Global Water Futures 2021 Operations Team Meeting – Project Reporting Template

Instructions: All GWF projects are asked to provide a summary update on their activities and accomplishments in preparation for the upcoming Operations Team meeting. **Please submit these by email to chris.debeer@usask.ca by no later than December 2.** These will be used to help guide discussions and breakout synthesis activities and will be made generally accessible on our website in advance of the meeting.

Project Name:	Managing Urban Eutrophication Risks under Climate Change: An Integrated Modeling and Decision Support Framework

Our major accomplishments to date are:

The accomplishments are provided for the four work packages (WPs) comprising the project (see Figure 1 for inter-linkages between WPs). The main objective of each WP is briefly described as well:

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:
- Collected spatial and temporal data, conducted data quality-control, and produced land cover, sewer network, and meteorological data in forms usable by the model.
- Verified monitoring data (runoff time series in summer 2012 and recent data since 2020) to be used for model calibration.
- Conducted automatic calibration of PCSWMM using the OSTRIC optimization software.
- Compared model simulations of runoff and TSS with observed values.
- 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.

WP2: lake modeling (*Main objective:* Simulate the nearshore biogeochemical cycling of P in WLO)

- Calculated the historical water budget of WLO:
- Hourly data of water currents and temperature of Lake Ontario since March 2016 till present were obtained from the Great Lakes Operational Forecast System. Note: these data are real-time predictions from the Princeton Ocean Model (POM), a 3-dimensional hydrodynamic circulation model.

WP3: ecosystem valuation (*Main objective:* Valuate ecosystem services impacted by nearshore eutrophication with the focus on determining how nearshore recreational use intensity and lakefront property differentials varies in WLO as a function of nearshore eutrophication)

- Collected data on response (i.e., price of lakefront properties) and predictor variables (i.e., population and dwelling density as proxies for urban input to aquatic systems) in the study area to be used in regression models.
- Used a mixed-effects model to capture fixed and random effects of covariates to compute the price differentials and premiums for lakefront properties in WLO.
- Mapped water-related cultural ecosystem services based on geo-tagged photos uploaded in social media websites.

WP4: integration of WP1-3: in progress.

Our current activities are:

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.

WP2: lake modeling

- Define the nearshore and offshore segments of WLO based on the water residence time of the segments, the degree of shoreline development, and the resolution of the available data of water currents (5 km in horizontal direction).
- Collect (and analyze) the tributary phosphorus (P) loadings 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.

WP4: integration of WP1-3: biweekly meetings of the entire project team (WP1-3).

The main accomplishments expected by the end of the project are:

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.

WP2: lake modeling

- Validate the algorithm for the satellite-derived nearshore Chl-a and *Cladophora* concentrations with in situ data.
- Develop the P mass balance model for WLO, this model and couple it to the Great Lakes Cladophora Model (GLCM v2.0); the mass balance model will represent the reactive P pools as well as biomass P pools of planktonic algae, *Cladophora* and mussels.
- Calibrate the nearshore algal growth model with the remote sensing data algorithm
- Assimilate the time series of P loading, temperature, and light intensities, and compute the monthly and annual P concentrations, plus the nearshore-offshore and inter-segment P exchange fluxes in different segments of WLO.

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).

WP4: integration of WP1-3

- Integrate the knowledge base and modeling tools of WP1-3 into a decision-support framework for adaptive urban stormwater management under climate change and urban development.

Here is a key visual from the project (figure, photo, table, graph, etc.)

