the images. Icings (also called aufeis) are surface ice lenses formed where groundwater discharges in the winter months, then freezes. Icings were statistically examined for all of the selected years to determine whether a significant difference in their occurrence and size existed. It was concluded that there was a significant difference in the spatial distribution of icings from year to year, but that there were several places where icings were recurring. During a field visit in August of 2018, high resolution thermal imagery was captured for several of these locations and it was found that groundwater was also discharging in the summer. This provides strong evidence to suggest that the recurring icings represent springs from which groundwater discharges year-round. These springs represent ideal locations to monitor the quality of discharging groundwater following the establishment of fracking operations. Furthermore, identifying these monitoring points remotely is expected to have drastically reduced the field efforts that would have been required to find them in situ. This work demonstrates the value of remote geophysical methods for hydrogeological applications, particularly in areas that have limited accessibility.

The Water-Energy Nexus in the Subsurface

Lead Author: Diane Van Hoy, Department of Civil and Geological Engineering, University of Saskatchewan
Presenting Author: Diane Van Hoy, Department of Civil and Geological Engineering, University of Saskatchewan
Email address: div686@usask.ca
Co-Authors:
Jennifer McIntosh, Department of Hydrology and Atmospheric Sciences, University of Arizona
Grant Ferguson, Department of Civil and Geological Engineering, University of Saskatchewan

Poster #: 142

Abstract:
Global population continues to grow exponentially, while potable water supplies remain finite. Climate change, particularly in more arid climates, is making precipitation-fed surface water sources less and less reliable. Therefore, more people are coming to rely on groundwater sources for both public, agricultural and industrial water supplies. Groundwater supplies are being depleted in many regions, leading to increased interest in deeper groundwater supplies to address water security issues. At the same time, there is a growing demand for energy, and a dwindling supply of fossil fuels. Oil and gas wells and associated injection wells are completed in close proximity to fresh and brackish groundwater supplies in many areas, such as the Michigan, Wind River, Powder River, Illinois, Williston, and the Western Canadian Sedimentary Basins or parts thereof. It is currently unclear how much separation should be required between energy developments and potential sources of drinking water. This study ultimately aims to answer this question by using data on the distribution of oil/gas and water wells, water chemistry and physical hydrogeology. It will focus on determining what level of separation currently exists between oil/gas and water wells in key sedimentary basins in the United States and Canada, as well as identifying data gaps.

Quantifying Produced and Injected Waters in Southeastern Saskatchewan

Lead Author: Keegan Jellicoe, Department of Civil and Geological Engineering, University of Saskatchewan
Presenting Author: Keegan Jellicoe, Department of Civil and Geological Engineering, University of Saskatchewan
Email address: keegan.jellicoe@usask.ca
Co-Authors:
Grant Ferguson, Department of Civil and Geological Engineering, University of Saskatchewan
Jennifer McIntosh, Department of Hydrology and Atmospheric Sciences, University of Arizona

Poster #: 143

Abstract:
Since the 1950s, oil and gas wells in Southeastern Saskatchewan and along Manitoba's western border have produced 3.87 x 109 m3 of water. 4.57 x 109 m3 of water has been injected into disposal wells or been used in enhanced oil recovery methods. Since 2005 there has been a significant increase in production due to the application of horizontal drilling and hydraulic fracturing, accounting for 46.2% (1.79 x 109 m3) of water produced and 46.8 % (2.14 x 109 m3) of water injected since the 1950s. However, the effect of long-term injection on groundwater remains uncertain. Large quantities of these injected waters are disposed of into nonproducing geologic intervals that could result in overpressuring. The overpressuring of deep aquifers may drive injected waters into neighbouring potable water-bearing formations. To better understand the effects of this water injection, this study is investigating the quantity of water used for injection and into major geological formations in the Williston Basin. Using these results the role of leaking legacy oil wells on these overpressured formations and groundwater contamination will be assessed.

The Significance of Groundwater Fluxes on Surface Water Flow

Lead Author: Xin Tong, Department of Earth and Environmental Sciences, University of Waterloo
Presenting Author: Xin Tong, Department of Earth and Environmental Sciences, University of Waterloo
Email address: willman@uwaterloo.ca
Co-Authors:
Walter Illman, Department of Earth and Environmental Sciences, University of Waterloo
Young-Jin Park, Department of Earth and Environmental Sciences, University of Waterloo
David L. Rudolph, Department of Earth and Environmental Sciences, University of Waterloo
Steven J. Berg1,2, 1. Department of Earth and Environmental Sciences, University of Waterloo; 2. Aquanty Inc.

Poster #: 144

Abstract:
Groundwater plays a vital role in the hydrologic cycle as it is the largest component of available freshwater. Therefore, diagnosing and predicting hydrologic changes and water futures in Cold Regions will have to account for groundwater. Hydrologic models play an important role in this process. There is a wide spectrum of models of varying complexities available to simulate surface water/groundwater flow and transport. The various users of such models question what level of complexities need to be considered within these different models to achieve project objectives. Currently, there are no clear guidelines or criteria to assist users in selecting appropriate hydrologic models for a specific application. In addition, enhanced sensor networks are being developed to monitor hydrologic processes at varying spatial and temporal scales. A large amount of data from different sensors (i.e., big, disparate data) are becoming available to parameterize and drive these models, which may influence the choice of modeling platforms. This, in turn, will likely have impacts on hydrologic predictions and result in profound economic implications.
The main objective of this project is to examine the significance of shallow/deep groundwater flow including the unsaturated zone on surface water flow predictions through high-resolution numerical simulations with HydroGeoSphere (HGS), a fully-integrated hydrologic model. Because of the availability of high quality data, datasets from the well-instrumented Alder Creek Watershed (ACW) (~79 km2) within the Grand River Basin in Ontario have been utilized to parameterize, calibrate, and validate the model.
A high resolution two-dimensional overland flow model was first developed for the ACW based on a digital elevation model. The model was then used to simulate base flow conditions within the ACW with an increasing level of complexity to represent the subsurface. In particular, three integrated hydrologic models using HGS are currently being developed to highlight the significance of groundwater fluxes on surface water flow within the ACW: (1) a model incorporating only overland flow data without considering the subsurface; (2) a model with a thin soil layer; and (3) a model with detailed subsurface information on hydrostratigraphy. These models share high-resolution topography information, landcover representation, temporal precipitation records, evapotranspiration and wellfield operation data to examine spatial and temporal variability in watershed behavior. Ongoing work will involve the calibration of the models with diverse sets of data and their validation. The model developed in this study can serve as a reference to further analyze the impact of anthropogenic activities in both surface water and groundwater, solute/contaminant transport, and winter processes at the watershed scale.

Characterization of Groundwater Flow Dynamics in Discontinuous Permafrost

Lead Author: Andrew Wicke, Earth & Environmental Sciences, University of Waterloo
Presenting Author: Andrew Wicke, Earth & Environmental Sciences, University of Waterloo
Email address: awicke@uwaterloo.ca
Co-Authors:
David Rudolph, Earth & Environmental Sciences, University of Waterloo
Brewster Conant Jr, Earth & Environmental Sciences, University of Waterloo

Poster #: 145

Abstract:
Surface water and groundwater resources in the Canadian North are under transition. Between unconventional oil and gas development and a changing climate uncertainty remains about how these hydrologic resources may be affected. Shale oil and gas development projects often utilize large amounts of water and may pose a potential contamination hazard to surface and subsurface water should active vertical transport pathways be available. The thawing permafrost may create new surface and subsurface pathways that could influence upward migration of deeper fluids and may influence flow dynamics and hydrologic conditions in the shallow subsurface. Baseline characterization and monitoring of surface water and groundwater on a regional scale in these remote northern environments may provide the reference information required to be able to detect these impacts over time. Currently, however, few protocols and approaches are in place to undertake these studies. Traditional hydrologic monitoring remains difficult due to short field seasons, limited site access and the tendency for monitoring wells to freeze even during warmer months. Groundwater flow in permafrost environments is also unique in that it is partitioned between shallow active-layer flow and a deeper perennial flow beneath and within the discontinuous permafrost. Gaps in permafrost known as taliks may exist around surface waterbodies. In a discontinuous permafrost region these windows allow for groundwater to exchange between shallow and deep zones; meaning surface water and groundwater in discontinuous permafrost remain inextricably linked. Therefore, characterization of the overall groundwater movements and quality could be investigated through groundwater and surface water interactions. Several techniques were applied during a summer field season south of Norman Wells, NT. These included locating of seeps and springs utilizing thermal cameras and the collection of isotope and geochemistry samples from various surface water bodies and shallow groundwater. When combined with other data collected in the region by government and industry, a clearer conceptual model of baseline conditions and potential changes is achieved.

Quantifying the Effectiveness of Reclamation Cover Materials on Soil Moisture Regimes in a Post-Oil Sands Landscape

Lead Author: Tyler Prentice, Geography and Environmental Management, University of Waterloo
Presenting Author: Tyler Prentice, Geography and Environmental Management, University of Waterloo
Email address: tyler.prentice@uwaterloo.ca
Co-Authors:
Richard Petrone, Geography and Environmental Management, University of Waterloo
Sean Carey, Geography and Earth Science, McMaster University

Poster #: 146

Abstract:
The Government of Alberta requires mining companies to restore land back to an equivalent capacity following oil sands operations. This includes the reclamation of fen peatlands which comprise 63% of the region's landscape. The reclamation of upland forests is a crucial part of peatland reclamation due to fens requiring an upland to fen ratio of 3:1 to meet their hydrological requirements. The use of different reclamation covers such as peat mineral mix (PMM) and identifiable litter, fragmented litter, humus mineral mix (LFH) are common practice in forest reclamation. The function of these cover materials in reclamation is to provide sufficient moisture and nutrients required for the establishment of pioneer plant species in reclaimed sites, but this function is not yet quantified among cover materials. A study was conducted to examine the soil hydro-physical properties and asses their influence on volumetric water content (VWC) and potential evapotranspiration (PET) throughout the 2018 growing season. It was found that LFH sites had higher porosity and infiltration rates than PMM sites. This resulted in larger fluctuations in PET and VWC following precipitation events, particularly at lower depths in the soil. When comparing these values to tree height, density and diversity, it was found that sites using LFH had higher tree density and height, however this may be due to LFH's higher N mineralization rates. Overall, species diversity appears to be the only parameter influenced by soil moisture regimes as sites with consistently low VWC had a higher frequency of coniferous species.

Historical Oil and Gas Well Integrity: Insights from the Early to Mid-1900s

Lead Author: Chris Perra, Civil, Geological, & Environmental Engineering, University of Saskatchewan
Presenting Author: Chris Perra, Civil, Geological, & Environmental Engineering, University of Saskatchewan
Email address: chris.perra@usask.ca
Co-Authors:
Grant Ferguson, Civil, Geological, & Environmental Engineering, University of Saskatchewan
Jennifer McIntosh, Hydrology & Atmospheric Sciences, University of Arizona

Poster #: 147

Abstract:
Unplugged or commingled wells can cause numerous problems relating to groundwater quantity, supply, and public safety. These wells can connect previously unconnected aquifers allowing fluids to freely migrate from high to low pressure constrained only by the size of the conduit (well). In sedimentary basins, oil and gas wells that have had their integrity fail could result in the migration of deep brines from over-pressured reservoirs to surficial aquifers degrading groundwater quality in the receiving aquifer. In Saskatchewan and Alberta, hundreds of thousands of oil and gas wells perforate the Western Canadian Sedimentary Basin. Modern regulations are largely thought to be protective of aquifers containing potable groundwater, however prior to the mid to late-1900s many oil and gas wells were constructed under far less restrictive regulatory regimes. In Alberta and Saskatchewan regulators use the occurrence of surface casing vent flow (SCVF) and gas migration as indicators of well integrity problems. Only Alberta has kept rigorous records of the presence or absence of these indicators for each abandoned well allowing for some dissemination of well attributes that are associated with an increase in the occurrence of surface casing vent flow (SCVF) and gas migration, such as wellbore deviation, and abandonment method, to be identified. Unfortunately, little information aside from anecdotal accounts is readily available for wells prior to the implementation of regulations requiring the measurement of SCVF for all wells in 1957. Even less information is available regarding the integrity of wells in Saskatchewan. The objectives of this study are to first provide insight into early well construction practices that may result in greater risk of well integrity failure. Then explore the limitations of the publicly available electronic database of well completions and abandonments in Saskatchewan and Alberta, and identify the spatial distribution of well completions and abandonments before the introduction of robust regulations which are thought to diminish the likelihood of well integrity failure.

Assessment of the hydrological sustainability of constructed systems within a post-mining landscape: initial results from the Cold Regions Hydrological Model

Lead Author: Kelly Biagi, School of Geography & Earth Sciences, McMaster University
Presenting Author: Kelly Biagi, School of Geography & Earth Sciences, McMaster University
Email address: biagikm@mcmaster.ca
Co-Authors:
Sean Carey, School of Geography & Earth Sciences, McMaster University

Poster #: 148

Abstract:
Bitumen extraction via open-pit surface mining has resulted in large scale alteration of Boreal forest and wetlands (>800 km2) in the Athabasca oil sands region (AOSR) of Alberta, Canada. As part of the operating license, companies must reclaim disturbed landscapes into functioning ecosystems such as forests, wetlands and lakes that existed in the landscape prior to mining. While reclamation of forest ecosystems has received considerable attention, only in the last decade have companies constructed integrated upland-lowland systems with the objective of forming sustainable peat-forming wetlands. The challenge is to design and construct sustainable ecosystems that are resilient to the disturbed landscape and the inherent climate variability. Syncrude Canada Ltd. has constructed the Sandhill Fen Watershed is one of two upland-wetland systems have been constructed in the AOSR, and only recently has sufficient data been collected to evaluate possible trajectories of these systems. To date, there has been limited work using hydrological models, particularly those focused on surface-atmosphere and cold region processes, to evaluate constructed ecosystem trajectory and their sensitivity to potential changes in climate at the landscape scale. The objective of this work is to 1) use initial six years of data and associated historical data sets to build a coupled HRU-based model (CRHM) of a constructed fen-upland system and 2) evaluate the sensitivity of constructed systems to potential changes in climate and vegetation. Results are preliminary and present model setup and initial simulations of potential future scenarios. Future work will involve using CRHM answer several key hydrological questions including How does the timing, magnitude and rate of fluxes change as the system develops in the longer term? Do hillslopes provide water to the lowlands (surface and groundwater)? What drives runoff from hummock slopes, snow or soil moisture? How does vegetation development influence snow accumulation and melt? Understanding the sustainability of these constructed systems is complicated as they will be eventually integrated into a larger reclaimed landscape. Yet, this information will be critical for future design and construction of these systems as landscape disturbance has the potential to reach 4800 km2.

