Appendix J

Assessment of GLRI-Supported Water Quality Tools

Great Lakes RESTORATION

Great Lakes Commission des Grands Lacs

Researching the Effectiveness of Agricultural Programs

Assessment of GLRI Supported Water Quality Tools in the Great Lakes

Informational Assessment of Water Quality Tools to support the "Researching the Effectiveness of Agricultural Programs" (REAP) Project

Great Lakes RESTORATION

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Assessment of Water Quality Tools

Introduction

This report was developed with funding from the U.S. Environmental Protection Agency (EPA) Great Lakes Restoration Initiative (GLRI) as a part of the Great Lakes Commission's (GLC) Researching the Effectiveness of Agricultural Programs (REAP) project. This assessment supports their work by evaluating and comparing tools used to estimate or predict reductions in pollutant loading and water quality improvements. It provides an informational assessment of tools that were either developed in part by funding through the GLRI or those that can support GLRI focus area three - *nonpoint source pollution impacts on nearshore health* objectives.

Background

Information in this report is intended to support future discussions through the REAP project. These discussions are intended to build confidence in water quality professionals using these tools and to explore a more unified approach for modeling water quality improvements. The following statement by GLC describes in more detail the rationale for these discussions and need for the informational assessment provided in this report.

> *In the absence of more comprehensive monitoring data, multiple watershed tools have been developed with GLRI financial support to estimate or calculate reductions in pollution loading and resulting water quality improvements. These tools provide federal, state and local entities and agricultural producers (as well as the GLC-led research team) the ability to estimate the benefits of conservation practices at the field and watershed scale. Field-scale tools in particular can potentially influence on-farm management decisions to avoid large nutrient losses in critical seasons during large rain events. Comparing these tools and summarizing their capacities may build confidence among Great Lakes agriculture and water quality practitioners toward a more unified approach in modeling water quality improvements.*

Methods

Comparing different types of water quality tools poses significant challenges due to variability in the uses, functionality, and outputs of these tools. This report focuses more on informational assessments rather than a direct comparison between tools.

The criteria used in this assessment are not intended to determine which tool is superior but to provide a means for the reader to quickly assess common characteristics of the tools to select which may be most appropriate for their use and how those tools were used for GLRI activities.

To conduct this assessment, a number of proposed criteria were reviewed and selected by IWR and the GLC. The criteria used are based on common factors exhibited in all of the tools being evaluated. Although the evaluation factors may be common, some tools have dissimilar purposes which should be noted when comparing tools.

Information on the water quality tools listed in this report was obtained through website and promotion materials as well as interviews with key contacts or managers of the tools.

Discussion

Table 1 provides a list of criteria used to deliver comparative information across tools. For each water quality tool discussed in this report, a narrative overview of the tool and accompanying table is provided. The GLC and EPA selected the tools included in this assessment report. Most of these tools were developed or supported by GLRI funding. Following is a brief overview of the tools with an attached informational table.

Tools Reviewed

Harmful Algal Bloom Tracker
NOAA Runoff Risk Model
NOAA Tipping Point Planner
Great Lakes Watershed Management System
Nutrient Tracking Tool
USGS NowCast

Criteria Table

Table 1. List of criteria to evaluate GLRI Water Quality Tools.

ID	Criteria	Description
1	Geographic Extent	Description of the geographic area(s) the tool can model.
2	Scale of Analysis	Scale of analysis (field, watershed, regional, etc.).
3	Delivery Platform	Description of the platform used by the tool (web-based, local installation, mobile device, etc.).
4	Pollutants Modeled	What pollutants can be modeled (sediment, phosphorus, nitrogen, etc.)
5	Level of Expertise/Training	How much training is required to use the tool.
6	Model Outputs	What are the total model outputs and in what format.
7	Data Requirements	What data are required to be collected or input by the user?

8	Funding Source	What agency or group funded the development of the tool?
9	Model Administrator	Who currently manages and supports the tool?
10	Legislated or Required Use	Is the tool required by legislation or by agreement; if it is, name the law and describe where, how, and when its use is required
11	Developer of Tool	Who created the tool?
12	Sub Models	What sub models, if any, are used in the tool?
13	Purpose of Tool	What does the tool do generally?
14	Software Requirements	What software is required to run the program?
15	Target User	Who is the tool designed for, and can anyone use it? (state agency, researchers, conservation districts, etc.)

