Friday, 20 January 2017

DEPARTMENT OF CIVIL ENGINEERING
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RE: Mississippi Lake Modelling Proposal

Background

In 2016, the Mississippi Lake Association (MLA), in conjunction with Mississippi Valley Conservation Authority (MVCA), approached Queen's University in order to develop a project to investigate water quality concerns in Mississippi Lake, in Lanark County, Ontario. Specifically, nutrient and algae levels have been identified as a concern for residents. With changing land use in the area, from intensification of agricultural operations to new rural residential development, a clearer understanding of the role of nutrient movement through the watershed, into the lake and ultimately nutrient effects on water quality was desired.

Scope

This project will gather existing water quality and flow data for Mississippi Lake and its tributaries. This data is expected to include parameters collected by various government, non-government and community organizations. This data also includes nutrient loading estimates and modelling outputs from an existing application of the CANWET hydrology model. The collected data will be analyzed to determine quality and quantity of data. If required, additional data collection may occur through the deployment of water quality monitoring equipment (e.g. chlorophyll a, dissolved oxygen, water flow) or through citizen science volunteers with the MLA.

The data will then be modelled using the three-dimensional Estuary and Lake Computer Model (ELCOM) coupled to the Computational Aquatic Ecosystem Dynamics Model (CAEDYM), developed at the University of Western Australia, with their realistic accounting of physical, hydrodynamic and biogeochemical processes. Coupled hydrodynamic and biogeochemical computer models are used by Canadian government agencies and consulting firms to guide environmental and resource policy and management. The most advanced three-dimensional lake model of this kind is ELCOM-CAEDYM, which has been applied to 100s of lakes worldwide. The Ontario MNRF has applied the model to manage fish recruitment in the Great Lakes (Zhao et al. 2009); the Ontario MOECC applied ELCOM-CAEDYM to guide phosphorus management (Bouffard et al. unpub.), determine invasive species impacts (Schwalb et al. 2014) and protect source water (Paturi et al. 2011); and NWRI-ECCC has applied ELCOM-CAEDYM for eutrophication/hypoxia management (León et al. 2010; Zhao et al. 2011), flood risk assessment (Rao and Zhao 2010), contaminant modelling (Rao et al. 2009) and assessing hydrology and climate change impacts on northern lakes (e.g., León et al. 2007). Boegman has recently worked to add ice algorithms to the hydrodynamic driver ELCOM, and validated simulations of winter dynamics against observed data from Canadian lakes (Oveisy et al. 2012).

In the proposed research, ELCOM-CAEDYM will be applied to determine the nutrient distributions and water quality response to nutrient loading within Mississippi Lake. The response of the lake to various nutrient control strategies will be assessed within the computational framework (CANWET/ELCOM/CAEDYM). Finally, a proposed watershed monitoring program will be developed, in consultation with MVCA and MLA.

Outcomes

The expected outcomes of this project are:

1) To determine the extent and suitability of available water quality and water flow data for Mississippi Lake and its immediate tributaries. This will include the identification of data gaps.
2) To develop, populate and run models using ELCOM (hydrodynamic model) and CAEDYM (water quality model) to understand nutrient dynamics and water quality response for Mississippi Lake, including several nutrient reduction strategies.
3) Develop a monitoring plan for the lake and its immediate tributaries for tracking nutrient sources to fill in data gaps.

Personnel

A post-doctoral fellow from the Department of Civil Engineering at Queen's will be employed to complete this project. The individual (Dr. Nader Nakhaei) has expertise in lake nutrient and flow modelling. He will report to Dr. Leon Boegman and Dr. Geof Hall.

Project Timeline

This project is delineated over the course of one year. Timelines may be changed depending on the progress of the project.

Time Period	**Project Targets**
May 1 – August 31, 2017	Collect and analyze existing data, identify data gaps, potentially collect additional data
September 1 – December 31, 2017	Data modelling (calibration and validation), additional data collection
January 1, 2018 – April 30, 2018	Data modelling, development of watershed monitoring strategies, identifying the key parameters, modeling remediation scenarios.

Funding

Funding for this project will be through the MITACS Accelerate program. This program provides 50% of the funds for the project. The remaining 50% of the funding must be provided by either MLA or MVCA. Each funding block from MITACS covers a four-month period. The following schedule is proposed to cover a 1-year project.

Time Period	MITACS Funding	MLS or MVCA Funding
May 1 – August 31, 2017	$7,500	$7,500
September 1 – December 31, 2017	$7,500	$7,500
January 1, 2018 – April 30, 2018	$7,500	$7,500
Funding Subtotal	22500	22500
Total Funding		45000

Dissemination of Findings

Dissemination of findings form this project will be through a report and presentation to MVCA and MLA. In addition, scholarly publication will also be sought in order to further the science of watershed monitoring and modelling.

Note: This project will require processing and vetting through Queen`s University Research Services Unit and the Head of the Department of Civil Engineering. Upon successful agreement of the project in principal, this will include an official signatory from Queen`s. As such this proposal does not reflect a signed, direct commitment from Queen`s University, but instead is designed to outline a path forward to enable an application for appropriate funding.

Sincerely,

Geof Hall, Ph.D.