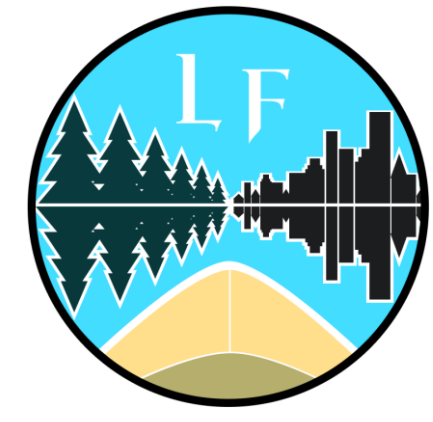# How can we improve water quality and reduce algal blooms in Canada's lakes?

UNIVERSITY OF WATERLOO

Lake Futures will deliver adaptive watershed and lake management solutions that minimize trade-offs between lake ecosystems, water uses, and economic growth.

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Lake Futures: Enhancing Adaptive Capacity and Resilience of Lakes and their Watersheds

Progress

- Developed a first-of-a-kind dataset of daily nitrogen (N) and phosphorus (P) loads for 202 monitored watersheds in the Great Lakes Basin (GLB).
- Developed a machine learning model for predicting N and P loads for any watershed in the GLB.
- Developed water quality models for N and P for multiple watersheds in the GLB -- these models take into account legacy nutrient accumulation for the first time.
- Developing roadmaps for two specific solutions to water quality challenges: wetland restoration, and manure management through investment in bioreactors.
- Quantified internal loadings of P in Lakes Erie and Ontario that are critical for bloom prediction.
- Developed a novel methodology for conducting regionalized mass balance modelling in large lakes, and quantified water and P exchange rates between the different regions of Lake Erie.
- Developed a machine learning model to predict chlorophyll-a concentrations and lake ice in large northern lakes.
- 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.
- Developed a hydro-economic model for the GLB which analyzes the direct and indirect impacts of possible future water use restrictions due to climate change on economic activities.
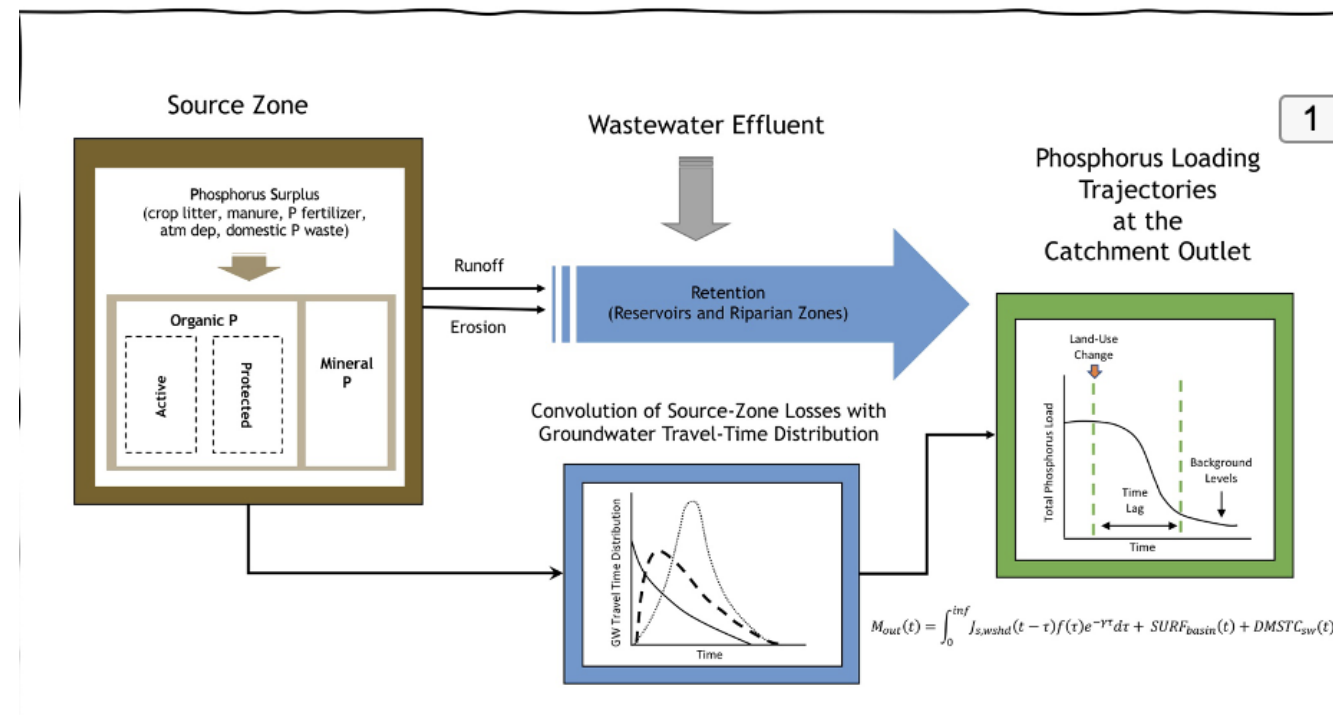
User Engagement

- Organized a workshop in collaboration with Water Institute and The Gordon Foundation on "Data Needs in the Great Lakes" that was attended by over 35 people across the region. The workshop catalyzed a recently funded NSERC Alliance grant on "From Data to Knowledge: Designing User-Driven Water Quality and Nutrient Loading Observatories across the Great Lakes Basin" with Environment and Climate Change Canada, DataStream and the Conservation Authorities as key partners.
- Developed the Lake Futures Webinar series, a unique engagement platform where project Co-PIs, partner organization and HQP presented research and was attended by over 450 students and members from various organizations around Canada.
- Partnering with the Grand River Conservation Authority to install high resolution (15-minute) P Sensors in their watershed.
- Developed Grand Expressions, a virtual art exhibit, composed of stories and artwork created by youth from Six Nations of the Grand River. This research was a collaboration with Music for the Spirit & Indigenous Visual Arts, a youth-led program for over 40 students.
- Presentation as part of the Watersheds Canada webinar series to share legacy P research with conservation authorities, cottage owners and farmers.