Energy and mass fluxes from a constructed wetland and end pit lake in Fort McMurray Alberta.

Lead Author: M.G. Clark, School Of Geography & Earth Sciences, McMaster
Presenting Author: M.G. Clark, School Of Geography & Earth Sciences, McMaster
Email address: mclark04@gmail.com
Co-Authors:
G. Drewitt, School Of Geography & Earth Sciences, McMaster
S. Carey, School Of Geography & Earth Sciences, McMaster

Poster #: 149

Abstract:
The closure of oil sand mining landscapes will require the construction of thousands of hectares of boreal plains ecosystems. The Sandhill Fen Watershed (SFW) and Base Mine Lake (BML) end pit lake are full scale pilot projects constructed to test closure design. The SFW was designed to promote the formation of peat accumulating landscapes on an infilled pit mine, whereas BML is a freshwater lake capping fluid tailings. Eddy covariance systems were installed at both sties to monitor the surface atmosphere exchange of energy, water, CO2 and CH4. At first CO2 dynamics in the SFW developed to be similar to natural peatland cycles, however recent changes in spring uptake has resulted in the two past years becoming net carbon sources. The methane emissions are negligible over SFW but daily methane fluxes can exceed 1.5 g CH4 day 1 from BML in the spring. Evaporation over BML has been increasing over the study period, whereas evapotranspiration has decreased in recent years over the SFW. This analysis will help improve closure landscape design by comparing actual carbon and water fluxes from the surface of these built ecosystems with expected quantities.

Modernizing Legacy Systems through Mining Association Rules

Lead Author: Manishankar Mondal, Computer Science Department, University of Saskatchewan
Presenting Author: Manishankar Mondal, Computer Science Department, University of Saskatchewan
Email address: mshankar.mondal@usask.ca
Co-Authors:
Banani Roy, Computer Science Department, University of Saskatchewan
Chanchal K. Roy, Computer Science Department, University of Saskatchewan
Kevin A. Schneider, Computer Science Department, University of Saskatchewan

Poster #: 150

Abstract:
While designing a software system, minimizing coupling among program entities (such as files, classes, methods) is always desirable. If a software entity (such as a file, class, or method) is coupled with many other entities, this might be an indication of poor software design because changing that entity will likely have ripple change effects on the other coupled entities. Evolutionary coupling is a well investigated way of identifying coupling among program entities. In this research, we investigate file level, class level, and method level evolutionary coupling among program entities through mining association rules and analyze whether this coupling is correlated with software change-proneness and bug-proneness. We find that evolutionary coupling is correlated with change-proneness and bug-proneness with good positive correlation. On the basis of our findings, we detect evolutionary coupling from a legacy software system, CRHM (The Cold Regions Hydrological Model), which is now being maintained in our laboratory. We detect groups of coupled entities from the system, manually analyze these groups and find possibilities to decouple entities in the groups for better maintenance and evolution of CRHM.

What the Flux? Carbon and Water Dynamics During the Development of a Reclaimed, Post-Oilsands Landscape in Northern Alberta

Lead Author: Nataša Popović, Department of Geography and Environmental Management, University of Waterloo
Presenting Author: Nataša Popović, Department of Geography and Environmental Management, University of Waterloo
Email address: npopovic@uwaterloo.ca
Co-Authors:
Adam Green, Department of Geography and Environmental Management, University of Waterloo
Eric Kessel, Department of Geography and Environmental Management, University of Waterloo
Myroslava Khomik, Department of Geography and Environmental Management, University of Waterloo
Richard M. Petrone, Department of Geography and Environmental Management, University of Waterloo

Poster #: 151

Abstract:
Wetlands comprise ~50% of the pre-disturbance landscape in the Athabasca Oil Sands Region (AOSR), making them the focus of reclamation efforts here. An effective means of assessing the functionality and success of a reclaimed ecosystem is by examining its water use efficiency. This study provides a temporal snapshot of a 32 ha constructed wetland in the AOSR. Here, carbon (C) and water exchanges during the first five years of ecosystem evolution (2013-2017) are quantified using growing season eddy covariance measurements located in the fen and adjacent upland. Results indicate trends particularly associated with the establishment of vegetation. The fen quickly evolved from a C source in 2013 (NEP: 124 gCm-2year-1) to a sink by 2015 (NEP: -229 gCm-2year-1) as plant development significantly increased net CO2 uptake. Evapotranspiration (ET) rates between 2013-2017 show a decreasing trend (2.95 to 2.27 mm day-1), coincident with a steady increase in water use efficiency (WUE) (1.40 to 3.11 gC kg H20-1 m-2 day-1). ET and WUE trends are attributed to the significant decrease in ponded or bare areas associated with the expansion and increased density of vegetation. The upland has developed at a slower rate than the fen with results indicating a net C loss (NEP: 4.46 to 1.12 gC m-2year-1) with the trajectory towards become a net C sink within the next 1-3 years as vegetation matures. Since 2015, ET rates have exceed precipitation, however, ET has remained relatively constant (145-211 mm day-1) indicating that vegetation has become interconnected to the groundwater network and no longer solely dependant on precipitation. Similar to the fen, WUE has been steadily increasing as vegetation continues to mature. Assessment of the carbon and water exchanges during early-development suggests the constructed system is evolving towards becoming a self-sustaining, carbon-accumulating, functional ecosystem.

Mapping permafrost in the Mackenzie River Basin

Lead Author: Mohamed Elshamy, Global Institute for Water Security, UofS
Presenting Author: Mohamed Elshamy, Global Institute for Water Security, UofS
Email address: mohamed.elshamy@usask.ca
Co-Authors:
Alain Pietroniro, Environment and Climate Change Canada
Howard Wheater, Global Institute for Water Security, UofS
John Pomeroy, (3)Centre for Hydrology, UofS
Zilefac Asong, Global Institute for Water Security, UofS

Poster #: 152

Abstract:
Earth system models predict that the current global warming trends will continue. Continental high latitudes have been warming at higher rates than the global average, resulting in permafrost thaw with implications for soil moisture, hydraulic connectivity, streamflow seasonality, land subsidence, and vegetation. Feedbacks are generally complex and depend on a multitude of factors including changes to precipitation intensity, timing, and phase as well as soil composition and hydraulic and thermal properties. The Mackenzie River Basin is the largest in Canada (1.8x106 km2) and is underlain by permafrost of various classes (continuous, discontinues, and sporadic) for most of its extent (70-80% by area). The MESH land surface hydrology model has been parameterised for the MRB with a deep soil profile (50 m) and organic soils to be able to simulate permafrost behaviour. A spin-up strategy has been devised to initialize permafrost based on experiments at sites with different permafrost classes. The vertical discretization of the soil column is important for accurate estimation of the active layer depth whilst avoiding numerical instabilities during long simulations. The model was validated against active layer depth and soil temperature observations at several selected locations and then used to investigate the impacts of climate change on permafrost evolution. The results indicate that the active layer is deepening over time and are consistent with point observations. An innovation from this approach is to map out temporal change for different land cover classes. This can be used to inform land management adaptations to permafrost and hydrological change.

Surface Hydrogeologic and Landscape Control on Permafrost Continuity in the Central Mackenzie Valley Using Electrical Geophysical Methods

Lead Author: Maxime Salman, Department of Earth and Environmental Sciences, University of Waterloo
Presenting Author: Maxime Salman, Department of Earth and Environmental Sciences, University of Waterloo
Email address: m4salman@uwaterloo.ca
Co-Authors:
David Rudolph, Department of Earth and Environmental Sciences, University of Waterloo
Colby Steelman, Department of Earth and Environmental Sciences, University of Waterloo

Poster #: 153

Abstract:
An experiment was conducted in an area along the Mackenzie River, in the Sahtu Region of the Northwest Territories, to determine whether surface hydrogeology and changes in landscape have associated changes in the depth of the permafrost table. Northern cold regions are especially susceptible to climate change, and changes in landscape can be large contributors to the acceleration of permafrost deterioration. There are many regions globally that are very difficult to access by conventional means and require the use of more extreme methods, such as helicopters to mobilize ground crews, and even then, operating on the ground in heavily vegetated or very rugged terrain can be near impossible, or at the very least inefficient and ultimately cost prohibitive. Therefore, there is motivation to innovate novel ways of monitoring ground conditions. This work serves as a proof of concept and the framework for continuing research in remote detection using decoupled geophysical methods. As a result, we propose that electromagnetic induction is a suitable method to detect a change in permafrost table depth. Two experimental sites were selected to test our hypothesis. The sites were selected using criteria specifically requiring that an anomalous or distinct surficial feature is evident. Site MW04T is a drill pad clearing, and Marg Lake is located adjacent to a lake. Preliminary measurements were taken using a permafrost probe, that was inserted into the ground until being halted by the permafrost table. Subsequently, data was collected using electrical resistivity tomography (ERT) and electromagnetic induction (EMI). The ERT profiles show the high resitivity anomalies where we expected. The permafrost table deepened from within a heavily vegetated area towards the drill pad or the lake. The EMI measurements show an increasing trend in conductivity as the permafrost table deepened, as was expected. The plunging nature in the permafrost has been characterized using first order derivatives of the quadrature component measurements. The anomalous behavior of the derivatives showed distinct correlation between the change in the trend of the conductivity measurements, and also correlates with the ERT measurements. We also noted that there is convergence in conductivities from measured from various ground conductivity meters, with varying investigation depths. This sounding and subsequent convergence is correlated spatially along the survey lines where the permafrost table plunges. This experiment successfully shows that decoupled electrical methods can be used to get information about the nature of the permafrost relative to surface hydrogeology and landscape modification.

Hydrophobicity of peat soils: Characterization of organic compounds associated with water repellency under laboratory heating

Lead Author: Charles-François de Lannoy, Chemical Engineering, McMaster University
Presenting Author: Yichen Wu, Chemical Engineering, McMaster University
Email address: wuy211@mcmaster.ca
Co-Authors:
Michael Waddington, Geography and Earth Sciences, McMaster University
Charles-François de Lannoy, Chemical Engineering, McMaster University

Poster #: 154

Abstract:
Boreal peatlands represent a globally significant terrestrial carbon reservoir and regional freshwater resource. Peat soil hydrophobicity has important implications on hydrological processes in northern region, which is largely impacted by soil initial properties (i.e. organic matter and moisture content) and wildfire conditions (i.e. fire temperature and duration). In this study, the chemical characterization of peat soils and their impact on water repellency under different fire conditions was evaluated. Organic compounds from unburned and 300 ℃ burned peat soil (feather moss) samples collected from Pelican Mountain, Alberta, Canada were extracted with an isopropanol/15.7 M ammonia mixture (v:v 7:3). The extracts were silylated and characterized by gas chromatography-mass spectrometry (GC-MS). Fatty acids, polycyclic compounds, saccharides, aromatic acids and short-chain molecules were detected at various concentrations for all samples. Supporting measurements by Fourier Transform Infrared Spectra (FTIR) indicate the presence of aliphatic hydrocarbons, lignin and carbohydrates structures for raw peat soils. Extending laboratory heating at 300 ℃ of peat soils led to the attenuation of hydroxyl and aliphatic hydrocarbon groups, indicating the persistent degradation of polysaccharides and irreversible fragmentation of long-chain aliphatic hydrocarbons. Peat soil hydrophobicity was measured by water drop penetration time (WDPT) test and contact angle (CA) measurement, and correlated to compounds identified through GC-MS and FTIR analyses. The reduction of certain FTIR peaks are also followed by significant decrease of water repellency, which manifests the important role these compounds play in altering hydrophobicity. This study also found that peat soil hydrophobicity is not only related to the organic composition of soils, but also to the water content of the soils. Natural peat soils were hydrophilic, but laboratory drying in an oven at 105 ℃ caused a marked increase of soil hydrophobicity. Hydrophobic peat soils are difficult to get wet at low water content, but can change markedly from hydrophobic to hydrophilic after exceeding a threshold which has been reported as a narrow transition range known as critical soil water content. In addition, heating kinetics experiments of dried and wet (3 g/g) peat soils at 250 ℃ and 300 ℃ indicate that regardless of the temperature in this experiment, 5 min is enough to get rid of all the water, and initially wettable moist samples altered rapidly to extremely hydrophobic level. Hydrophobicity was associated with the organic compounds rather than changes in soil structural properties, as BET N2 adsorption surface area of peat soil samples was small. Scanning Electron Microscopy (SEM) characterization of unburned and 300 ℃ burned peat soils demonstrate that the peat soils are non-porous and don't have significant morphological changes under 20 min heating duration. These findings suggested that coating of hydrophobic compounds on soil particle surfaces during the drying process may be primarily responsible for the peat soil water repellency.

The response of carbon and water fluxes to environmental variability in two contrasting forest types in Southern Ontario, Canada

Lead Author: Eric Beamesderfer, School of Geography & Earth Sciences, McMaster University
Presenting Author: Eric Beamesderfer, School of Geography & Earth Sciences, McMaster University
Email address: beamesde@mcmaster.ca
Co-Authors:
Dr. Altaf Arain, School of Geography & Earth Sciences, McMaster University

Poster #: 155

Abstract:
Temperate forests within Eastern North America play a significant role in the regional and global carbon and water cycles by acting as a carbon sink through the absorption of CO2 emissions, and by affecting the hydrologic cycle through evapotranspiration (ET) processes. Recent increases in extreme weather such as drought and heat stress, or the absence of winter freezing events, may directly affect the abilities of these forests to sequester carbon, adversely impacting regional water resources. The result of a shifting climate may lead to a change in the balance between deciduous and coniferous forests as regions once dominated by needle-leaved conifers may yield way to more deciduous broad-leaves species. Even for climatically and geographically similar forests, differences in the timing of photosynthesis, respiration, and water-use by each forest would lead to asymmetries in the partitioning of the resulting flux, net ecosystem productivity (NEP). This research investigated six years (2012 – 2017) of carbon and water exchanges measured using eddy covariance systems for two forest sites (15 km apart) within the Global Water Futures (GWF) – Southern Forests Water Future's (SFWF) Turkey Point Observatory. These sites include a 90+ year old deciduous (Quercus alba) forest (TPD) located at the northern edge of the temperate deciduous biome in North America, and a 78-year old conifer (Pinus strobus) plantation forest (TP39). Study results showed that maximum values of daily NEP at TPD were observed under much warmer (3°C higher) conditions as compared to TP39, although more pronounced differences existed in heat-stressed and drought years (2012 and 2016). Energy use efficiency (EUE) and canopy conductance (Gc) were higher at TPD as compared to TP39, while both forests saw decreasing Gc with increasing atmospheric vapour deficit. Mean annual NEP (ET) for TPD and TP39 was 200 ± 76 g C m-2 yr-1 (388 ± 31 mm) and 218 ±100 g C m-2 yr-1 (442 ± 30 mm), respectively. These results illustrate the complexities of water and carbon exchanges between forests of differing species growing under similar meteorological conditions in the Great Lakes region, and how they may respond to future climates and extreme events.

