INFORMATION SYSTEMS

Great Lakes - Nutrient Loading Policy Evaluation

Evaluation of Policy Options to Achieve Nutrient Reductions from Canadian Sources to Lake Erie

Client: Environment Canada and Climate Change

In 2015, GREENLAND® in association with faculty from the University of Guelph, were retained by Environment and Climate Change Canada, and an inter-agency Steering Committee and Technical Committee, to undertake the study *"Evaluation of Policy Options to Achieve Phosphorus / Nutrient Reductions from Canadian Sources to Lake Erie".* This initial study established an extensive list of the most viable policy options. Subsequent evaluations then examined the effectiveness of all policy options on the basis of achieving nutrient load reduction targets; sustainable cost effectiveness; potential impact to the economy; social acceptance; and, efficiency of implementation. The study also considered what initiatives were in place and recommended how gaps might be filled.

The main project objective was to determine what "best suite of policy actions" could achieve the greatest nutrient load reductions, while also being the most effective in terms of cost, time and social acceptance.

A unique modelling approach was used with the "**CAN**adian **W**atershed **E**valuation **T**ool" ("**CANWET**") as means of quantifying and better understanding the origin / timing of phosphorus loads reaching Lake St. Clair and draining from the Thames River Watershed. The Thames River basin is located in Southern Ontario and has a drainage area of 3,432 km². The watershed is home to almost 500,000 people and supports a diverse economy – including, extensive agriculture operations, supporting businesses and other industries. The mixed urban-rural (land use) grid CANWET model provided a means of testing policy options to determine the likely outcome in terms of load reductions and water quality. This approach was used as a means of demonstrating how policy options might be evaluated or applied over the larger Ontario portion of the Lake Erie Basin and to the other Great Lakes, as the Thames River watershed represents only a portion of the overall contributing source area to the Great Lakes.

Figure 7-1 Catchment / reach index map with monitoring stations

The Thames River Watershed was modeled as a series of 33 subwatersheds that were simulated and routed on a continuous daily time step for the period from 2008 through 2013. The simulation also used a series of geographic and meteorological information to estimate sediment and nutrient loads from sources and processes within each contributing catchment.

The routing routine in CANWET computes daily accumulated flow and load (and associated concentrations) from upstream reaches plus the current catchment. Loads from upstream contributing reaches are then decayed according to an exponential decay equation based on a calibrated decay factor, computed travel time and water column depth for each reach and day of the simulation. Any point source discharges are added at the outlet of a given reach. The simulated loads, flows and concentrations represent the stream discharge condition at the outlet of the reach segment.

Table 8-1 Summary of Watershed Model Scenarios

	Non-Prioritized	Spatially / Temporally Prioritized[3]
Baseline Voluntary **Standard Outreach and Cost Share Programs (existing level of resources)**	Scenario 1 Baseline calibrated model	Scenario 2 Prioritize BMPs to catchment-source-seasons with higher delivered loads. Moderate application rate
Voluntary with **Enhanced Outreach[4]**	Scenario 3 Uniform BMP application across watershed. Higher application rate due to enhanced outreach	Scenario 4 BMPs prioritized to higher loading catchment-source-seasons. Enhanced outreach increases application rate and BMP efficiency
Regulated and Enforced with **Enhanced Outreach**	Scenario 5 Enforced regulated approach. Outreach and compliance incentives across all catchments and sources. Enhanced outreach to prioritized catchment-source-seasons. This could involve phased implementation – (ex. address manure spreading in phase 1, WWTP optimization in phase 2, etc.) – or directing enhanced outreach to higher loading sources at a landscape scale.	