Assessment of Tools

HAB Tracker

The Experimental Lake Erie Harmful Algal Bloom (HAB) Tracker was first developed in 2014 as a forecast model that provides the location, size, and trajectory of blooms in Lake Erie. HAB Tracker evolved out of projects and activities such as the National Oceanic and Atmospheric Administration (NOAA) Lake Erie HAB Bulletin and NOAA Lake Erie HAB Forecast Tool. GLRI funding to NOAA and the Great Lakes Environmental Research Laboratory (GLERL) helped support the development of the tool by GLERL and the Cooperative Institute for Great Lakes Research (CIGLR), NOAA, and NOAA Ocean Service.

The NOAA Experimental Lake Erie HAB Tracker uses the latest satellite imagery of Lake Erie to produce an up-to-date estimate of the present location and 5-day forecast of HABs in western Lake Erie. In addition to these images, weather forecast information and modeled currents in Lake Erie during the HAB season are also used to produce a forecast.

The subset of models/technology used to produce the forecast include a remote sensing satellite-derived cyanobacterial index, lake currents forecasted by the Great Lakes Coastal Forecasting System (GLCFS), and a Lagrangian particle model to determine vertical bacterial distribution.

These forecasts are used by public water systems, anglers, beach-goers, researchers, and others to avoid negative impacts from the blooms and for better enjoyment of the water resources.

The HAB Tracker is available at: https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html

ID	Criteria	Discussion
1	Geographic Extent	Currently is available for Western/Central Lake Erie
2	Scale of Analysis	Regional
3	Delivery Platform	The HAB tracker is delivered through a web browser https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html
4	Pollutants Modeled	Cyanobacterial biomass
5	Level of Expertise/Training	No training required to read or use
6	Model Outputs	Animated image similar to a precipitation radar
7	Data Requirements	No data are required to be input by the user
8	Funding Source	GLRI with early work and products produced through NOAA
9	Model Administrator	GLERL and CIGLR
10	Legislated or Required Use	No
11	Developer of Tool	GLERL, CIGLR, NOAA, NOAA Ocean Service
12	Sub Models	Remote sensing satellite-derived cyanobacterial index, Great Lakes Coastal Forecasting System (GLCFS) provides lake currents, Lagrangian particle tracking model for vertical bacterial distribution.
13	Purpose of Tool	Provide information on the size, location, and projected direction of algal blooms.
14	Software Requirements	Internet connection and web browser
15	Target User	Public water systems, anglers, beach-goers, and researchers

NOAA Runoff Risk Model

The Runoff Risk Decision Support model provides real-time forecasting guidance that gives farmers and nutrient applicators information about when not to apply fertilizers or manure to their fields. The Runoff Risk model was jointly developed by NOAA and Wisconsin around 2009. In 2014, the National Weather Service (NWS) received funding through the GLRI to expand the tool to other Great Lake states including Michigan, Ohio, and Minnesota and to update the previously-used lumped Operational River Forecasting model to a gridded version.

NWS works with state and university partners to deliver a web-based service that estimates a low, medium, or high risk of runoff probability. Each state operates and develops their websites. The presence of risk is defined by 1) runoff occurring, 2) upper layers of soil near saturation, and 3) meteorological driver (rain or snow melt occurring). NWS provides two model runs per day each with a 10-day forecast posted to a secure file transfer protocol (FTP) site. Partnering states download the new information and display it through their own web-based interface.

The Runoff Risk Model runs the Snow 17 Snow Accumulation and Ablation Model and Sacramento Soil Moisture Accounting Model with Heat Transfer and Enhanced Evapotranspiration (SAC-

HTET). The model is run on a 4km x 4km HRAP grid using the NWS Hydrology Lab Research Distributed Hydrologic Model (HL-RDHM) structure to help predict the risk of runoff. The only data requirements for these two models are precipitation and temperature. The Snow 17 model accounts for the accumulation and ablation of snow, while the Sacramento Soil Moisture model predicts hydrological soil conditions, evapotranspiration, runoff, and percolation. For each grid cell, simulated runoff from the SAC-HTET model is accumulated into events that are then compared to the historical event magnitudes for that grid cell over a historical simulation. These events are then stratified into risk categories based on the historical event magnitudes. Risk categories have initially been chosen based on a comparison analysis of simulated event presence versus observed edge-of-field runoff presence.

For each model run a set of geoTIFF files is provided. For each forecast day NWS provide grids for daily average model states. Data include runoff risk, soil temperature, soil saturation, precipitation, temperature, and winter snow pack. This service is currently available for all Great Lakes states. However, only Michigan, Wisconsin, Ohio, and Minnesota have developed web-based interfaces to share with target audiences, which include producers, fertilizer applicators, agricultural and state agencies, and the public.