Characterizing Soil Microbial Diversity through Freeze-Thaw Cycles and the Winter Transition

Lead Author: Grant Jensen, Department of Biology, University of Waterloo
Presenting Author: Grant Jensen, Department of Biology, University of Waterloo
Email address: grant.jesnen@uwaterloo.ca
Co-Authors:
Laura Hug, Department of Biology, University of Waterloo
Konrad Krogstad, Earth and Environmental Sciences, University of Waterloo
Fereidoun Rezanezhad, Earth and Environmental Sciences, University of Waterloo

Poster #: 156

Abstract:
Microbial activity in soil persists under snow and ice throughout the winter transition, before reaching its apex during thaw events. With the onset of climate change, the active layer of soils will experience colder temperatures as snowpack insulation is lost. Consequently, soils and their microbial communities will undergo a higher frequency of freeze-thaw cycles. Evidence of impacts to activity and bulk changes to microbial community structure under winter and freeze-thaw conditions have been identified, but specific changes to microbial phyla over the course of the entire non-growing season remain unclear. The objective of this study was to characterize changes in microbial diversity and bioenergetics through winter conditions, including planned freeze-thaw cycles, as a function of the changing environmental metrics of soil geochemistry and nutrient availability. We dynamically simulated a condensed climate model of the winter transition in laboratory soil columns, allowing for high resolution of depth and temporal sampling. We used agricultural soil to additionally investigate the efficacy of pre-winter fertilizer amendments, as higher frequencies of thaw events may hasten microbial consumption of fertilizer, decreasing fertilizer availability and efficacy in spring. Our microbial analyses included high-throughput community composition profiling and bulk metabolic assessment for community activity. This longitudinal study will provide insights as to the specific development of the soil microbiome through the winter transition and establish causative links to geochemical conditions, clarifying impacts of winter freeze-thaws on agricultural best-practices and microbial impacts on biogeochemical cycling.

Soil carbon dioxide fluxes: Decoupling the effects of soil moisture and oxygen

Lead Author: Linden Fairbairn, Ecohydrology Research Group, University of Waterloo
Presenting Author: L. Fairbairn, as above
Email address: lgfairbairn@uwaterloo.ca
Co-Authors:
Fereidoun Rezanezhad, Ecohydrology Research Group, University of Waterloo
Chris Parsons, Ecohydrology Research Group, University of Waterloo
Merrin Macrae, Department of Geography and Environmental Management, University of Waterloo
Philippe Van Cappellen, Ecohydrology Research Group, University of Waterloo

Poster #: 157

Abstract:
The degradation of soil organic matter results in massive annual fluxes of carbon to the atmosphere. Greenhouse gas effluxes from soils depend on several environmental factors such as temperature, soil moisture and oxygen. Understanding the responses of carbon dioxide (CO2) fluxes to changes in these environmental conditions due to climate change will be critical for predictive modeling of future global carbon emissions. Soil moisture and oxygen are recognized as important factors but their effects on soil CO2 fluxes are closely linked; thus, few experimental studies have attempted to characterize their effects separately. To decouple these two factors, we conducted a factorial batch experiment by incubating soil at different moisture contents (30%-100% saturation) and under oxic versus anoxic conditions. Measurements of gas fluxes (CO2 and methane), pore water chemistry and microbial biomass were performed at the end of the 21-day incubation. The results demonstrated that, as expected, CO2 fluxes were maximal at moderate soil moisture (~65%), becoming moisture-limited at low soil moisture contents and oxygen-limited at high soil moisture contents. The results also demonstrated that CO2 fluxes occurred under anoxic conditions and that these fluxes were affected by soil moisture independently of oxygen availability. Methane fluxes and the depletion of more favourable electron acceptors suggested that methanogenesis was likely the major pathway. The CO2 fluxes under saturated conditions and under anoxic incubation indicated that anaerobic production (via fermentation and/or anaerobic respiration) may be an important source of CO2 that is ignored in existing models, which typically consider aerobic respiration only. An improved soil moisture function that incorporates aerobic and anaerobic sources of CO2 was conceptualized and fit to the CO2 flux results. These findings highlight the need for improved, mechanistic understanding of greenhouse gas-emitting processes and models that can adequately represent biogeochemical processes in soils and their environmental drivers.

Changing Carbon Sinks In Subarctic Canada

Lead Author: Schiff, sherry, University of Waterloo
Presenting Author: Schiff, sherry, University of Waterloo
Email address: sschiff@uwaterloo.ca
Co-Authors:
Aukes, Pieter, University of Waterloo
& English, Michael, & Venkiteswaran, Jason, Wilfrid Laurier University
Couture, Raoul, Laval University
Elgood, Richard, University of Waterloo

Poster #: 158

Abstract:
Lakes and ponds in the Precambrian Shield geology of northern Canada store large amounts of Carbon (C) in their sediments. This C largely originates in terrestrial catchments where soils, particularly in wetlands, have high organic C content. Decomposition produces high levels of Dissolved Organic Carbon (DOC) within the subsurface that can be transported to surface waters during periods of hydrologic flow. DOC is important in the mobility of trace metals and contaminants and in the provision of safe drinking water to northern communities. In open water bodies, DOC is transformed and can accumulate in lake sediments or be released as Greenhouse Gases (GHG: CO2 and CH4). This part of the subarctic and low arctic shield (taiga and tundra respectively) covers a large portion of Canada and is warming at an accelerated rate resulting in rapidly degrading permafrost and increased drought frequency, both of which affect C pathways. Carbon cycling is also disrupted by human activities including building of infrastructure (dams, communities, roads, mining activities), and forest fire and wildlife management (particularly beaver populations). The subarctic is particularly sensitive to human actions because of shallow active layer depths and low rates of microbial processing. In general, lakes and ponds in the subarctic Boreal Shield have the highest DOC levels in Canada but the fate of DOC under changing conditions is uncertain. We focus on three main sites along a 300 km transect including Yellowknife (forest; sporadic permafrost and where complimentary work is on-going), Snare (treeline; continuous permafrost) and Daring Lake (tundra; continuous permafrost)., we couple hydrology, landscape unit analysis, biogeochemistry and modelling and incorporate new techniques using stable isotopes in addition to natural 14C. In addition, we collaborate in ABoVE2 (Arctic-Boreal Vulnerability Experiment2), a NASA program to quantify North American C emission rates via remote sensing (aircraft missions & satellite) coupled with “ground truthing” (literally) and process-based research. Our overarching objective is to improve the quantitative understanding of carbon dynamics and dissolved organic carbon in Canadian subarctic freshwaters with a focus on processes governing the sources and fate of DOC and the balance between carbon sinks and carbon sources to the atmosphere. Date from inflow streams, groundwaters and lakes from important terrain units will be collected and used in state-of-the-art numerical models for enhancing both understanding and for predicting future scenarios of change. This research is linked with the Subarctic Metal Mobility Study (SAMMS) funded by GWF.

Simulation of preferential flow in snow with a 2D non-equilibrium Richards equation

Lead Author: Nicolas Leroux, Geography and Planning, University of Saskatchewan
Presenting Author: Nicolas Leroux, Geography and Planning, University of Saskatchewan
Email address: nicolas.leroux@usask.ca
Co-Authors:
John Pomeroy, Geography and Planning, University of Saskatchewan

Poster #: 159

Abstract:
Recent advances have been made to better represent water flow through snowpacks, particularly the representation of preferential flow through snow. These advancements aim at improving the simulation of the timing and magnitude of snowmelt discharge, which can be the main hydrological event in cold regions. Preferential flow is inherently unstable and so a previous study presented a 1D non-equilibrium Richards equation model, which was evaluated against measured 1D capillary pressure overshoots in artificial snow samples. From soil studies, it is known that capillary pressure overshoot causes preferential flow formation; however, this had not been demonstrated in snow. The current study expands the 1D non-equilibrium Richards equation model to 2D. For the first time, the simulation of preferential flow in snow with a 2D non-equilibrium Richards equation model is demonstrated and the model is compared to laboratory experiments. After adjusting model parameters to account for snowpack properties and input rates, the model shows good agreement with the experimental data. This advanced model represents a new understanding of flow through snowpacks that can aid the development of snow hydrology models for hydrological prediction and operational use.

Quantifying soil freeze-thaw phenomena in the Kenaston soil moisture network using 50 MHz coaxial impedance dielectric reflectometry probes

Lead Author: Renato Pardo Lara, Department of Geography, Environment and Geomatics, University of Guelph
Presenting Author: Renato Pardo Lara, Department of Geography, Environment and Geomatics, University of Guelph
Email address: rpardo@uoguelph.ca
Co-Authors:
Aaron Berg, Department of Geography, Environment and Geomatics, University of Guelph
Jon Warland, School of Environmental Science, University of Guelph
Erica Tetlock, National Hydrology Research Centre,Environment and Climate Change Canada

Poster #: 160

Abstract:
We present a method to quantify the near-surface soil moisture/freeze-thaw state and freezing point-depression by modeling the unique relationship between the soil permittivity, temperature, and state. Soil freeze-thaw processes play a critical role in the surface energy and water balance in cold regions. The single most important control on flood risk and water for crops in the Canadian prairies is, arguably, the partitioning of snowmelt into runoff and infiltration. However, understanding the physical processes involved is fraught with challenges and there remain major gaps. In general, there is an inability to interpret soil moisture instrumentation in frozen conditions. Furthermore, F/T state is often inferred from temperature measurements and classified against a 0 °C threshold. However, for soils, temperature measurements are an imprecise proxy of the F/T state. Moreover, binary classification obscures the fact that soil moisture in the solid state generally coexists with the liquid state.
To address these gaps, we conducted an experiment to characterize the response of Steven's HydraProbe (HP), a coaxial impedance dielectric reflectometry probe, to phase state transitions of soil moisture using coincident measurements from heat pulse probes (HPP). HPs are the most widely used soil moisture sensors in water supply forecast and climatological networks. Recently, the probes have been used to validate remote sensing F/T products. This method is still relatively uncommon and depends on binary classification techniques based on seasonal reference states of frozen and non-frozen soil conditions. We developed a data-driven semi-empirical model of the unique relationship between the soil permittivity and temperature in the context of soil moisture F/T transitions to estimate the F/T transition temperature range and relatively assess the degree to which the soil is frozen. The model developed is extended to the field scale in this investigation, allowing for quantification of the soil freezing-point depression and hydraulic properties of the soils from soil moisture network data. The model was applied to soil permittivity and temperature measurements collected over the last five years from Kenaston Soil Moisture Network, in the Brightwater Creek basin, Saskatchewan, Canada. We present insights into the model's limitations when applied to real-world data and some of the ways the model can be adapted for particular applications.

Evaluating intrinsic water use efficiency (iWUE) and productivity in different-aged pine forests in the Great Lakes region using tree ring, isotopic, and eddy-flux techniques

Lead Author: Shawn McKenzie, Earth and Environmental Science, McMaster University
Presenting Author: Shawn McKenzie, Earth and Environmental Science, McMaster University
Email address: mckenzsm@mcmaster.ca
Co-Authors:
M. Altaf Arain, Earth and Environmental Science, McMaster University
Greg Slater, Earth and Environmental Science, McMaster University
Michael FJ Pisaric, Department of Geography and Tourism Studies, Brock University

Poster #: 161

Abstract:
The full effect of water availability and environmental factors on forest productivity, vulnerability, and the carbon cycle has not been fully assessed. Dendrochronology offers one approach to explore past climate and forest growth patterns. Tree ring records may be used to identify past environmental events that impacted tree growth and to provide insight into the functioning of forest ecosystems in the future. Additionally, stable carbon isotope ratios (δ13C, or 13C to 12C) of tree ring material can provide information about intrinsic water use efficiency (iWUE), which is not captured in radial width measurements. In this study, tree ring stable isotopes and eddy-covariance flux records were measured and constructed to explore the dynamics of growth over the lifespan of three white pine (Pinus strobus L.) plantation forests. The forest sites were established in 1939 (TP39), 1974 (TP74) and 2002 (TP02) and all are part of the Global Water Futures (GWF) – Southern Forests Water Future (SFWF)'s Turkey Point Observatory in southern Ontario. Air temperature, precipitation, and drought indices were analyzed at monthly resolution to determine controls on water use efficiency and productivity. Temperature was consistently negatively correlated to growth, while precipitation and drought indices (e.g. self-calibrating Palmer Drought Severity Index (scPDSI)) were consistently positively correlated to growth. Variations in the δ13C time series from whole wood samples also provided a record of iWUE. Long-term iWUE was found to increase by 50 µmol/mol with nearly all of the increase occurring as the tree shifted into active homeostasis of stomatal control. In all three forest sites, inter-annual variation of gross ecosystem productivity derived using eddy covariance fluxes was found to be significantly related to tree ring growth over the 2003 to 2017 period. These relationships enabled an inter-annual estimate of tree ring-inferred fluxes to be constructed for all three growth chronologies. These results suggest that dendrochronology and isotope tracers are useful tools to be used to evaluate historical environmental impacts on growth and water use efficiency in these different-age plantation stands. The relationships of tree ring growth, ring isotopic compositions, and eddy-flux quantifications found here serve as useful background knowledge on which to base additional studies of forest climate change impacts in the Global Water Futures (GWF) network.

Landscape change in Taiga Shield on discontinuous permafrost: shifts in vegetation, lakes, and watercourses over 60 years of warming

Lead Author: Anastasia Sniderhan, Dept. of Biology, Wilfrid Laurier University
Presenting Author: Anastasia Sniderhan, Dept. of Biology, Wilfrid Laurier University
Email address: asniderhan@wlu.ca
Co-Authors:
Jennifer Baltzer, Dept. of Biology, Wilfrid Laurier University
Chris Spence,Watershed Hydrology and Ecology Research Division, Environment and Climate Change Canada

Poster #: 162

Abstract:
Warming at high latitudes is often associated with permafrost thaw leading to landscape change through dramatic ground subsidence, drunken forests, and transitions from raised permafrost plateaus to wetland features. However, studies quantifying these thaw-induced changes across the landscape have largely been focused in the Taiga Plains ecoregion. Unlike in the Taiga Plains, the Taiga Shield landscape is comprised of sparsely treed or exposed bedrock, a large network of lakes and wetlands, forest patches on glaciolacustrine sediments and peatlands that have accumulated in bedrock depressions. The underlying bedrock in the Taiga Shield offers some stability to the landscape that may lead to different thaw dynamics than observed in the Taiga Plains. In this study, we will be using air photos to quantify changes to the Taiga Shield landscape over the past 60 years. High-resolution air photos dating back to the 1950s will be used to document landscape change in the Baker Creek watershed, a typical Taiga Shield basin north of Yellowknife NT, through this period of rapid climate warming. In particular, we will be addressing questions such as: (1) are there changes in forest extent and forest density across the Baker Creek watershed? (2) Are these changes associated with permafrost thaw, and did this lead to the development of waterbodies? Here we present preliminary results of this study, documenting some of the changes that we have seen in this Taiga Shield basin over the past 60 years.

