SEARCH TERM: Quality (and synonyms) – 9 projects

Southern Forest Water Futures

- Collaboration with the GWF Co-creation of indigenous water quality tools and ecosystem health group to conduct modelling studies at McKenzie Creek to explore the impacts of climate change on hydrological processes and water resources in the Six Nations Community.

Agriculture Water Futures

- Integration of water quality components into hydrological models
- Integration of water quality components into hydro-economic models
- Review of water quality trading schemes across North America
- Targeting BMPs in the landscape and across the Lake Erie watershed and Prairie region (screening and scoping-level) to improve water quality
- Continuing to improve inclusion of crops and water quality in hydrological models
- Exploring interactions between climate, landscape drivers and land management practices on water quality to improve the targeting of conservation practices within and across regions
- Improved understanding of regional differences in nutrient dynamics and the impacts of climate, landscape and management on water quality
- Inclusion of both crop water use and water quality and their driving factors into hydrological models
- Simulations of how future climates may impact crop water use and water quality in the Canadian agricultural sector

Co-Creation of Indigenous Water Quality Tools

- Installing our first two water quality sensor modules in the McKenzie creek for preliminary testing in collaboration with Six Nations
- Coordinated a youth engagement in Six Nations to discuss sensors and water quality together with the STEAM academy
- Deployment of water quality sensors at Six Nations
- Completing water quality analysis
- Developing study on impacts of climate change on McKenzie Creek water quality
- Addressing reliability issues of water quality and turtle sensors
- Extending the software functionality of water quality and turtle sensors

Water Governance in Canada

- PhD student Erin Murphy-Mills completed an exhaustive study of the drivers of eutrophication in the western Lake Erie basin, and evaluated the extent to which they are accounted for in the water governance system. Core findings will be published in three manuscripts, which will be submitted shortly after her defense in early 2022. We also delivered presentation and briefings to key organizational actors in the Ontario provincial government, and to the Great Lakes Water Quality Board of the International Joint Commission.

eDNA

- In situ eDNA indicators projecting irrigation district water quality

FORMBLOOM

- Baulch HM, Venkiteswaran JJ, Davies J-M. 2018. The Water Quality Toolbox. Lakeline. 38(3): 16-19
- Work to assess public preferences, and willingness to pay to support water quality improvement. (current survey on Elk/Beaver Lake).

Rather than a key photo, we note key synthesis goals that could touch across projects:

We see the need to coordinate of key insights and communications efforts related to work to understand and manage water quality.

- Critical decline in water quality in many regions of the nation. (emphasis to coordinate is need for agricultural interventions, and importance of managing nutrients very carefully with blooms as an exemplar of risk)
- Importance of bloom risk, risk perception, bloom management, and willingness to pay to improve water quality
- Place-based nature of problems, place-based nature of solutions means we need for increased capacity and coordination to help address water quality issues. Current disjointed management, and limited capacity in many regions is a barrier to progress. Coordination and co-learning is required.

Integrated Modelling Program for Canada

- **Water quality and rive ice (**Dr. Lindenschmidt's team): WASP Sediment transport model set up for the lower South Saskatchewan River in preparation for coupling with water management models (MODSIM). Also developed a novel framework for identifiability and identification analyses for cold region integrated models and performed an analysis on water quality models in the Prairies. In terms of river ice research, team developed a graphical-user-interface (GUI) for the RIVICE hydrodynamic model for Monte-Carlo Analysis (MOCA) and data/result visualization in the Athabasca River and Saint John River. MESH-RIVICE was also tested successfully in the Athabasca River in Fort McMurray.

Integration of next-generation hydrological and land surface models to address changing cold region processes:

- Detailed statistical analysis based on the available in situ and gridded observation data, as well as CMIP6 projections; comparison between observation and projections. Downscaled CMIP6 precipitation projections for target regions alone with quality assessment of the downscaled products.

Integration of water quality metrics, ecological metrics, and climate change scenarios into the water management modelling framework:

- Couple flows and fluxes between MODSIM and WASP; calibrate/validate MODSIM-WASP modelling system; complete development of MESH-WASP modelling system. Run water-management and climate-change scenarios with MESH-WASP and MODSIM-WASP modelling systems.

- Deriving a target range of river flows for people and wildlife to thrive in the Saskatchewan River Delta (based on 'presumptive standard method' that estimates sustainable boundaries for flow) and using integrated models to understand how these targets may be met or not.