ID	Criteria	Discussion
1	Geographic Extent	Modeled for the Great Lakes. MI, WI, MN, and OH have web-based interfaces available
2	Scale of Analysis	4km grid for analysis with decisions made at the field level
3	Delivery Platform	Web-based systems: MI: https://enviroimpact.iwr.msu.edu/ OH: https://www.arcgis.com/home/webmap/viewer.html?webmap=b5d6145c98ad481bac08e8a63b957c32 WI: http://www.manureadvisorysystem.wi.gov/app/runoffrisk MN: https://mnag.maps.arcgis.com/apps/MapSeries/index.html?appid=7a6538ffc8994715ba668f0579fe53a2
4	Pollutants Modeled	No pollutants modeled, runoff risk generated
5	Level of Expertise/ Training	No training required to read or use
6	Model Outputs	Geotiff containing runoff risk, soil temperature, soil saturation, precipitation, temperature, and winter snow pack
7	Data Requirements	No data are required to be input by the user
8	Funding Source	GLRI with early work initiated by the NWS and Wisconsin
9	Model Administrator	NWS with each state managing their own website delivering runoff risk maps

10	Legislated or Required Use	No
11	Developer of Tool	NWS and participating states – WI, MI, OH, MN
12	Sub Models	Snow 17 model, which requires temperature and precipitation; hydrological soil model, which simulates soil conditions; Evapotranspiration model, with precipitation and temperature inputs required. Gridded data is a 20 yr historical run. Runoff risk by magnitudes and runoff events, comparing to historical data for that grid cell.
13	Purpose of Tool	Provides forecasted runoff risk to aid in decision making for when to apply nutrients to a field.
14	Software Requirements	Internet connection and web browser
15	Target User	Those applying nutrients to landscape, ag agencies, producers, applicators, and the public.

NOAA Tipping Points Model

The Tipping Points Model is used to assist Lakewide Action and Management Plans (LAMPs), watershed and fisheries communities, along with watershed planning groups with planning and visioning for their community. By identifying the status of watershed health and exploring the impacts of land use change, communities learn how future development will move ecosystems closer to or further from tipping points. A "tipping point" is a threshold of human-induced ecological stress and indicators of natural resource condition that can indicate change in how ecosystems function.

A web-based tool provides users with dials and gauges representing indicators that can be used to connect the effects of land use changes on stream and near-shore biota. Users can conduct "what if?" scenarios by modifying land use changes and seeing how those changes impact changes in water quality. Phosphorus, nitrogen, and heavy metals are some of the pollutants modeled in this system.

Several models are run in the background to predict impacts from various land use changes. These models include a spatially-explicit land use change model (Land Transformation Model) and a Stream Health model that is indexed by fish and invertebrate community composition. The SPARROW model considers landscape factors (climate, soils, topography, etc.) as well as transport and fate properties (stream network, loss, etc.) at the stream segment catchment level to estimate the mean-annual load delivered to the stream.

Catchment loads are then aggregated to estimate the phosphorus load at the HUC 8 spatial scale. In addition, the Spatially Explicit Nutrient Sources model identifies nutrient sources at the 12 digit HUC for atmospheric deposition, septic tanks, agriculture and non-agriculture chemical fertilizer, animal manure, and point sources. The Long-Term Hydrologic Impact Assessment (L-THIA) model calculates the impact of land use changes on the hydrology of a watershed. The gauges display changes in nitrogen, phosphorus, suspended solids, lead, copper, and zinc before and after land use changes are made. Food web models predict impacts of nutrient loads on biomass of plankton, benthos and fish in nearshore and offshore waters in Lakes Michigan, Huron and Erie, and in development for Lake Ontario. The food web models are coupled with the land use and nutrient models to predict water quality and bio-health impacts from land use changes. A model linking wetland health to land use is completed and will be available through the web site.

The Tipping Points Model provides a number of maps and plans for watersheds and water resources in the community in the form of an action plan. The watershed action plan is a product of the community's vision because it is developed with extensive community input.