Hydraulic traits plasticity of boreal tree species along a latitudinal climate and permafrost gradient in northwestern North America

Lead Author: Christoforos Pappas, Département de géographie, Université de Montréal
Presenting Author: Christoforos Pappas, Département de géographie, Université de Montréal
Email address: christoforos.pappas@umontreal.ca
Co-Authors:
Jennifer L. Baltzer, Department of Biology, Wilfried Laurier University
Matteo Detto, Department of Ecology and Evolutionary Biology, Princeton University
Nia Perron, Département de géographie, Université de Montréal
Katherine Staden, Department of Biology, Wilfried Laurier University and Oliver Sonnentag, Département de géographie, Université de Montréal
Oliver Sonnentag, Département de géographie, Université de Montréal, Montréal, Canada

Poster #: 163

Abstract:
Hydraulic traits plasticity of boreal tree species along a latitudinal climate and permafrost gradient in northwestern North America
Christoforos Pappas1, Jennifer L. Baltzer2, Matteo Detto3,4, Nia Perron1, Katherine Staden2, Oliver Sonnentag1
1Département de géographie, Université de Montréal, Montréal, Canada
2Department of Biology, Wilfrid Laurier University, Waterloo, Canada
3Center for Tropical Forest Science-Forest Global Earth Observatory, Smithsonian Tropical Research Institute, Panamà, Republic of Panamà
4Department of Ecology and Evolutionary Biology, Princeton University, Princeton, USA
Boreal forests cover about one third of the world's forested area and undergo rapid changes in composition, structure, and function in response to environmental changes. Here we investigated the inter- and intra-specific variability and plasticity of boreal tree hydraulic traits along a 2000-km latitudinal climate and permafrost gradient. The study area is located in northwestern Canada and includes forests with no permafrost, over isolated, sporadic and discontinuous, to continuous permafrost, spanning from the southern- to the northern edge of the boreal forest ecozone. Focusing on the region's dominating boreal tree species, namely, black spruce (Picea mariana) and larch (Larix laricina), we monitored growing-season sap flow of ~200 individuals. Sap flow data were used to characterize crown-level water conductance and were combined with leaf-level measurements of stomatal conductance to water for selected individuals across the study domain. By jointly analyzing crown- and leaf-level water use strategies, together with the prevailing environmental and micrometeorological conditions along the gradient, we were able to provide a detailed quantification of black spruce and larch inter- and intra-specific hydraulic trait variability across and within sites. Moreover, species-specific water use strategies were revealed and associated with tree morphological and architectural characteristics across sites. This analysis allowed us to obtain a better understanding of boreal forest functional trait plasticity and resilience to the ongoing environmental changes.

Seed dispersal as an explanation of spatial variability in shrub expansion at the taiga- tundra ecotone of the Northwest Territories.

Lead Author: Cory A Wallace, Geography and Environmental Studies, Wilfrid Laurier University
Presenting Author: Cory A Wallace, Geography and Environmental Studies, Wilfrid Laurier University
Email address: wall1643@mylaurier.ca
Co-Authors:
Jennifer L Baltzer, Biology, Wilfrid Laurier University

Poster #: 164

Abstract:
The arctic is undergoing dramatic increases in primary productivity. This change has been largely attributed to proliferation of shrubby vegetation, driven by warming summer temperatures. The resulting shift toward a shrub-dominated landscape could have important consequences on surface energy distribution and hydrology, however there is a great degree of spatial variability in this expansion, making future rates and patterns of spread difficult to predict. Spatial variability in shrub expansion is generally associated with increased productivity at the bottom of slopes and within water channels. These observations are often hypothesized to be caused by increased resource availability associated with the downslope movement of water and plant available nutrients, though our recent studies of Alnus viridis (green alder) at the treeline- tundra ecotone of the Northwest Territories do not support this hypothesis. While the majority of alder recruitment occurs in lower slope positions directly downslope of alder patches, these patterns of recruitment are not associated with either nutrient or soil moisture gradients, suggesting an alternative mechanism driving seedling establishment. Considering the low viability of alder seed in this region, germination may only result in significant establishment if a microcosm were to accumulate large numbers of seed. Here, we test whether patterns of alder recruitment are explained by two mechanisms of seed dispersal: 1) transport of seed by way of preferential water flow paths and 2) accumulation of seed in snow drifts associated with the predominant wind direction.
In order to test these mechanisms, we deployed seed traps throughout three alder shrub patches at the Trail Valley Research Station 50km north of Inuvik, NT. Traps were placed in a grid formation with rows and columns separated by 15m and deployed in the fall of 2016 to ensure capture of alder seed fall. Seed traps were then collected after snow melt in the spring of 2017 and seedling counts were performed in the vicinity of each trap. Because alder generally release their seed after snowfall, seed density was also measured by way of snow cores in the spring of 2017 in order to elucidate the pattern of seed distribution before snowmelt. For each alder patch around which seed traps were deployed, we developed two spatially explicit models of seed distribution using a LiDAR based digital elevation model and orthoimagery of shrub patch locations; one predicting seed accumulation from preferential water flow and one predicting accumulation from the predominant wind direction. Counts of alder seedling density were used to test each dispersal mechanism as predicted by the models. In general, the models did not explain variation in alder seedling density. Next steps will involve comparing seed density collected from the traps to the model results. Alder seed density will also be compared to seedling density in order to test the validity of seed dispersal as a mechanism of spatial variability of alder expansion.

Using dendrochronology to study long-term carbon sequestration in a red pine (Pinus resinosa) plantation in response to variable retention harvesting (VRH) and climate change, southern Ontario, Canada

Lead Author: Jessica I. Zugic, Environmental Sustainability Research Centre, Brock University
Presenting Author: Jessica I. Zugic, Environmental Sustainability Research Centre, Brock University
Email address: jessica_zugic_17@hotmail.com
Co-Authors:
Michael F. J. Pisaric, Department of Geography and Tourism, Brock University
Shawn M. McKenzie, School of Geography & Earth Sciences and McMaster Centre for Climate Change, McMaster University
M. Altaf Arain, School of Geography & Earth Sciences and McMaster Centre for Climate Change, McMaster University

Poster #: 165

Abstract:
Atmospheric carbon dioxide (CO2) emissions have been rising since the beginning of the Industrial Revolution, but the ability of trees to efficiently utilize this available CO2 for growth has been questioned. Silvicultural practices, such as variable retention harvesting (VRH), have been suggested as ways to increase carbon sequestration in forest environments. This study aims to explore the effect that climate change and VRH have on tree growth and carbon sequestration at a red pine plantation in Turkey Point, Ontario. This research will contribute to the Global Water Futures (GWF) Southern Forests Water Futures project, which aims to understand the impact forest management practices and environmental change have on water, energy, and carbon cycling in managed forest ecosystems. This project will ultimately explore how water and carbon budgets will respond to future climate change and disturbance events in southeastern Canadian forests. The Southern Forests Water Futures project utilizes the GWF observatory at the Turkey Point Flux Station, and includes four flux towers at different aged coniferous and deciduous forests. This area was subjected to intensive agricultural use in the late 1800s and early 1900s and resulted in the area undergoing desertification. Turkey Point is an ideal area for this project because the plantations in this region were established with the goal of increasing biological diversity and preventing environmental degradation through afforestation and forest management practices. Red pine trees were chosen in the afforestation process in the early 1930s because this species is one of the few species that thrive on dry and exposed sites, as well as aiding in the stabilization of the soil. Since the establishment of these pine plantations (and many others across Ontario) during the early 20th century, many of these planted systems have been maintained to varying degrees with some being left to naturally develop and others being managed using direct management strategies, including VRH. However, the effects of VRH on carbon sequestration and tree growth of pine plantations in Ontario are not fully understood, even though they comprise a prominent portion of the 2 million hectares of forested area in southern Ontario. This study will examine carbon sequestration at 20 VRH plots at Turkey Point, Ontario. At each site 30 trees will be sampled in stands managed with different VRH treatments. The plantation forests were planted in 1931 and VRH took place in 2014. In order to determine the effect VRH has on tree growth and carbon sequestration, 5 years pre- and post-harvest will be analyzed by calculating percent growth change and tree biomass. The relationship between various climate parameters and carbon sequestration will also be analyzed as this correlation requires further understanding for this climatic area. In general, carbon sequestration seems to be positively correlated to climate warming, but its relationship can vary with precipitation. This relationship is likely to be further impacted by the specific tree species and their tolerance to changes in

climate. While preliminary, this research will aid in informing larger questions concerning carbon uptake in plantation forests in southern Ontario.

Effects of harvesting and vegetation change on boreal forest water balance and runoff

Lead Author: Maxime Beaudoin-Galaise, Département des sciences du bois et de la forêt, Université Laval
Presenting Author: Maxime Beaudoin-Galaise, Département des sciences du bois et de la forêt, Université Laval
Email address: maxime.beaudoin-galaise.1@ulaval.ca
Co-Authors:
Sylvain Jutras, Département des sciences du bois et de la forêt, Université Laval

Poster #: 166

Abstract:
For the boreal forest in Eastern Canada, previous studies related to the impact of logging on hydrological processes have focused on analyzing short-term changes. While there is generally a rapid increase in streamflows following forest harvesting, few studies in Quebec have evaluated the effects of forest regeneration on a decrease of flows in long-term.
In order to contribute to the improvement of knowledge in forest hydrology, the main objective of my research project is to analyze the effects of harvesting and vegetation change on boreal forest water balance and runoff. The first chapter of my thesis aims to evaluate the effect of logging and regeneration on snow accumulation and melt rate using a modeling approach. The hydrological model chosen for this study is the Cold Region Hydrological Model. For the second chapter, the objective is to evaluate the long-term effect of logging and vegetation changes on the water balance of watersheds of different sizes. The objective of my third chapter is to assess whether the effects of logging could be modified in a climate change perspective.
Based on the long history of logging and hydro-meteorological data from the Bassin Expérimental du Ruisseau des Eaux-Volées (BEREV) at Forêt Montmorency, this study will be one of the first implementation of CRHM in Quebec. Based on the water balance analysis of the BEREV and a subwatershed of the Montmorency River, it will be possible to better understand the impact of past logging and its consequences for the future.

Wildfire impacts on freshwater ecosystem services in North American high-latitude forests: a scoping review

Lead Author: François-Nicolas Robinne, Renewable Resources, University of Alberta
Presenting Author: François-Nicolas Robinne, Renewable Resources, University of Alberta
Email address: robinne@ualberta.ca
Co-Authors:
Dennis W. Hallema, USFS
Kevin D. Bladon, Oregon State University
Jim Buttle, Trent University

Poster #: 167

Abstract:
The importance of North American high-latitude forests for the provision of safe surface water resources to communities and aquatic ecosystems has been acknowledged for a long time. In parallel, these forests regularly experience large and severe wildfires, a necessary disturbance maintaining the long-term health of these ecosystems. However, a growing number of extreme wildfires have revealed the exposure of many watersheds providing hydrologic services, such as drinking water or protection against floods, hence the vulnerability of downstream communities' water supply to post-fire hydrologic hazards. Compared to other research topics in wildfire science, post-fire hydrology has only received little attention in this part of the world. We reviewed more than 100 studies assessing the impacts of wildfires on watershed hydrologic functioning and their capacity to maintain hydrologic services in Canada and Alaska. Our aim was to evaluate the current state of science in post-fire surface hydrology in northern forests and to propose a research agenda addressing concerning knowledge gaps. Our main results show that our current knowledge is spatially clustered to a few research sites, that the description of fire and watershed attributes is highly variable from a study to another, and that the implications for the maintenance of hydrologic services was seldom discussed. We conclude that future research must focus both on the development of a standard method to describe the post-fire hydrologic environment and on the use of computer simulations to integrate current and future wildfire hazards in water resource planning.

Exploring the ecohydrological function and smouldering vulnerability of peat under future climate in fire-prone peatlands

Lead Author: Sophie Wilkinson, Geography and Earth Science, McMaster University
Presenting Author: Sophie Wilkinson, Geography and Earth Science, McMaster University
Email address: wilkisl@mcmaster.ca
Co-Authors:

Poster #: 168

Abstract:
Peat properties such as bulk density, moisture retention and drainable porosity influence water table fluctuations, drying rates and peat combustion vulnerability, therefore determining peat susceptibility and response to wildfire. Smouldering peat fires are challenging to suppress and emit vast quantities of carbon and particulate matter into the atmosphere. A 120-year peatland fire return interval was used to constrain a landscape-wide space-for-time chronosequence in the boreal plains ecozone of Alberta, where peat properties were assessed along spatial gradients within 26 peatlands. Bulk density depth profiles are different between microforms where hummocks < hollows < margins, correspondingly drainable porosity followed the opposite trend. Hollows and margin peat characteristics tend to be optimised for water conservation whereas hummock peat is optimised for the maintenance of moss productivity. Hummock moisture retention parameters, modelled using the Van Genuchten-Mualem model, are maintained over time whereas hollows and margins experience changes due to wildfire impacts and subsequent recovery, causing decreased drainable porosity immediately following fire but increased moisture retention. This trend is exacerbated in coarse and moraine hydrogeological settings where the margin to peatland-proper area ratio tends to be greatest. We find that increases in growing season water deficit predicted with future climatic change will cause high combustion vulnerability in hollows and margins. This study provides the first landscape-wide assessment of peat properties across a fire return interval and assessment of potential smouldering vulnerability given increased water deficits under future climate change. Such studies will be imperative to inform wildfire management decision-making especially at the wildland society interface.