Lake Futures

- Developed a process-based model ELEMeNT that predicts N and P concentrations and loads as a function of current land use and climate and past nutrient legacies. ELEMeNT is the first ever process-based model that can describe legacy accumulation and time lags to water quality improvement. We have developed ELEMeNT-N and ELEMeNT-P models for the Grand River Basin (Liu et al. 2021, Van Meter et al. 2021).
- Developed a detailed mass balance for P inputs and outputs across Ontario and potential water quality risks from legacy P (Van Staden et al 2021)
- Wrote a review paper on how to manage water quality, given nitrogen legacies (Basu et al., in press Nature Geosciences). The paper provides major insight on nutrient legacies as watershed managers and policy makers are grappling with this question
- Developed an integrated cross sectoral modelling framework to assess the cost effectiveness of water quality improvement policy measures in rural agriculture and urban wastewater treatment
- Compared freshwater monitoring approaches with and developed a comprehensive monitoring framework with diverse stakeholders and collaborators using the principles of Community-based Participatory Action Research to improve water quality monitoring activities in the Grand River-Lake Erie interface (Ho et al. 2020)
- Completing an economic analysis, including conducting cost-benefit analysis of the implementation of policy measures in the Great Lakes to improve water quality
- A new operational version of the Water Quality Valuation Model for the Great Lakes
- Conversation Canada article highlighting nutrient legacies and water quality
- Phosphorus legacies and future water quality trajectories in the Grand River Watershed, Ontario, Canada [Image]

Managing Urban Eutrophication

WP1: watershed hydrology and water quality modeling (*Main objective:* Predict the spatially distributed fluxes and chemical speciation of phosphorus (P) supplied to the littoral zone of Western Lake Ontario (WLO) littoral zone by streamflow and stormwater outflow)

- Modelled hydrology and total suspended sediment (TSS) transport in two sewersheds in Ajax with the PCSWMM model
- Built PCSWMM for the project's study areas: Pickering, Ajax, Whitby, and Oshawa watersheds. Collected and verified calibration data: stormwater management network, land cover, and meteorological data. Collected TSS and phosphorus (P) data from literature and technical reports to be used in the water quality component of PCSWMM.

WP1: watershed hydrology and water quality modeling

- Finalize the development of calibrated PCSWMM model for the two Ajax sewersheds by representing the snowmelt processes.
- Scale up the PCSWMM model for the entire study area by incorporating more detailed GIS layers of land cover and soil data.

- Combine the urban hydrology component (PCSWMM) with a simple representation of water balance in agricultural areas in the region to model the combined effects of agricultural and urban water and pollutants export to WLO.

WP3: ecosystem valuation

- Collect and archive data on historical (i) chlorophyll (*chl-a*) concentrations from publicly available Moderate Resolution Imaging Spectroradiometer (MODIS) daily data (and other remote sensing sources), and (ii) additional open access water quality (P concentrations, temperature, meteorological data) and demographic plus socio-economic (census) data.

WP1: watershed hydrology and water quality modeling

- Complete the PCSWMM of the two Ajax sewersheds in PCSWMM and predict trends in P loadings to WLO under different climate change scenarios. A manuscript will be submitted comparing the sources, fate and transport of P in these two urban sewersheds.
- Build the upscaled PCSWMM model for the study area to quantitatively predict the loadings of TSS and P species (i.e., reactive and unreactive, organic and inorganic, particulate and dissolved) to WLO. This model outcome will be input for WP2.

WP3: ecosystem valuation

- Quantify the influence of water quality changes in the WLO nearshore zone (i.e., eutrophication) on lakefront properties' price premium.
- Valuate the recreational value of the WLO nearshore zone and include these in cost-benefit analyses of P abatement investments (in particular, green infrastructure and LID).

Northern Water Futures

- *Evaluating how warming-induced biophysical changes alter water quality and biological process*
  - Evaluate linkages between rates of permafrost thaw and landcover change and water quality of adjacent surface water
- *Mitigating risks associated with changing fish resources*
  - Develop the conceptual and analytical framework for linking terrestrial changes with fish mercury concentrations
  - Evaluate relationships between water quality and healthy fatty acid concentrations in fish
- Impacts of Thaw on Water Quality in AB-NT Transboundary Watersheds

Sub-Arctic Metal Mobility Study

DOM Quantity and Quality, Metal Binding, and Toxicology

- Sharma S. 2021. Modeling Impact of Changing Hydroclimatic Regime on Dissolved Organic Carbon Export from Baker Creek Catchment. MES thesis. University of Saskatchewan.
  Terrestrial Stores of Historical Metal Deposition and Transport to Aquatic Ecosystems
- Leathers J. Assessing the potential of mining pollution-affected subarctic peatlands to act as sources of metal(loid) pollutants to downstream waters. MSc thesis in progress. Wilfrid Laurier University.