Tipping Points Model is available at: http://tippingpointplanner.org/resources/model-resources

ID	Criteria	Discussion
1	Geographic Extent	Modeled for MI, WI, MN, and OH
2	Scale of Analysis	HUC 12 Watershed
3	Delivery Platform	The Tipping Point Planner is delivered through a web browser http://tippingpointplanner.org/
4	Pollutants Modeled	Phosphorus, Nitrogen, heavy metals
5	Level of Expertise/Training	No level of training required to read or use, but intended to be used with trained Tipping Points professional
6	Model Outputs	Watershed action plan that includes maps, documents, plans
7	Data Requirements	No data are required to be input by the user
8	Funding Source	A variety of funding sources including EPA Star and GLRI
9	Model Administrator	Tool is hosted at Purdue University
10	Legislated or Required Use	No
11	Developer of Tool	University of Michigan, Purdue University, Michigan State University, Natural Resource Research Institute at University of Minnesota Duluth, NOAA GLERL.
12	Sub Models	Land Transformation Model, Stream Health Model, SPARROW Model, Spatially Explicit Nutrient Sources, L-THIA Model, Food Web Model
13	Purpose of Tool	Provide communities with a watershed health based planning tool to help with strategic planning
14	Software Requirements	Internet connection and web browser
15	Target User	Watershed communities, LAMP communities, fisheries communities, and watershed planning groups

Great Lakes Watershed Management System

The Great Lakes Watershed Management System (GLWMS) is an online tool for field and watershed scale modeling of water quality and quantity in the Great Lakes region. It was released by the Institute of Water Research at Michigan State University (IWR-MSU) in 2013 with support from the Michigan Chapter of The Nature Conservancy (MI-TNC) and the U.S. Army Corps of Engineers. The tool provides a user-friendly mapping interface to delineate farm fields, view local catchments, explore current estimates of soil erosion, sediment loading, nutrient loading, groundwater recharge, and wind erosion, and to evaluate the impacts of various conservation practices on those outputs. To produce these outputs the GLWMS links multiple environmental models in the backend, including the Revised Universal Soil Loss Equation (RUSLE), Wind Erosion Prediction System (WEPS), Soil and Water Assessment Tool (SWAT), Long-Term Hydrological Impact Analysis (L-THIA), and Spread Sheet Tool for Estimating Pollutant Load (STEP-L). Web services are hosted by Purdue University's Agricultural & Biological Engineering Department. The system allows users to store model outputs to their accounts, build reports, and run batch simulations. Modeled outputs are reported on an annual basis.

The GLWMS has been utilized as a platform for implementing multiple conservation programs. MI-TNC used the GLWMS to track and monitor sediment load reductions for a USDA-NRCS Regional Conservation Partnership Program project, GLRI Saginaw Bay Pay for Performance Sediment program, and groundwater recharge enhancements for a Mott Foundation conservation project. IWR-MSU and The Stewardship Network are currently utilizing the GLWMS to estimate conservation payments for GLRI-funded phosphorus reduction efforts in the River Raisin watershed of the western Lake Erie basin. The Delta Institute is currently using the system to carry out a sediment reduction pay for performance project in the Rabbit River watershed of southwest Michigan.

The GLWMS is available at: https://iwr.msu.edu/glwms

ID	Criteria	Discussion
1	Geographic Extent	Saginaw Bay basin (Michigan), Maumee River basin (Ohio and Michigan), Kalamazoo River basin (Michigan), Fox River basin (Wisconsin), Genesee River basin (New York), River Raisin Watershed, MI.
2	Scale of Analysis	Field scale
3	Delivery Platform	The GLWMS is delivered through a web browser https://iwr.msu.edu/glwms
4	Pollutants Modeled	Water quality: sediment, phosphorus, nitrogen. Water quantity: groundwater recharge
5	Level of Expertise/Training	No level of training required to read or use, though familiarity with background models (e.g. RUSLE, SWAT,

		STEP-L) will aid interpretation of results. System includes user-guides.
6	Model Outputs	Depending on the models run the GLMWS will provide sediment, nutrients, or gallons of groundwater recharge by modeled area. These are displayed on screen in a report format, downloadable PDF reports with modeled results and maps can be produced, and batch simulations produce downloadable spreadsheet outputs.
7	Data Requirements	User must digitize field boundaries, though there is an option to upload shapefiles of existing field boundaries. System can utilize default data for current cropping system, crop rotation, and crop residue. However the user is able to provide more detailed model inputs (e.g. RUSLE C-factors, SWAT crop rotations, current land covers, etc.)
8	Funding Source	Michigan TNC, U.S. Army Corps of Engineers though GLRI
9	Model Administrator	Institute of Water Research, MSU
10	Legislated or Required Use	No
11	Developer of Tool	Institute of Water Research, MSU
12	Sub Models	RUSLE, SEDMOD, STEP-L, L-THIA, SWAT, WEPS
13	Purpose of Tool	Field-scale evaluation of potential impacts of conservation on water quality and quantity.
14	Software Requirements	Internet connection and web browser
15	Target User	Conservation technicians, farmers, crop consultants, researchers, government farming agency, government environmental regulators

The Nutrient Tracking Tool

The Nutrient Tracking Tool (NTT) is an online tool that models sediment and nutrient losses from fields. It was developed and is hosted by the Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University, with funding from USDA. Though the tool is available nationally, it is primarily focused on evaluating losses from farm fields and its default inputs were tailored for the western Lake Erie basin. However, the tool's home page indicates that future updates will tailor parameters for other regions.