Results

- Developed the first-ever process-based model (ELEMeNT) for modelling legacy nutrients to answer the question: "When you make changes on the landscape how long will it take for the water quality to improve?"
- Model quantified that since 1900 only 4% of the net P applied to the land has been exported in rivers, while the rest has accumulated as legacy P in soils.
- Model identified efficient manure management as a key strategy for water quality improvement.
- Developed a roadmap for policy makers and researchers on managing water quality in agricultural watersheds given legacies (published in Nature Geoscience).
- Developed a novel water quality trading program (WQT) database that will serve as an effective pollution control instrument.
- Found evidence of salinization in urban lakes and its impact on algal blooms.
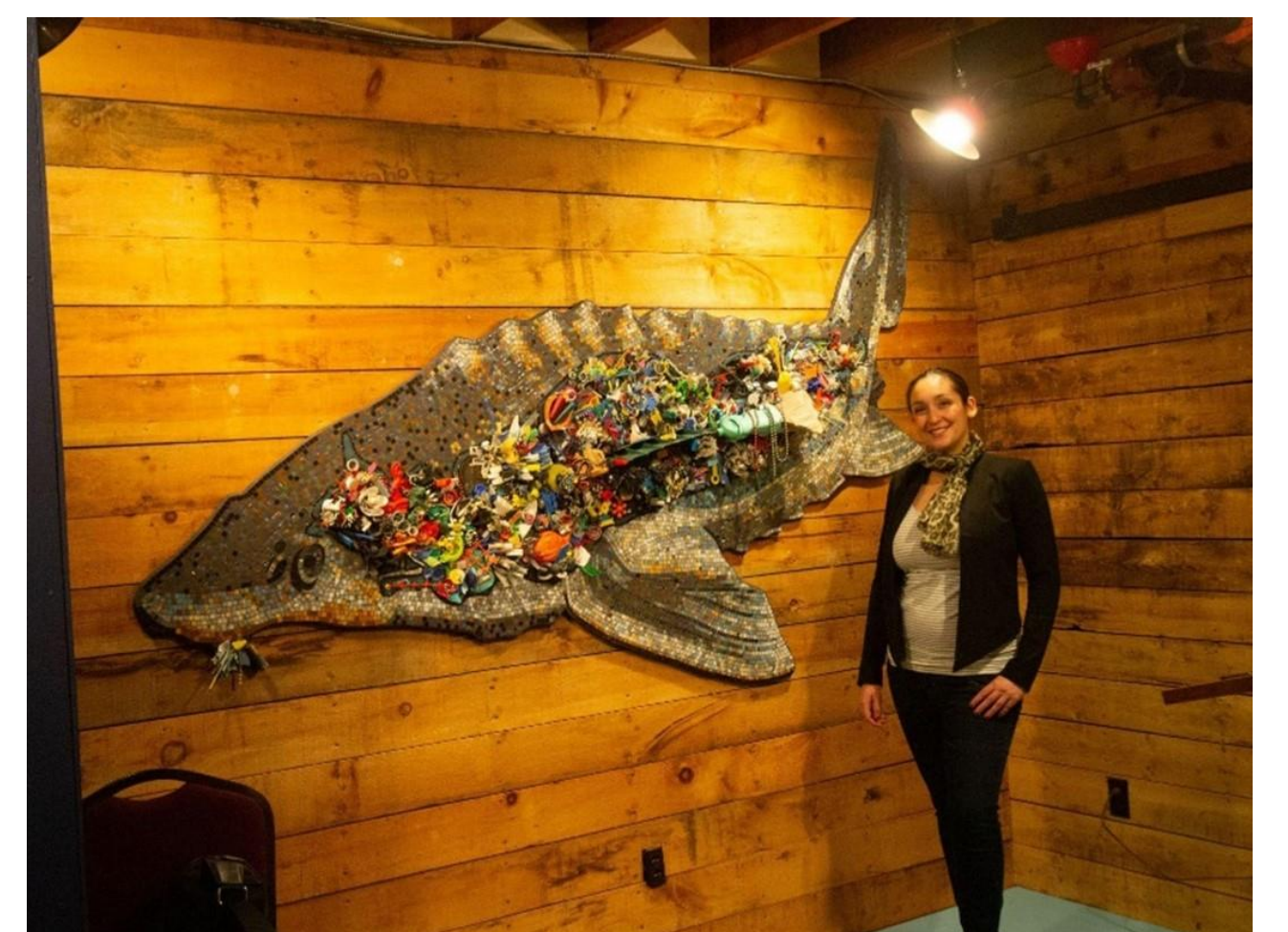
Outcomes and application uptake/ impact

- Recognizing the value of the legacy modelling framework by the Lake Futures team, a subgrant was awarded by ECCC to develop the ELEMeNT model for the Thames and Sydenham River watersheds.
- New wetland project funded by Ducks Unlimited Canada to quantify wetland P removal across the Lake Erie Basin and develop scenarios for wetland restoration.
- Two new projects were initiated in collaboration with OMAFRA and Canadian Biogas Association to quantify the feasibility of manure to biogas as a potential water quality improvement strategy across Canada. This was driven by project findings on the significant role of manure in water quality improvement.
- Collaborative development of a new community-based water quality program across Lakes Superior, Huron, and Michigan.

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