- Climate-induced changes to dissolved organic matter quality in the Northwest Territories, Canada, will affect disinfection by-product formation in freshwaters (mid-2022 submission.)

Saskatchewan Private Wells

- Hard copy data digitized for complete water quality database
- Baseline understanding of water quality in private wells in Saskatchewan
- Identification of key drivers of adverse water quality
- Exploration of potential impacts of climate change on water quality in private wells

Sensors and Sensing Systems

Major achievements of sensors and sensing water quality monitoring system are completion of sensors prototyping, lab testing, and their field deployment (in a limiting way, deployment delayed, and impacted by COVID 19). Some of the highlights are:

- A highly sensitive solid state phosphate sensor was developed. A new electrochemical sensing approach to phosphate can allow detection as low as 10^-7 M. Prototype is ready to be field tested. This work has led into a new startup company "Phosphosense".
- A novel pre-concentration approach for sensitive colorimetric monitoring of trace level detection of Copper and Iron has been established using passive aliquoting and cost effective-readily available materials. This method can detect copper at 10 ppb, and experiments are ongoing for low level lead (at 1-10 ppb levels) detection.
- A chemiresistive sensor that utilized exfoliated graphite to form a few-layer graphene (FLG) film is developed to detect trace levels of copper, and silver cations in aqueous solution. Detectable range for silver ions is in range of 3-1000 ppb in solution. When tested in environmental waters (Spencer Creek, Hamilton ON), recovery values were similar to that obtained by ICP-MS. Work is underway to identify suitable ligands detect lead in aqueous solution.
- A working DNAzyme GR5 sensor has been developed for bioavailable fraction of lead sensing. DNA-zymes is found to respond to Pb2+, PbOH+, and PbCl+ species. DNAzyme can be used for understanding the effect of dissolved organic matters (DOMs) on metal binding and sensing.
- LoRa sensors, and enclosures for long-term continuous housing of sensors are designed for continuous monitoring of water quality along rivers and creeks of Six Nations. Biofouling in the lab on sensors is simulated to identify impact of biofouling and establishing ways to eliminate fouling on sensor surfaces.
- Fluorescent sensor to detect low concentration cyanobacteria has been successfully achieved to measure Chl-A and multiple algae species (Spirulina, Chlorella, mixed species) and tested at field site (Buffalo Pound). This has important application for early warning of potential cyanobacterial blooms.

- Libelium based network has been deployed in lakes downstream of mining operations in collaboration with Orano (previously Areva Resources, a uranium mine in northern Saskatchewan). Functioning water quality sensors for temperature, dissolved oxygen, pH, ORP, turbidity and conductivity, calibrated in the Aquatic Toxicology Research Facility (ATRF) have been used in this study. Analysis of all samples from 2019 is now completed and analysis of water samples collected from McClean Lake during March 2021 are presently being processed. The outcome of these analysis will help elucidate the research hypotheses of seasonal differences (summer vs winter) in selenium bioaccumulation and trophic transfer.

- The first Phase of the Virtual reality (VR) storytelling experience is completed. The experience utilizes a virtual sensor and water quality station at the knowledge center to train users on water quality analysis. Demos can be viewed on the Ohneganos website.

Transformative Sensor Technologies and Smart Watersheds

- An increase in the accuracy and precision of data collected to quantify flooding, drought and water quality.

- Development of a smart water quality monitoring system based on the microwave technology integrated with microfluidic platforms. The system is expected to realize real-time detection and remote monitoring of heavy metal and other matters in water. The system should be affordable and portable.

What is Water Worth?

- Completed and published (in Canadian Water Resources Journal) a review of existing economic valuation literature related to water quality improvements in Canada

- Worked on the regional application of the water quality valuation model in the Great Lakes

- Further developing the water quality valuation model for the Great Lakes

- Synthesize the existing economic valuation literature related to water quality improvements in Canada (published recently in 2021 here:https://doi.org/10.1080/07011784.2021.1973568

- Connect the economic valuation of aquatic ecosystem services to available water quality monitoring data and policy-relevant biophysical indicators for the water quality challenge in question. Where possible, use will be made of available environmental models to assess changes in baseline water quality conditions due to water quality policy intervention scenarios. In particular, we aim to employ and update the current prototype of the Water Quality Valuation Model developed by ECCC as an integrated environmental-economic water quality modeling framework.

- Derive and test a generic Canadian water quality valuation function for aquatic ecosystem services that can be used by policy-makers to assess the benefits of improving water resources. We will explore potential collaboration with the Environmental Valuation Reference Inventory (EVRI), initiated in the 1990's by ECCC.