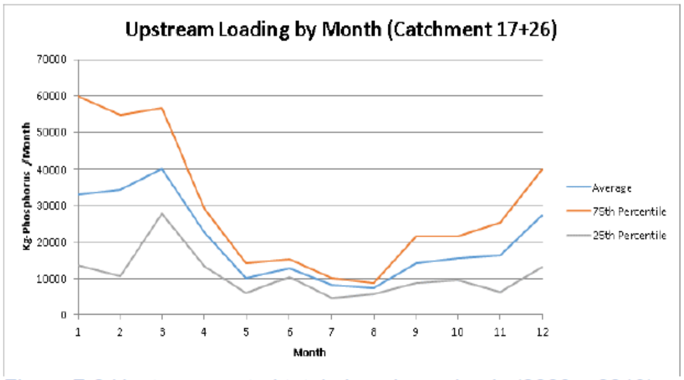
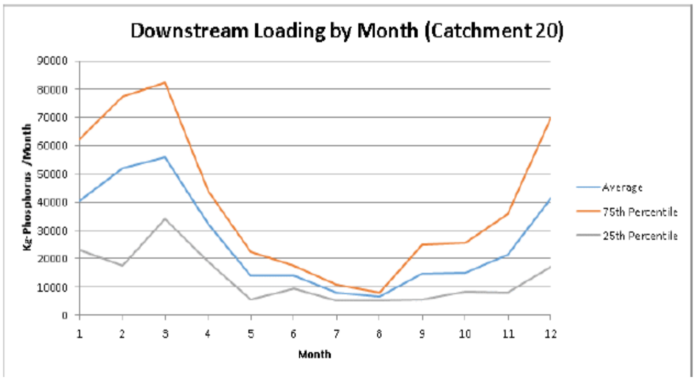


Figure 7-2 Upstream routed total phosphorus loads (2008 – 2013)



A series of watershed modeling scenarios were developed for the Thames River system to evaluate phosphorus loading and in-stream concentrations. CANWET modelling scenarios were representative of policy mechanisms too.

Delivered catchment-source-season loads per area (from the CANWET results) were ranked from 1% (highest delivered load per area) to 100% (lowest delivered load per hectare). The models also incorporated a new “evolutionary solver” that iteratively attempted different combinations of prioritization on each source type and in an attempt to achieve the 40% load reduction target for the lowest cost. The more area BMPs are applied to or the greater number of septic system and/or WWTP upgrades, the greater the cost and load reduction. If the CANWET model was not able to achieve a solution, the target was manually reduced until the solver was able to find a solution. The recommended policy option then involved developing an enhanced outreach program to inform and educate watershed stakeholders as well as providing technical support and financial incentives.

At the completion of the study, the Inter-agency Steering Committee had questions about how climate change might impact the effectiveness of policy on nutrient load reduction. GREENLAND® completed another study in 2016-17 (and using the same CANWET models) to evaluate climate change impacts on policy effectiveness in achieving nutrient reductions from the initial Thames River Watershed analyses.

The climate change scenarios used in this other study followed the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) Representative Concentration Pathway 8.5 (RCP 8.5) scenario.

A total of twelve (12) CANWET scenario runs were undertaken and summarized in the following table.

Summary of model scenarios

Model Calibration Period 2008-2013	Simulation Period 1986-2005 (Baseline)	Simulation Period 2020-2049 (Composite Climate Change)
Calibrated model under recent conditions	Baseline historical model	AR5 RCP8.5 using 4 driving climate models
Calibrated model with Policy Option 5 BMPs	Baseline historical model with Policy Option 5 BMPs	AR5 RCP8.5 using 4 driving climate models with Policy Option 5 BMPs

The final recommended policy option considered the use of approaches like one-on-one consultations and site specific planning, in addition to prioritizing BMPs seasonally and spatially to areas that contribute higher amounts of delivered nutrient load.

It was also concluded that decision making around use of BMPs must consider provision of “co-benefits”. For example, practices that reduce soil and nutrient loss may also reduce greenhouse gas emissions; retain / build soil organic content; reducing flood potential; reduce irrigation needs; increase bio-diversity; and improve habitat. All of these ecological goods and services will be best achieved if practices are designed to deliver under the projected climate change conditions.

Finally, in late 2017, another related study was initiated by Environment Canada and Climate Change. GREENLAND® was retained so that CANWET and another proprietary tool (THREATS) could be used.