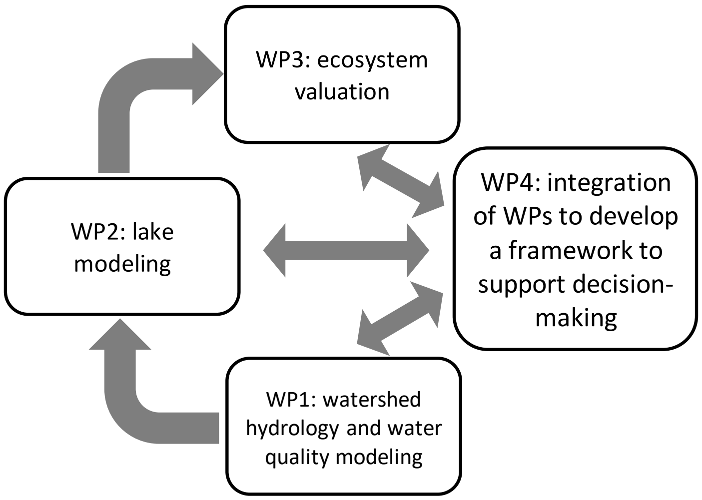

Figure 1. Inter-linkages among work packages

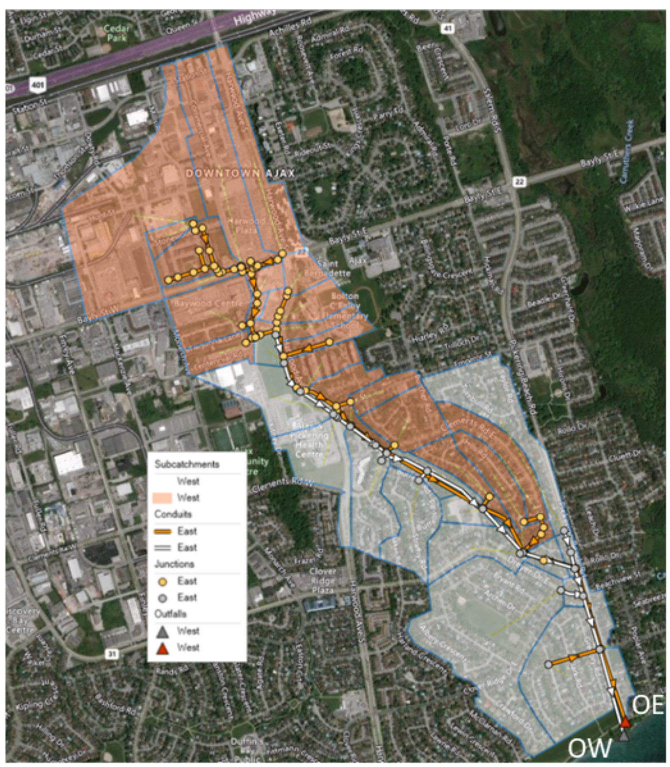

Figure 2. Layout of two modeled Ajax sewersheds where the blue lines identify the sub-basin boundaries, orange and gray circles are stormwater collection nodes, orange and white lines are the main sewers, red and gray triangles (OW and OE) are the stormwater outfalls of the two sewersheds.

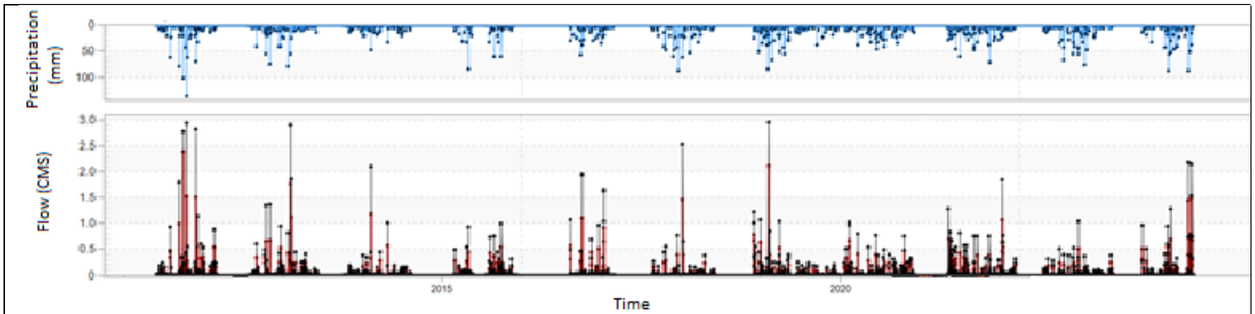

Figure 3. PCSWMM model output including precipitation (top panel), hourly runoff (bottom panel) in the eastern Ajax sewershed; red and black represent simulations and observations, respectively.

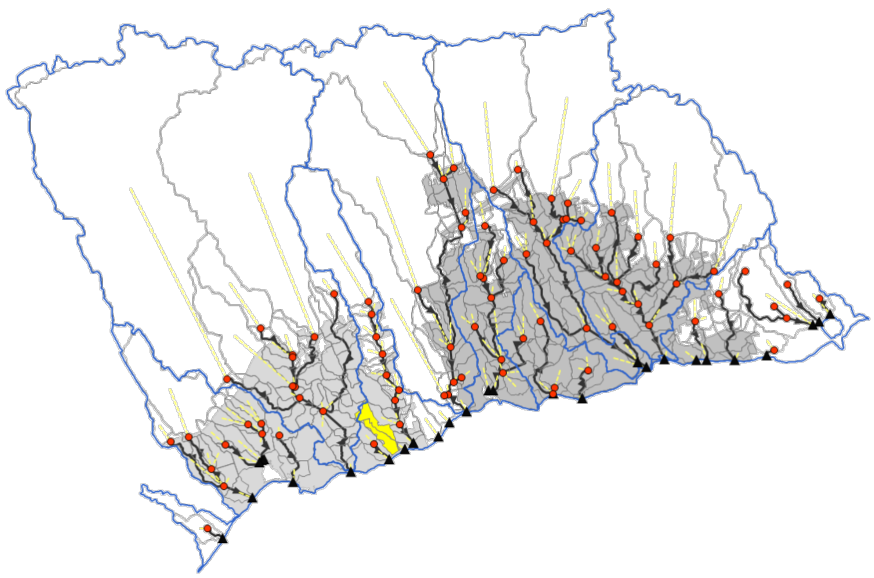

Figure 4. Hydrology and stormwater management systems for the upscaled PCSWMM model for Pickering, Ajax, Whitby, and Oshawa watersheds (in gray). The two Ajax sewersheds are identified in yellow.