PEAT BURN SEVERITY ALTERS THE POST-FIRE HYDROPHOBICITY-EVAPORATION FEEDBACK: IMPLICATIONS FOR CLIMATE CHANGE

Lead Author: Gregory James Verkaik, SGES, McMaster University
Presenting Author: Gregory James Verkaik, SGES, McMaster University
Email address: verkaikg@mcmaster.ca
Co-Authors:
James Mike Waddington, School of Geography and Earth Sciences, McMaster University
Sophie Wilkinson, School of Geography and Earth Sciences, McMaster University
Paul Moore, School of Geography and Earth Sciences, McMaster University

Poster #: 169

Abstract:
Peatlands are important ecosystems within their regional settings, and globally holding approximately one-third of the world's soil carbon stores while only covering 3% of the land surface. In the Boreal Plains (BP) of Alberta the largest impact on peatlands is wildfire, releasing large amounts of carbon through smouldering combustion and potentially leaving remnant carbon stocks exposed to drying and decomposition. Feedback mechanisms are an important aspect of peatland function and act in the protection of these carbon stocks. Our research examines the factors affecting one such feedback mechanism: the hydrophobicity-evaporation feedback, such as water table depth (WTD) and burn severity. Following wildfire peatland surfaces are known to become hydrophobic and to show reduced evaporation. However, it is hypothesized that a threshold exists at a certain burn severity, after which evaporation is increased and carbon stocks are potentially exposed to further degradation through drying and decomposition. A partially-drained BP treed bog burned during the Horse River Creek Fort McMurray wildfires of 2016. The conditions induced by the drainage experiment led to the peatland experiencing a gradient of burn severities, from lightly burned to severely burned conditions. We found that within severely burned areas mean evaporation rates (2.75 mm day-1) are increased when compared to lightly and moderately burned areas (1.64 mm day-1 and 0.82 mm day-1, respectively). This supports our hypothesis that a burn severity threshold exists within the hydrophobicity-evaporation feedback A controlled experiment using samples from this peatland examined the impacts of WTD on hydrophobicity and near surface moisture contents. We found that increasing WTD increases hydrophobicity within singed feather moss samples but not in burned feather moss, and that increasing WTD decreases the near surface moisture contents of all samples, with both burned and singed feather moss showing greater decreases in near surface moisture than Sphagnum samples. This, along with hydrophobicity not being present within Sphagnum shows that the hydrophobicity evaporation feedback is present within feather moss, but not Sphagnum cover, further supporting the hypothesis that once burn severity increases to remove the feather moss cap from a peatland the hydrophobicity-evaporation feedback is removed, which has implications for climate change scenarios under which BP peatlands will experience further pre-fire drying and increasing burn severities, potentially leading to further carbon losses due to post-fire drying and decomposition.

Remote-sensing indices of post-fire recovery for five Boreal forests in Alberta

Lead Author: Prabha Amali Rupasinghe, Department of Biology, McMaster University
Presenting Author: Prabha Amali Rupasinghe, Department of Biology, McMaster University
Email address: rupasinp@mcmaster.ca
Co-Authors:
Patricia Chow-Fraser, Department of Biology, McMaster University

Poster #: 170

Abstract:
Wildfires are the primary disturbance factor in Boreal forests and play an important role in altering forest succession, biogeochemical cycling, and carbon sequestration. Natural fires spread unevenly through the landscape, but man-made structures and activity can influence these natural patterns. Furthermore, climate change has altered the long-term fire regimes and successional dynamics. Here, we use remote sensing and GIS (Geographic Information System) techniques to investigate post-fire recovery of five selected Boreal forests in Alberta: Bistcho Lake region, Wood Buffalo National park, Lesser Slave Lake region, Richardson backcountry, and Waterton Lakes National Parks region. First, we used the spatial wildfire data from the Alberta Ministry of Agriculture and Forestry to identify fire events from 1931 to 2018 and to determine potential effects of historical fire events on the occurrence of more recent fires and changes in the fire regime. Using the Normalized Burn Ratio (NBR), we quantified the severity of fire outbreaks occurring between 1985 to 2018 in all available Landsat 4 to 8 imagery. To assess the post-fire recovery process in the five Boreal forests, we calculated indices for vegetation greenness (Normalized Difference Vegetation Index; NDVI), area of vertical leaf layers (Leaf Area Index; LAI), and examined changes in hydrology of affected areas using time series images of Google EEflux to estimate evapotranspiration (ET) rates. All indices showed a gradual improvement in vegetation health following the fire outbreak, but the LAI also reflected effects of anthropogenic activity on the affected area. For areas within ~10 km of water features (lakes and rivers), there was a faster recovery rate for areas closer to the water features than those further away, but these areas also experienced multiple fire outbreaks, likely because they reached pre-fire NDVI and LAI values rapidly and were then susceptible to fire outbreak again. Overall, post-fire recovery rate was dependent on the location and pre-fire conditions (including the dominant tree species and proximity to anthropogenic activities), and was inversely proportional to fire severity, fire duration, and the total area burnt. In future, we plan to study the effect of topography and meteorological conditions in relation to post-fire recovery. Moreover, we will analyze the fire fuel accumulation rates, land cover types, and proximity to human settlements on the post-fire recovery process.

Environmental and physiological controls on transpiration and evaporative partitioning in a white spruce boreal forest, Wolf Creek, Yukon Territory

Lead Author: Erin Nicholls, School of Geography and Earth Sciences, McMaster University
Presenting Author: Erin Nicholls, School of Geography and Earth Sciences, McMaster University
Email address: nicholem@mcmaster.ca
Co-Authors:
Gordon B. Drewitt, School of Geography and Earth Sciences, McMaster University
Sean K. Carey, School of Geography and Earth Sciences, McMaster University

Poster #: 171

Abstract:
Quantification of evapotranspiration (ET) across a range of vegetation units spanning thermal gradients is critical to predicting water yield from northern and alpine catchments, yet challenging due to complex environmental and phenological controls on transpiration (T). Predictions of catchment scale water availability under varying climate scenarios will change depending on physiological alterations of species controlling ET. To date, the partitioning of T from total ET has been limited, specifically over large scales and in heterogeneous, mountain environments. Here, we partitioned the evaporative components in a ~20 m white spruce (Picea glauca) forest within a subarctic catchment near Whitehorse, Yukon using sap flow and under and above-canopy eddy covariance (EC) methods from 2018-2019. Environmental and physiological controls on T were assessed diurnally and seasonally. Surface resistance was calculated using a Penman Monteith framework and compared with timing of transpiration. T accounted for an approximately 60% of total ET during the growing season (May-Sept). Stomatal resistance showed distinct seasonal patterns, shifting from winter to summer values gradually in spring. Transpiration was mainly controlled by net radiation and vapour pressure deficit (VPD). Soil water became a more dominant control on transpiration during periods of limited rainfall. Hysteresis loops between sap flow and radiation, VPD and temperature existed at the diurnal scale. As projections of climate change predict increased air temperature and changing precipitation regimes at high latitudes, the role of vegetation in water and energy partitioning will become increasingly important and need to be properly quantified in energy exchange models. These results further the understanding of the influence of vegetation type and phenological control on water partitioning in northern boreal forests.

Overview of the Wolf Creek Research Basin

Lead Author: J. Tyler de Jong, McMaster University
Presenting Author: J. Tyler de Jong, McMaster University
Email address: tyler.dejong@mcmaster.ca
Co-Authors:
David Barrett, McMaster University
Sean Carey, McMaster University

Poster #: 172

Abstract:
The Wolf Creek Research Basin (WCRB), located in the Boundary Range Mountains near Whitehorse, Yukon, has a long and rich history in cold regions hydrological research. For over 25 years continuous hydro-meteorological data has been collected, providing invaluable forcing data to many hydrological models. In addition, the longevity of the data records at WCRB make it an ideal location to study the impacts of climate change in an intact northern watershed. In recent years with support from the Global Water Futures and Government of Yukon, researchers have been able to continue collecting essential environmental data, but also be at the forefront of testing new technologies and methodologies in attempt to better answer key hydrological questions. This poster will provide an overview of the ongoing research, current field datasets being collected, and future work planned at WCRB.

Biogeochemical, fluorescence and isotopic techniques provide insights into catchment function in Wolf Creek, YT

Lead Author: Nadine J. Shatilla, School of Geography and Earth Science, McMaster University
Presenting Author: Nadine J. Shatilla, School of Geography and Earth Science, McMaster University
Email address: n.j.shatilla@gmail.com
Co-Authors:
Sean K. Carey, School of Geography and Earth Science, McMaster University
Weigang Tang, School of Geography and Earth Science, McMaster University

Poster #: 173

Abstract:
Permafrost and frozen ground play a critical role in the transfer of water and solutes from the landscape to the stream, and in biogeochemical cycling by acting as a cold season or semi-permanent aquitard. Conceptual models of permafrost hydrology have been well defined for over several decades, yet renewed interest in the face of climate change and rapid degradation of frozen ground has provided an opportunity to revisit previous paradigms. At the same time, new instruments and techniques to understand coupled hydrological and biogeochemical processes have emerged, providing a more nuanced view of northern catchments. Previous research in Wolf Creek Research Basin (WCRB), Yukon Territory, with stable isotopes from precipitation and within streams has provided information on water sources using traditional hydrograph separation techniques. More recent research (2013-2018) has includes stable isotopes from soil and xylem water to investigate how vegetation affects water use and cycling at the headwater scale. In addition to stable isotopes, dissolved organic matter (DOM) fluorescence, often used to classify dissolved organic carbon (DOC) composition, was compared across surface water bodies in WCRB to determine DOC quality during snowmelt and rainfall-runoff events. Analysis showed that DOC quality during freshet was distinct when compared to summer and fall seasons, and with increasing microbial processing from headwater scales to the catchment outlet. Three years of high frequency records of stream flow, specific conductance (SpC) and chromophoric dissolved organic matter (CDOM) were also assessed at a headwater basin (Granger Creek) in conjunction with climatic (air temperature, precipitation) and catchment variables. A matlab toolkit was used to delineate snowmelt- and rainfall-driven events, plot normalized hysteresis loops and extract relevant hysteresis metrics generated from the sub-hourly data sets. The direction and magnitude of SpC-Q and CDOM-Q loops suggest seasonality strongly controls solute export mechanisms, and illustrate key differences between processes related to weathering ions and DOM. Hysteresis direction and magnitude also suggest changing proximal and distal sources of solutes and organic material in response to active layer thickening, soil moisture and precipitation intensity; highlighting spatial connections among landscape units not previously reported. Evaluation of these patterns at the headwater scale in conjunction with new insights from across WCRB provide alternate hypotheses for how solute and water cycling in permafrost landscapes may evolve in a changing climate.

Evaluating vegetation change in Wolf Creek, Yukon Territory through fusion of remotely sensed data

Lead Author: Sean C. Leipe, School of Geography & Earth Sciences, McMaster University
Presenting Author: Sean C. Leipe, School of Geography & Earth Sciences, McMaster University
Email address: leipes@mcmaster.ca
Co-Authors:
Sean K. Carey, School of Geography & Earth Sciences, McMaster University

Poster #: 174

Abstract:
High-latitude ecosystems have experienced substantial warming over the past 40 years, which is expected to continue. Consequently, an increase in vegetation growth has occurred throughout the circumpolar North as documented through remote sensing and plot-level studies. Changes in shrub and other vegetation properties are critical to document due to their first-order control on water, energy and carbon balances. Furthermore, understanding the rate, location and type of vegetation change and is critical for predicting the future of northern watersheds under a rapidly changing climate. The objective of this work in progress is to use a combination of LiDAR (Light Detection and Ranging), optical imagery, and field methods to measure temporal changes in vegetation properties over a well-studied subarctic mountain basin. LiDAR from 2007 and 2018 for the Wolf Creek Research Basin (WCRB) in south-central Yukon Territory, along with high-resolution DigitalGlobe imagery, are being used to quantify changes to vegetation metrics such as areal coverage, height, and density over the 11 years between surveys. Landscape and vegetation classes are being identified using both multispectral imagery and LiDAR metrics through a Random Forest classification approach, supported by ground truthing. Terrain indices are also being created from a LiDAR-derived digital elevation model of the basin, which will be used for quantitative comparisons of individual species over different landscape positions. Preliminary LiDAR-derived height above ground (HAG) models show clear differences between the 2007 and 2018 datasets, although artifacts that must be resolved still remain. Considering the rapid change to circumpolar systems, results from this study will help: 1) quantify the rates of vegetation change in an alpine subarctic ecosystem, and 2) link these changes to ecotone and physiographic variables such as aspect, slope, wetness, elevation and permafrost extent.

Linking hydrological processes to streamflow variability in an headwater alpine glacierized catchment

Lead Author: Caroline Aubry-Wake, Geography and Planning, University of Saskatchewan
Presenting Author: Caroline Aubry-Wake, Geography and Planning, University of Saskatchewan
Email address: caroline.aubrywake@usask.ca
Co-Authors:
Dhiraj Pradhananga, Geography and Planning, University of Saskatchewan
John Pomeroy, Geography and Planning, University of Saskatchewan

Poster #: 175

Abstract:
Mountain glacierized headwaters are currently witnessing a transient shift in their hydrological and glaciological systems. This shift is reducing the glaciers' volume, extent, elevation range, in addition to changing the snow dynamics and cover type across both glacierized and non-glacierized areas. These interconnected changes occur simultaneously, driven by complex physical feedbacks, and they impact streamflow generation processes. To characterize these changes, a robust understanding of the hydrological processes at play in the catchment and their interactions is needed. Here, we present a comprehensive investigation of the hydrological processes present in a glacierized headwater catchment, the Peyto Glacier Research Basin, in the Canadian Rockies for a 27 years period (1990-2017). A distributed, physically based glacier hydrology model is designed using the Cold Region Hydrological Modelling Platform to simulates both on and off-glacier high mountain hydrological processes, as snow accumulation and redistribution by wind and avalanches, glacier melt and mass balance, energy budget snowmelt, icemelt under debris cover, water flow through sloping snowpacks, groundwater flow through talus and infiltration into seasonally frozen soils. The model spatial configuration shifts to accommodate glacier retreat and changes in land cover types in the basin. Over the 27-year period, inter-annual variability dominates the hydrological processes of this cold alpine catchment, leading to both variable annual streamflow and streamflow composition. Snowmelt always provides the largest volume to annual streamflow (49 to 80%), with
lower snowmelt contributions occurring in high streamflow years. Ice melt provides between 17 to 37% of total streamflow, with higher contribution associated with high flow years. Both rainfall runoff and firn melt contribute less than 10% of annual streamflow. Years with high streamflow are on average 1.4C warmer than low streamflow years. High streamflow years also have lower winter snow accumulation, earlier snowmelt and higher summer rain than years with low streamflow. The glacier snow, firn and ice melt provides a disproportionate amount of streamflow, as the glacier covers only 56% of the area but its runoff provides on average 64% of annual streamflow, with some years as high as 73%. This is associated with a net mass loss of the glacier, with the lower elevations of the glacier losing on average -3.6 m w.e annually. By comparison, the debris-cover glacier area, located at similar elevations, lose only -0.9 m w.e., and the extensive ice-cored moraine, -0.4 m w.e. This research provides a thorough investigation of the processes at play in an alpine glacierized catchment under current conditions and provides information on the causes inter-annual streamflow variability at Peyto basin. This work is relevant to gain insights on how future climate, and increase variability, will impact glacier meltwater contribution to streamflow and water availability for downstream environments.

Evaluating the water use efficiency of a sub-alpine wetland

Lead Author: Dylan Hrach, Geography and Environmental Management, University of Waterloo
Presenting Author: Dylan Hrach, Geography and Environmental Management, University of Waterloo
Email address: dmhrach@uwaterloo.ca
Co-Authors:
Richard Petrone, Geography and Environmental Management, University of Waterloo

Poster #: 176

Abstract:
Alpine regions are important regulators of global water and carbon balances, contributing up to 60% of global surface runoff. Evapotranspiration and net ecosystem exchange are two key variables used in meteorological science as they define water losses and carbon dynamics. Understanding water and carbon budgets of alpine regions is critical because of their role in global water storage and the impending water scarcities that are expected. Thus, water use efficiency, which links photosynthesis with water use, provides a useful metric to evaluate the utilization of water and carbon resources. The objective of this study is to quantify seasonal evapotranspiration and net ecosystem exchange, and to determine the water use efficiency across a heavily shaded sub-alpine wetland. The study was conducted at Fortress Mountain (Alberta), at the base of a 400m tall headwall that shades the immediate area and establishes a microclimate that influences turbulent fluxes. Cumulative growing season evapotranspiration was 157.7mm with a maximum daily evapotranspiration of 3.9mm on July 17th. Net ecosystem exchange indicates that the system fluctuates between a source and a sink until July 7th and is a sink afterwards (likely due to the greening of vegetation and diminished snow cover). Average seasonal water use efficiency was 2.9 umol CO2/mol H2O and was lowest (average 2.0) following snowmelt from June 24th to July 6th when soil was highly saturated. Since water use efficiency fluctuated over the summer but remained low, vegetation had high-water consumption resulting from difficult environmental conditions resulting from the microclimate.

Assessing the role of tree growth patterns on the spatial variability of evapotranspiration on a subalpine hill-slope in Kananaskis, Alberta

Lead Author: Jessica Williamson, Geography and Environmental Management, University of Waterloo
Presenting Author: Jessica Williamson, Geography and Environmental Management, University of Waterloo
Email address: ja5willi@uwaterloo.ca
Co-Authors:
Dr. Richard Petrone, Hydrometeorology Research Group, University of Waterloo

Poster #: 177

Abstract:
Canada's Rocky Mountains are essential for the supply and security of fresh water to downstream communities. Past research has demonstrated that warmer temperatures, associated with climate change, are expected to increase the reproduction and recruitment of trees towards alpine zones, which were once inhospitable to tree establishment. This research addresses this advancement of treeline, by focusing on how treeline expansion, in the form of tree islands and krummholz, influences evapotranspiration (ET) of a south-facing mountain ridge at Fortress Mountain, Kananaskis, Alberta. Using atmometer gauges, system ET was measured within closed-canopy tree islands and surrounding open-canopy plots with scattered krummholz patches. ET measurements were compared with dominant growth control factors, including temperature, wind speed, snow pack and microtopography. Positive feedbacks are anticipated between growth controls and the progression or stability of tree islands and krummholz. Higher ET was measured in open-canopy plots, where exposure to wind and net radiation was increased, while ET rates in closed-canopy tree islands increased with stand size and density. Krummholz had a unique relationship with snow pack. They exhibited high insulation properties, promoting a sustained snow-pack that lasted later into spring-melt, resulting in increased moisture supply and continued growth. Our results suggest that the presence of trees above the forest boundary layer, with the potential for expansion under current and projected meteorological conditions, could result in more water being evaporated at higher elevations and potential decreased downstream flows.

Emerging conceptual cryohydrogeological models of rock glaciers

Lead Author: Jordan Harrington; BGC Engineering Inc.; Department of Geoscience, University of Calgary
Presenting Author: Jordan Harrington; BGC Engineering Inc.; Department of Geoscience, University of Calgary
Email address: jharrington@bgcengineering.ca
Co-Authors:
Lukas Arenson; BGC Engineering Inc.
Masaki Hayashi; Department of Geoscience, University of Calgary

Poster #: 178

Abstract:
Across the globe, numerous semi-arid areas downstream of mountain ranges are experiencing water stress and uncertainty in future water availability due to changing water use and shifting hydrological regimes. Many of these cold, dry mountain headwaters contain rock glaciers, yet there are substantial uncertainties concerning their hydrological processes, functions, and relevance. A small number of hydrological studies on rock glaciers were initiated in the 1980s and their hydrological behaviours have primarily attracted scientific attention only in the last two decades. Recent process-based research on rock glaciers in the South American Andes, the European Alps, and the Canadian Rockies has started to highlight emerging similarities in their hydrological behaviour. These include (i) little to no surface runoff due to the infiltration capacity of coarse surficial sediments, (ii) a groundwater flow pathway at or near the sediment-bedrock interface, (iii) permafrost ground ice melt from rock glacier degradation contributes minimally to the catchment water budget, and (iv) hydrological behaviour that differs from finer-grained mountain hydrogeomorphic units. Some of these commonalities also appear to be shared by other coarse-grained mountain landforms such as taluses and moraines. However, these studies also highlight that the hydrogeologic behaviour of rock glaciers is dependent on local geologic history and climatic factors. The observations synthesized here are based on a relatively small number of studies, largely due to the logistical difficulties in conducting subsurface research in mountain environments. Substantial challenges and opportunities remain in furthering the scientific understanding of the hydrological roles of rock glaciers, particularly regarding supra-permafrost thermo-hydrological dynamics, specifically under changing climate conditions, and interactions with catchment-scale water fluxes. Tackling these challenges will require a holistic catchment hydro(geo)logical framework approach, carefully designed field characterization studies, and complementary numerical thermo-hydraulic simulations.

Estimation of shortwave irradiance from temperature and humidity records in cold region and mountain environments

Lead Author: Dhiraj Pradhananga, Centre for Hydrology, University of Saskatchewan
Presenting Author: Dhiraj Pradhananga, Centre for Hydrology, University of Saskatchewan
Email address: dhiraj.pradhananga@usask.ca
Co-Authors:
John W. Pomeroy, Joseph Shea, Juan I. López-Moreno, Antoine Rabatel, Jean Emmanuel Sicart

Poster #: 179

Abstract:
In high mountain basins, empirical relationships between melt and temperature have often been preferred to more physically appropriate energy budget calculations for snow and glacier melt. Major reasons cited to do so are the lack of high-elevation observations of shortwave irradiance and the uncertainty in estimating irradiance from other variables on glacierized terrain. However, empirical methods, based primarily on air temperature, have been applied in lowlands to estimate shortwave irradiance for snowmelt energy budget, soil thaw or evapotranspiration calculations. This study evaluates existing empirical methods and two reanalysis products for estimating atmospheric transmittance; and then proposes a modified method that can be applied with greater confidence at high elevations and in other cold regions. Observations from thirty snow-dominated and/or glacierized sites in North America, Europe, South America and the Himalayas, were used to develop an atmospheric shortwave radiation transmittance model based on air temperature and humidity which, when coupled with existing extraterrestrial shortwave radiation models, permits a more accurate estimation of shortwave irradiance than was previously possible. The globally-available reanalysis products provided good estimates of solar radiation for a site at lower elevation (<3000 m a.s.l.) but did not provide robust results at higher elevations.

Assessing the Canadian land surface scheme in simulating snowpack in mountains

Lead Author: Abbas Fayad, Centre for Hydrology, USASK
Presenting Author: Abbas Fayad, Centre for Hydrology, USASK
Email address: abbas.fayad@usask.ca
Co-Authors:
John Pomeroy, Centre for Hydrology, USASK

Poster #: 180

Abstract:
In this study, we evaluate the coupled Canadian Land Surface Scheme (CLASS) with a distributed hydrological model (MESH) in simulating snow processes in the Canadian mountains. We use a physical model parameterization approach. The model is run in single column configuration using observed meteorological datasets at different instrumented sites, representing different mountain environments (e.g., montane grassland, forest clear-cuts, and alpine and sub-arctic forests). The model is validated against in-situ snow observations. Initial results indicate good model performance in capturing snow water equivalent (SWE), snowmelt onset, and ablation rates at lower elevations and in areas with less complex topography. Model performance in capturing snow removal by winds and snow interception and sublimation in forests requires further investigations and provide some potentials for model improvement.

Canadian Rockies Hydrological Observatory Stations

Lead Author: Robin Heavens, Centre for Hydrology, University of Saskatchewan
Presenting Author: Robin Heavens, Centre for Hydrology, University of Saskatchewan
Email address: robin.heavens@usask.ca
Co-Authors:
Greg Galloway, Centre for Hydrology, University of Saskatchewan

Poster #: 181

Abstract:
Poster describing CRHO stations and activities.

Geophysical and Geochemical constraints on a hydrogeological model of Banff Hot Springs.

Lead Author: Thomas Wilson, Department of Geoscience, University of Calgary
Presenting Author: Thomas Wilson, Department of Geoscience, University of Calgary
Email address: thomas.wilson1@ucalgary.ca
Co-Authors:
Dr Rachel Lauer, Department of Geoscience, University of Calgary
Dr Masaki Hayashi, Department of Geoscience, University of Calgary

Poster #: 182

Abstract:
In the Banff area, located within the Front Ranges of the Canadian Rockies, nine thermal springs occur in a linear trend along the Sulphur Mountain Thrust (SMT) fault. In recent years some of the springs have experienced frequent flow stoppages which threatens the habitat of the endangered snail, Physella johnsoni, and causes operational interruption to a swimming pool which is filled by the hot water from Upper Hot spring. To understand the ecological threat and limit flow disruption to the pool, short- and long-term forecasts of spring discharge are required.
Two conceptual models of the Banff Hot Springs system have been published. The first publication hypothesizes that spring flow in this system is driven by precipitation infiltrating the flanks of neighbouring mountains on either side of the SMT. Water entering the system permeates down through a unit of carbonate rock to a maximum depth of 3.2 km, where it intercepts the SMT and is quickly returned to the surface via the high permeability fault zone. The emergent deep thermal water is mixed with shallower local ground water and is discharged as hot spring water. The second hypothesis is that the Banff Hot Springs are connected to a network of karst conduits that are oriented parallel to the SMT, which is recharged approximately 80 km along strike from the hot springs. Deep thermal water which is hydraulically driven along the SMT mixes with shallow ground water before being discharged from the hot springs. Seasonal variations in the mixing ratio of deep thermal water to shallow fresh water throughout the year causes the seasonal spring flow and temperature variation observed in the springs.
We propose to build a two dimensional coupled fluid and heat flow model of the spring systems hydrogeology, and apply future climate forcing conditions to forecast spring flow behaviour of the Upper Hot Spring. To avoid introducing the unnecessary complexity of modeling the unknown hydrogeology of the deep flow system discussed in the hypotheses above, while still adequately represent the system dynamics, we treat the bottom fault zone boundary as an input flux boundary, which provides deep thermal water to the system.
We use geophysical and geochemical investigations to provide spatial and temporal constrains for regional model. Preliminary results from geophysical investigations show the springs are restricted to the lower elevation boundary of the 100 m wide SMT fault block, which is interpreted as a low resistivity zone (10 – 100's Ωm) associated with water bearing fractured rock. The fault zone strikes NNW-SSE and dips 80 degrees to the west, which is in agreement with structural geological maps of the area. Simple geochemical mixing models suggest that the ratio of shallow to deep thermal groundwater may be significantly changing over decadal time scales.

Simulations of forest disturbances on streamflow in Bow River Basin above Calgary

Lead Author: Xing Fang, Centre for Hydrology, University of Saskatchewan
Presenting Author: Xing Fang, Centre for Hydrology, University of Saskatchewan
Email address: xing.fang@usask.ca
Co-Authors:
John Pomeroy, Centre for Hydrology, University of Saskatchewan

Poster #: 183

Abstract:
This study evaluates the impacts of forest disturbances on streamflow in Bow River Basin above Calgary using the Cold Regions Hydrological Modelling platform (CRHM). Hydrological models were created in CRHM for two forested basins: Upper Bow River Basin (~7823.6 km2) and Elbow River Basin (~1191.9 km2) above Calgary. These models were parameterized from local research results to represent relevant streamflow generation processes: wind redistribution of alpine snow, gravitational snow transport on steep mountain slope, glacier accumulation and melt, intercepted snow from forest canopies, infiltration to frozen and unfrozen soils, hillslope sub-surface water redistribution, and evapotranspiration from forests and alpine tundra. Models were driven by the bias corrected near-surface outputs from the Weather Research and Forecasting (WRF) model during October 2000-September 2015. First, air temperature, vapor pressure, wind speed, incoming shortwave radiation, and precipitation outputs from the 4-km WRF were bias corrected using the same outputs from 10-km Global Environmental Multiscale and Canadian Precipitation Analysis (GEM-CaPA), generating an initial 10-km bias corrected WRF. Then, additional precipitation bias correction was made by a double-mass curve analysis of streamflow from the model runs using the initial 10-km bias corrected WRF and Water Survey of Canada (WSC) streamflow from the natural flow gauges in Upper Bow River and Elbow River above Calgary. With these two-step bias corrected WRF, the streamflow simulations showed reasonable predictions compared to the observed streamflow, with Nash-Sutcliffe efficiency ranging from 0.25 for Elbow River at Sarcee Bridge, Calgary to 0.72 for Bow River at Banff, and model bias ranging from -0.16 for Bow River at Lake Louise to 0.22 for Elbow River at Sarcee Bridge, Calgary. Then, simulations of forest disturbances were conducted for three types of disturbance scenarios: forest fire, pine forest harvesting, and pine beetle infestation. Forest canopy parameters and soil parameters for infiltration were adjusted for three fire severity scenarios, ranging from 20% reduction in forest canopy for low fire severity to 80% reducing in forest canopy with development of hydrophobic soil for high fire severity. Two pine forest harvesting scenarios were created: half maximal harvest area (25% pine area) and maximal harvest area (50% pine area) by adjusted pine forest area, forest canopy and soil storage parameters from soil compaction during harvesting. Two scenarios of final stage of pine beetle infestation were set up, and both are 100% pine area affected, with one allowing salvage logging and the other keeping infested pine standing. Preliminary results showed that all forest disturbances increased streamflow for Upper Bow River and Elbow River above Calgary, with highest increase from high fire severity scenario, followed by pine beetle with salvage logging and maximal harvest area scenarios. Other forest disturbance scenarios had minimal impact on the streamflow.

The precipitation propagation over the plains east of the Rockies in the future climate change

Lead Author: Yunsung Hwang, School of Environment and Sustainability, University of Sakatchewan
Presenting Author: Yunsung Hwang, School of Environment and Sustainability, University of Sakatchewan
Email address: hisnameys@gmail.com
Co-Authors:
Yanping Li, Yunsung Hwang, School of Environment and Sustainability, University of Sakatchewan

Poster #: 184

Abstract:
Predicting precipitation is important for the prevention of accidents in the fields of aviation, agriculture, construction, and emergency management. Predicting likelihood of precipitation in the future can lower the economic costs and can allow time for preparation for the impact. Convection permitting high resolution numerical weather forecast model simulation can be utilized as guidelines for the future climate. In order to predict the impact of climate change, the Pseudo Global Warming (PGW) method, was applied to obtain potential changes in weather phenomena till the end of the 21 century using the Weather Research Forecasting (WRF) model.
In the future, it is known that the precipitation would be less frequent but more extreme as the warmer air can hold additional moisture. In this study, precipitation systems are divided into moderate and extreme to obtain their potential changes in the future. In order to represent changes, two 7 years (2007 to 2013) WRF simulation results were utilized as retrospective simulation (CTRL) and future climate (PGW). Warm season precipitation (March to August) in the central region (Southern and Northern Plains, -105 to -90 longitude and 30 to 45 latitude) over the plains east of the Rookies were chosen to examine precipitation systems with less topographical impacts.
Statistical analysis shows that moderate precipitation systems are the main contributor to the propagation of precipitation systems. While the PGW simulations demonstrate additional occurrence of extreme precipitation in the central region (over 100mm/hr) for June, July and August. When divided into sub-regions (5 degrees in the latitude), the contribution of extreme precipitation to the propagation increased in the region within 30-35 latitude.

Convective initiation affected by the dryline at the lee side of the Canadian Rockies on the historical and future climate

Lead Author: Lucia Scaff, School of Environment and Sustainability, Global Institute for Water Security
Presenting Author: Lucia Scaff, School of Environment and Sustainability, Global Institute for Water Security
Email address: lucia.scaff@usask.ca
Co-Authors:
Yanping Li, School of Environment and Sustainability, Global Institute for Water Security
Andreas Prein, National Center for Atmospheric Research

Poster #: 185

Abstract:
Summertime precipitation in the lee side of the Canadian Rockies is associated with convective storms, which may cause major flooding or large hail if they turn severe. However, little is known about the atmospheric processes that modulate the initiation of convective precipitation. Here we use a convection-permitting model simulation (CPM) to understand the influence of the mesoscale feature on convection initiation (CI).
Convective precipitation in this region is influenced by a strong gradient of low-level moisture across the foothills which plays a key role in the initiation. In this study a description of a critical mesoscale mechanism related to the CI over a complex terrain as the Rocky Mountains vulnerable to climate change is presented. It was found that the dryline shows its maximum intensity in July and is a clear feature that triggered 37% of the initiation of the biggest storms in the study region. The maximum average value of the specific humidity gradient is 0.15 g/kg/km. The solenoidal term from the vorticity equation generates a secondary circulation across the mountain west of the dryline location. The percentage of the dryline frequency on CI in the future climate at the end of the 21st century is similar to the historical simulation, but is more intense and narrower. Additionally, a northern shift is found in the future simulation on the standardized frequency of CI east of the dryline.
These changes are related to changes in the thermodynamical forcing for the selected events over the southern part of the region. This research delivers a reference point to assess forecast of CI and provides information on precipitation changes in a future scenario with warmer climate. These finding can be used by scientists, policy makers, and others responsible for adapting measures, designing infrastructure design or making decision based on the impact of future precipitation.

Climatology of the precipitation events associated with a transition snowline in the Canadian Rockies using regional climate simulations.

Lead Author: Obert Tchuem, Atmospheric science, University of Quebec at Montreal
Presenting Author: Obert Tchuem, Atmospheric science, University of Quebec at Montreal
Email address: tchuemobert@yahoo.fr
Co-Authors:
Julie M. Thériault, Atmospheric science, University of Quebec at Montreal

Poster #: 186

Abstract:
The location of the snowline in complex terrain is critical to understand the variability of snowpack and to anticipate the available water resources in the spring season. Furthermore, severe flooding events can occur during the spring season on the eastern side of the Canadian Rockies. These are driven by atmospheric conditions aloft and at the surface, which influence the location of the 0°C isotherm. As a result, the goal is to conduct a climatology of precipitation events occurring in the Canadian Rockies that is associated with a transient snowline. To address this, the Weather Research and Forecast (WRF) 4 km simulations over North America from 2000-2013 are used. A first analysis focuses at 2 sites where major flooding events occurred in 2013. These are Kananaskis, Alberta and Fernie, British Columbia. First, a climatology of the precipitation events will be presented. Second, the occurrence of precipitation amounts and types as well as the associated air temperature are documented. Most of the long duration events are associated with mixed precipitation. This indicates a variability of the elevation of the snowline, which will be characterized. Overall, this will contribute to a better understanding of the processes influencing the location of the snowline in complex terrain.

Agroclimate Indices Changes in Western Canada by the end of the 21st Century in a Convection Permitting Regional Climate Simulation

Lead Author: Richard Agyeman
Presenting Author: Richard Agyeman
Email address: r.agyeman@usask.ca
Co-Authors:
Yanping Li, GIWS, University of Saskatchewan
Zhenhua Li, GIWS, University of Saskatchewan

Poster #: 187

Abstract:
Future changes, trends and variability in agroclimate indices and how patterns of growing season precipitation will change under future climate over Western Canada are investigated. At a time of rapid population growth and rising demand for food, a better understanding of the changes and regional differences in agroclimate indices by the end of the century will be crucial to agriculture. A better understanding of these changes will allow farmers and policymakers to take advantage of the opportunities these changes will offer and inform adaptation measures against the constraints. Using simulations from convective permitting scale Weather Research and Forecasting model (WRF) with a 4km spatial resolution for historical (2000-2015) and future (2085-2100) under RCP8.5 using Pseudo Global Warming (PGW) approach. The effect of changing climate on the onset, length and cessation of the growing season are examined together with the constraints or opportunities these changes will present to agriculture. This high-resolution simulation provides better delineation of future changes in climate by the end of the century in Western Canada, especially those associated with extreme precipitation and temperature events, which in turn can be translated to better agroclimate information for the agricultural sector of the economy.

The Impact of Landuse Change on Regional Climate in the Canadian Prairies Simulated by a Convection-Permitting Regional Climate Model

Lead Author: Zhenhua Li, GIWS, U of Saskatchewan
Presenting Author: Zhenhua Li, GIWS, U of Saskatchewan
Email address: zhenhua.li@usask.ca
Co-Authors:
Yanping Li, GIWS, U of Saskatchewan
Zhe Zhang, GIWS, U of Saskatchewan
Alan Barr, ECCC

Poster #: 188

Abstract:
Climate change in the Northern Hemisphere high latitudes are more prominent compared to other regions. Accompanying the significant warming and the increase of the length of growing season is the expansion of agriculture activity to the northern Canadian Prairies and northward shift of the boreal forest biome by the end of century. To understand the projected land use changes' impact on the regional climate over the Canadian Prairies provinces, we conduct several scenario experiments with projected changes in land-use with high-resolution (4km) convection-permitting WRF. The hydro-climatic changes due to the warming and those due to landuse change are investigated through cross comparison with simulations with the current landuse distribution and the projected landuse distribution.

Understanding Extreme Precipitation Characteristics over Western Canada

Lead Author: Mostofa Kamal, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Mostofa Kamal, School of Environment and Sustainability, University of Saskatchewan
Email address: mostofa.kamal@usask.ca
Co-Authors:
Dr. Yanping Li, School of Environment and Sustainability, University of Saskatchewan

Poster #: 189

Abstract:
Abstract
Extreme precipitation is highly variable both in space and time which severely affected human and natural systems over the years. According to Environment and Climate Change Canada, Canada is warming at twice the global average. Warmer temperature affects precipitation characteristics (e.g., rate, frequency) more significantly than total precipitation. Globally, the frequency and intensity of extreme precipitation events have already increased and are expected to rise in the future under increased greenhouse gas emissions and climate change scenarios. In a warming world, both human and built infrastructure will feel the burden of extreme precipitation, including urban flooding, sewer overflows, untreated effluent discharge, decreased water quality, drinking water supply, soil erosion, and waterborne disease outbreaks. The adverse impacts of climate change that induce extreme weather events are a severe threat to accomplishing the UN Sustainable Development Goals (SDGs) by 2030. A comprehensive understanding of the projected changes in extreme precipitations events under changing climate conditions and the associated risks inherent to lives and property may result in better-informed decisions and drive society towards sustainability. Thus, my study investigates observed characteristics of extreme precipitation over western Canada using multiple statistical techniques and explores the impacts of climate change on future extreme precipitation by comparing the Pseudo Global Warming (PGW) projection against retrospective simulation (CTL) generated using the Weather Research Forecasting (WRF) model at convection permitting scale (model's horizontal grid spacing < 4km). Preliminary analysis of the observed station data shows heterogeneous pattern of precipitation change over western Canada. The PGW simulations show increased total precipitation compared to CTL simulations. Further analyses will be presented in the annual meeting.

An Unusual Cold February in Regina – A Case Study for Winter 2019 using NCEP Reanalysis Datasets

Lead Author: Soumik Basu, Prairie Adaptation Research Collaborative, University of Regina
Presenting Author: Soumik Basu, Prairie Adaptation Research Collaborative, University of Regina
Email address: Soumik.Basu@uregina.ca
Co-Authors:
David Sauchyn, Prairie Adaptation Research Collaborative, University of Regina

Poster #: 190

Abstract:
In February 2019 Central Canada especially Saskatchewan experienced an extreme cold weather. It was the coldest February in 82 years and 2nd coldest in 115 years. So, in this study we examine NCEP NCAR Reanalysis data to understand the atmospheric processes leading to this cold snap. A detailed investigation of surface air temperature, sea level pressure, surface fluxes and winds reveals a linkage between the North Pacific storm track and the February cold snap. A shift in the jet stream pattern triggered by the storm acitivity over the North Pacific causes a stagnant high pressure system which results in unusual cold temperatures in Saskatchewan in February.

Tracking precipitation systems using a convection-permitting climate model in western Canada

Lead Author: Lintao Li, Global Institute for Water Security, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
Presenting Author: Lintao Li, Global Institute for Water Security, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
Email address: lintao.li@usask.ca
Co-Authors:
Yanping Li Global Institute for Water Security, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
Zhenhua Li, Global Institute for Water Security, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

Poster #: 191

Abstract:
Object-based algorithm provides additional spatiotemporal information of precipitation, besides traditional information like amount and intensity. Precipitation features derived from a convection-permitting climate model (CPCM) were compared with features from three independent precipitation datasets: the Canadian Precipitation analysis (CaPA) system, North American Regional Reanalysis (NARR), and Multi-Source Weighted-Ensemble Precipitation (MSWEP). It shows the CPCM is able to depict precipitation features including its size, track length, duration, and propagation speed.

Comparison of GEM and WATCH data with synoptic stations' temperature and precipitation data in Iran

Lead Author: Abdolreza Bahremand, Watershed Management Department, Gorgan University of Agricultural Sciences
Presenting Author: Abdolreza Bahremand, Watershed Management Department, Gorgan University of Agricultural Sciences
Email address: abdolreza.bahremand@usask.ca
Co-Authors:
Mohammad Mohammadlou, Watershed Management Department, Gorgan University of Agricultural Sciences
Saman Razavi, Global Institute for Water Security, University of Saskatchewan
Daniel Princz, Environment and Climate Change Canada

Poster #: 192

Abstract:
The Global Environmental Multiscale Model (GEM) is an integrated forecasting and data assimilation system developed by Environment and Climate Change Canada. The model is currently operational for the global 25 km data assimilation cycle and medium-range forecasting, the regional 10 km data assimilation cycle and short-range forecasting over North America, and the high-resolution 2.5 km data assimilation cycle and short-range forecasting over Canada. In this research, we are going to evaluate the performance of the global forecast outputs of GEM, and the WATCH data for all of Iran (1,648,000 km2) using the temperature and precipitation data of all synoptic stations. The primary results using 7 stations located in Sefidrud River Basin (60,000 km2) show that both data sets have acceptable accuracy regarding temperature, but various discrepancies for precipitation.

Central U.S. WRF comparison of simulated composite radar and precipitation

Lead Author: Jason Flemke, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Jason Flemke, School of Environment and Sustainability, University of Saskatchewan
Email address: jason.flemke@usask.ca
Co-Authors:
Yanping Li, School of Environment and Sustainability, University of Saskatchewan
Changhai Liu, Research Applications Laboratory, National Center for Atmospheric Research

Poster #: 193

Abstract:
A continental-scale convection-allowing simulation was conducted by the National Center for Atmospheric Research (NCAR) using the regional Weather Research and Forecasting (WRF) model version 3.4.1 (Skamarock and Klemp, 2008). These model simulations are composed in two parts: (1) A 13-year (2000–2013) simulation of historical weather and climate patterns, and (2) A pseudo global warming (PGW) simulation to project the weather and climate at the end of the 21st century. The primary objective of this study is to evaluate the historical portion of the WRF model's capabilities in producing similar characteristics of observed warm-season convection in the central United States, with an emphasis on radar reflectivity population, the diurnal cycle of precipitation and storm propagation. The secondary objective is to evaluate the PGW projection to understand how a future climate will impact radar reflectivity populations, the diurnal cycle of precipitation and storm propagation. This model was designed to have 4-km grid spacing covering the entire continental U.S. and the southern portion of Canada (up to 56ºN) and downscaled the ERA-Interim reanalysis for the period from October 2000 to September 2013. Downscaling to a higher resolution permits the model to simulate deep convection without parameterization, proving to be more realistic. Previous studies have shown that the simulation can realistically capture the spatial pattern of sub-seasonal, seasonal, and annual precipitation and temperature in most of the contiguous United States. Furthermore, the simulation can also partially produce propagating mesoscale convective systems (MCSs), as well as their major climatological features. The simulated composite (column maximum) radar is validated by the Weather Surveillance Radar-1988 Dopplers (WSR-88Ds) national mosaic. Along with radar, the accumulated modeled precipitation is validated against the Stage IV multisensory gridded observed precipitation product. The comparison focuses on the Central Plains of the U.S. for March through August. Specifically, the area of interest for this research is bounded by 30 and 45 degrees north, and 90 and 105 degrees west. Initial results show that the simulation can produce a similar distribution of moderate to extreme reflectivity values, yet tends to underestimate light to moderate reflectivity and precipitation values. This study has determined that the model is able to capture the diurnal cycle of precipitation including the general propagation of thunderstorms across the domain. Further analysis is being done to determine if precipitation from convection will become more frequent and more severe in the PGW projection.

Extreme midsummer rainfall event induces early onset cyanobacterial bloom

Lead Author: Megan L. Larsen, Geography and Environmental Studies, Wilfrid Laurier University
Presenting Author: Megan L. Larsen, Geography and Environmental Studies, Wilfrid Laurier University
Email address: mlarsen@wlu.ca
Co-Authors:
Helen M. Baulch, School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan
Sherry M. Schiff, Earth and Environmental Sciences, University of Waterloo
Dana F. Simon, Department of Chemistry, Université de Montréal
Sébastien Sauvé, Department of Chemistry, Université de Montréal

Poster #: 194

Abstract:
The prevalence and increasing global distribution of cyanobacteria-dominated harmful algal blooms is strongly associated with changing climatic patterns and local biogeochemical and hydrological processes. Changes to precipitation frequency and intensity, as predicted by current climate models, are likely to alter bloom development and composition due to nutrient fluxes and water column mixing. However, few studies have directly documented the effects of precipitation events on cyanobacterial composition, biomass, and toxin production. Here, we compare an early-initiated cyanobacterial bloom following heavy rainfall and flooding and a typical late-summer bloom in Conestogo Lake, a eutrophic flood-control reservoir located in southwestern Ontario. After the heavy rainfall in June 2017, a surge in bioavailable phosphorus, increased water temperature and sediment anoxia lead to large biomass increases of Aphanizomenon flos-aquae throughout the reservoir approximately 2 weeks later. Anabaenopeptin-A and three microcystin congeners (microcystin-LR, -YR, and -RR) were detected at varying levels across sites during the bloom period, which lasted 3–5 weeks. In 2018, a year with the typical late-summer bloom, sediment anoxia and internal phosphorus loading preceded the bloom dominated by A. flos-aquae. Detectable levels of anatoxin-a and homoanatoxin-a, anabaenopeptins, and microcystin-LR and-YR were documented. Together, these findings indicate that a) a sequence of elevated phosphorus and temperature precede the bloom and b) climate-change induced increases in large storms will result in earlier cyanobacteria blooms. Therefore, effective management goals and mitigation strategies for bloom-related water quality impairment must be both responsive and adaptive to the complexity of drivers affecting blooms.

The analysis of extreme precipitation and convective indices using convection-permitting regional climate simulations

Lead Author: Xiao Ma, School of Environment and Sustainability, University of Saskatchewan
Presenting Author: Xiao Ma, School of Environment and Sustainability, University of Saskatchewan
Email address: xiao.ma@usask.ca
Co-Authors:
Yanping Li, School of Environment and Sustainability, University of Saskatchewan

Poster #: 195

Abstract:
Deep convections are associated with many extreme weather events such as extreme precipitation, hail and tornadoes, which cause severe natural hazards and economic loss. To determine the potential for the occurance of the severe convective precipitation events, some thermodynamic indices underlying the Mesoscale Convective Systems (MCSs) are investigated, such as Convective Available Potential Energy (CAPE) and Lifting Index (LI). Analyzing features of these indices especially under climate change, is helpful to predict future changes of MCSs-related extreme precipitation.
This study uses 4-km convection-permitting Weather Research Forecasting (WRF) model output including a historical simulation (CTRL) for 13 years (2001-2013), and a future climate simulation using Pseudo Global Warming (PGW) method. The model domain covers the whole Continental United States (CONUS) amd southern part of Canada (south of 56N). The study analyzes the frequencies of occurrences of convective indices under different conditions, i.e. moderate or severe precipiation events, and compares their differences between two simulations during summertime (June to August), to show the potential changes of deep convections under future climate condition.

Precipitation types and weather conditions impacting NB Power infrastructure

Lead Author: Julien Chartrand, Department of earth and atmospheric sciences, UQAM
Presenting Author: Julien Chartrand, Department of earth and atmospheric sciences, UQAM
Email address: chartrand.julien.2@courrier.uqam.ca
Co-Authors:
Vanessa McFadden, Department of earth and atmospheric sciences, UQAM
Médéric St-Pierre, Department of earth and atmospheric sciences, UQAM
Julie M. Thériault, Department of earth and atmospheric sciences, UQAM

Poster #: 196

Abstract:
Precipitation amounts and types during winter storms can impact many sectors of society as well as ecosystems. In particular, wet snow and freezing rain can impact the electricity distribution, causing power interruptions for up to several days. The ice build up on power lines, infrastructure and vegetation, combined with strong winds, can lead to even more damages depending on the wind direction. In collaboration with New Brunswick (NB) Power, meteorological events that led to significant power outages and damages to infrastructure have been identified. One of these events is the recent ice storm in the Maritime Provinces on 22-24 January 2017 that led to one third of the population of NB being without power for days. To better understand the links between the meteorological conditions and the power outages, a high-resolution simulation have been conducted using the Global Multiscale Environmental (GEM) model. First, the accumulated precipitation and average wind speed were compared with the duration and location of power outages. Second, these meteorological factors are put in perspective with the geographic location of the power transmission and distribution networks. Third, this storm will be put in perspective with other storms impacting NB Power infrastructure to better document the similarities and differences in the storm's severity as their evolution in the future. Overall, this study contributes to a better understanding of meteorological factors leading to power outages to better anticipate the impact of climate change on those storms.

The Manitoba 2011 Flood: A Review of Hydrometerological Processes

Lead Author: Phillip Mutulu, AquaClim Enviro Solutions
Presenting Author: Phillip Mutulu, AquaClim Enviro Solutions
Email address: phill.mutulu@gmail.com
Co-Authors:
Youssef Loukili, Centre for Hydrology - GIWS

Poster #: 197

Abstract:
In 2011, Manitoba was hit by floods of unprecedented scope and severity in the Canadian history. The flooding caused extensive infrastructure damage and led to displacement of communities and emergency evacuations. The cost of this loss was pegged at $1.025 billion (Winnipeg Free Press, 2012) and the impact is being felt up to date as the provincial government continues to resettle displaced communities and pay out flood damage compensations. The main objective of this presentation is to review key hydro-meteorological processes prior to and during the 2011 Manitoba widespread flooding and to highlight the importance of hydrological forecasting duty. Much higher than normal levels of both antecedent soil moisture before freeze-up and snowfall were identified and communicated as threatening conditions as early as November 2010. Subsequent winter snow and spring snowmelt conditions as well as spring/summer rainfall events aggravated flooding leading to several local states of emergency. To a large extent, the operations of Shellmouth Dam, Portage Diversion and Red River Floodway played a beneficial role in reducing flood impacts. The overwhelming succession of river and lake inundation occurrences is also outlined over calendar and geography, providing extraordinary learning lessons and knowledge to water resources scientists and engineers, emergency preparedness personnel and various stakeholders among others.

Translation of probability distribution of precipitation to streamflow distribution

Lead Author: Chandra Rupa Rajulapati, Global Water Futures, University of Saskatchewan
Presenting Author: Chandra Rupa Rajulapati, Global Water Futures, University of Saskatchewan
Email address: chandra.rajulapati@usask.ca
Co-Authors:
Dr. Saman Razavi, School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan
Prof. John Pomeroy, Global Water Futures, University of Saskatchewan

Poster #: 198

Abstract:
Hydrological models are in general used for modelling streamflow, where the hydro-meteorological and the geographical aspects of the drainage basin are given as an input to obtain the streamflow. Though hydrological models are good in modelling the mean flows, extreme flows at short timescales (daily to sub-daily) are particularly difficult to model and continue to be a challenge to research communities. While statistical methods (using copulas, transfer functions) and other black-box type of models are accurate in assessing the extremes they do not consider other aspects of the drainage basin like evapotranspiration, soil characteristics etc. The work aims at analyzing the transformations of precipitation distribution to that of the streamflow using the Modélisation Environmentale–Surface et Hydrologie (MESH) model, taking the advantage of statistical transformations. To simulate the precipitation time series, a unified theory, under the assumption that any process with a linear correlation structure and a prescribed marginal distribution has a specific parent Gaussian process, is used. The theory transforms the correlation structures of precipitation time series to parent Gaussian correction structure using a unique transformation function thereby enabling to fit an autoregressive process. The precipitation time series simulated from the parent Gaussian process is used in the hydrological model to obtain the streamflow probability distribution. The proposed methodology is applied for the Bow river basin.

How good are the gridded precipitation datasets in representing the extremes?

Lead Author: Chandra Rupa Rajulapati, Global Water Futures, University of Saskatchewan
Presenting Author: Chandra Rupa Rajulapati, Global Water Futures, University of Saskatchewan
Email address: chandra.rajulapati@usask.ca
Co-Authors:
Dr. Simon Micheal Papalexiou,Department of Civil, Geological & Environmental Engineering, Global Institute for Water Security, University of Saskatchewan
Prof. John Pomeroy, Global Water Futures, University of Saskatchewan

Poster #: 199

Abstract:
Gridded precipitation products are increasingly used by the hydrologic community in applications such as hydrological modelling. Several datasets are derived at various spatial and temporal resolutions by assimilating the data from various sources like ground observations, satellites and radar using different techniques. While such datasets come handy in understanding the spatial and temporal changes in the global precipitation, the answer to the question that how reliable are these datasets in representing extremes remains elusive. Under changing climate, with consequently changing frequency and magnitudes of the extremes, it is important to understand the spatial and temporal variations in global extreme precipitation. In this work we have considered five global precipitation gridded datasets, derived from various sources of information (e.g. ground observations, satellite data, reanalysis) and different assimilation techniques (e.g. optimal interpolation), to understand the spatial variation of tail index, a measure to characterize the magnitude and frequency of the extremes. We have considered the NOAA Climate Prediction Center (CPC) dataset, derived from in-situ observations, as a benchmark and compare the differences in the tail index with four other datasets. The results show that the spatial pattern of the tail index is similar for the CPC and PERSIANN-CDR (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks–Climate Data Record) datasets, and the pattern closely matches with the Köppen-Geiger climate classification. We see a considerable difference in the spatial patterns of other datasets and also the return levels for a given return period vary significantly among the five datasets.

Monitoring the Vegetation Water Balance and Crop Growth Using Earth Observation and Agroecosystem Models

Lead Author: Catherine Champagne – AAFC
Presenting Author: Catherine Champagne – AAFC
Email address: catherine.champagne@canada.ca
Co-Authors:
Elizabeth Pattey – AAFC
Aston Chipanshi – AAFC
Insuo Zhang – AAFC
Jiangui Liu – AAFC

Poster #: 200

Abstract:
Monitoring water quantity in agroecosystems, including extremes such as drought and excess moisture, requires an accurate estimation of the water content of vegetation canopies. In agricultural environments, vegetation is highly dynamic due to annual cropping cycles and land management designed to optimize biomass and grain production. Estimating vegetation water content is traditionally done use crop growth models or remotely sensed estimates of biomass. Models often lead to inaccurate estimates of biomass due uncertainties in meteorological forecasting data, soil hydrological properties and land management practices. Remotely sensed estimates are often inaccurate as a result of saturation of vegetation indices and the impacts of confounding factors on signal response. The objectives of this work are to improve the estimation of vegetation water content and biomass using a combination of modelling and earth observation to better estimate vegetation water content, and ultimately crop yield. A three year study at Agriculture and Agri-Food Canada is underway to improve biomass estimation using biostatistical and process based modelling approaches, using the Canadian Crop Yield Forecating System (CCYF) and the Simulateur mulTIdisciplinaire pour les Cultures Standard (STICS) model. Progress from the first year of this project will be presented.

Improved Understanding, Diagnosis and Prediction of Earth System Change in Western Canada: The Achievements and Legacy of the Changing Cold Regions Network

Lead Author: Chris DeBeer, Centre for Hydrology & Global Institute for Water Security, University of Saskatchewan, Saskatoon, SK, Canada
Presenting Author: Chris DeBeer, Centre for Hydrology & Global Institute for Water Security, University of Saskatchewan, Saskatoon, SK, Canada
Email address: chris.debeer@usask.ca
Co-Authors:
Howard Wheater, Centre for Hydrology & Global Institute for Water Security, University of Saskatchewan, Saskatoon, SK, Canada
John Pomeroy, Centre for Hydrology & Global Institute for Water Security, University of Saskatchewan, Saskatoon, SK, Canada
Ron Stewart, Department of Environment and Geography, University of Manitoba, Winnipeg, MB, Canada
Sean Carey, School of Geography & Earth Sciences, McMaster University, Hamilton, ON, Canada

Poster #: 201

Abstract:
The interior of western Canada is at the forefront of rapid hydroclimatic change. The Changing Cold Regions Network (CCRN; www.ccrnetwork.ca) was a Canadian research network (2013–18) that addressed global challenges facing cold regions by improving the understanding of past and ongoing changes in climate, land, vegetation, and water, and predicting their future responses, with a geographical focus on the Saskatchewan and Mackenzie River Basins. The network included 45 scientists from eight Canadian universities and four government agencies, as well as many international collaborators, and it developed important linkages with several international programs, principally WCRP GEWEX, NASA ABoVE, and NCAR. CCRN utilized a set of well-studied, instrumented research basin observatories to study process interactions and develop and test models. Its science goals were to:
1.Document and evaluate observed Earth system change, including hydrological, ecological, cryospheric and atmospheric components over a range of scales from local observatories to biome and regional scales;
2.Improve understanding and diagnosis of local-scale change by developing new and integrative knowledge of Earth system processes, incorporating these processes into a suite of process-based integrative models, and using the models to better understand Earth system change;
3.Improve large-scale atmospheric and hydrological models for river basin-scale modelling and prediction to better account for the changing Earth system and its atmospheric feedbacks; and
4.Analyze and predict regional and large-scale variability and change, focusing on the governing factors for the observed trends and variability in large-scale aspects of the Earth system and their representation in current models, and the projections of regional scale effects of Earth system change on climate, land and water resources.
This presentation reviews the scientific achievements made in CCRN, and highlights the observations and projections of Earth system change over the region. The insights, predictive tools, observational datasets, and improved understanding developed in CCRN represent a considerable advance that is guiding the development of water and climate observation and prediction systems in the new pan-Canadian Global Water Futures program.