NTT utilizes the Agricultural Policy Environmental eXtender (APEX) model as its primary analytical engine. Users can define field boundaries within a browser window, which NTT then utilizes to retrieve soils input from backend databases. The user can then describe various aspects of their agricultural operation, including crop rotations, drainage systems, nutrient applications, irrigation management, tillage methods, and scheduling to view annual and monthly baseline averages of sediment and nutrient losses, crop yields, and water flows. Users can also model conservation practices such as cover crops, grassed waterways, and buffer strips to evaluate their impacts on model outputs.

Results can be viewed in a tabular format displaying total nitrates, total phosphorus, organic phosphorus, soluble phosphorus, and sediment. A variety of pathways for these pollutants including surface, subsurface, and tile drains are displayed. Crop yields and plan stress indicators are also available. All these results can be stored in a user's account.

NTT is available at: http://ntt.tiaer.tarleton.edu

ID	Criteria	Discussion
1	Geographic Extent	National, though initial inputs are tailored for Ohio and Western Lake Erie Basin.
2	Scale of Analysis	Field and small watersheds.
3	Delivery Platform	NTT is delivered through a web browser http://ntt.tiaer.tarleton.edu
4	Pollutants Modeled	Sediment, total phosphorus (organic and PO4_P), nitrogen
5	Level of Expertise/Training	User must have basic understanding of agricultural management to utilize system and interpret outputs.
6	Model Outputs	Tabular and graphical outputs of sediment and nutrient losses, crop yields. These include a variety of pathways for pollutants including surface and subsurface, along with plant stress indicators.
7	Data Requirements	User must digitize field boundaries. System utilizes backend soil databases, but the advanced user can customize soil inputs. Users must describe agricultural management options.
8	Funding Source	USDA, NRCS.
9	Model Administrator	Ali Saleh, Ph.D., Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University
10	Legislated or Required Use	No
11	Developer of Tool	TIAER at Tarleton State University
12	Sub Models	APEX
13	Purpose of Tool	Field-scale simulation of sediment and nutrient losses on agricultural fields, evaluation of conservation practices
14	Software Requirements	Internet connection and web browser
15	Target User	Conservation technicians, farmers, crop consultants, researchers, government farming agency, government environmental regulators

USGS NowCast

NowCast is a forecasting system used to predict *E. coli* concentrations in swimmable water. Managers can use that information to determine the likelihood of whether or not recreational water body contact standards will be exceeded.

Through a mathematical system, NowCast uses easily measured environmental and water-quality "variables," such as turbidity and rainfall, to estimate levels of fecal indicator bacteria (FIB). Mathematical models are developed from several years of measurements taken at a particular site, and all models used in the NowCast are swimming area or site specific. A multivariate statistical model is used to develop relationships between bacterial concentrations and parameters that influence them.

NowCast variables are measured each morning by a beach manager or technician and entered into computer software. The NowCast for swimming areas provides the probability (in percent) that the established state recreational water quality standard will be exceeded. So on any given morning, there can be from a 1- to 100- percent probability that the standard will be exceeded.

The NowCast is the result of multi-year partnerships on several projects between the U.S. Geological Survey (USGS), and other federal, state, and local agencies and universities. Current and past partners include Chautauqua County Department of Health (NY), Cleveland Metroparks (OH), Cuyahoga County Board of Health (OH), Erie County Health Department (OH), Erie County Department of Health (NY), Erie County Department of Health (PA), Lake County General Health District (OH), Monroe County Health Department (NY), Muskingum Watershed Conservancy District (OH), New York State Department of Health, New York State Office of Parks, Recreation and Historic Preservation, Northeast Ohio Regional Sewer District (OH), Ohio Department of Health, Ohio Department of Natural Resources, Ohio Lake Erie Office, Ohio Water Development Authority, University of Toledo (OH), EPA, and the U.S. National Park Service.

ID	Criteria	Discussion
1	Geographic Extent	Modeled in Lake Erie at beaches in New York, Pennsylvania, and Ohio.
2	Scale of Analysis	Beach swim areas
3	Delivery Platform	NowCast has a web-based interface that shows predicted colony forming units. https://ny.water.usgs.gov/maps/nowcast/
4	Pollutants Modeled	*E. coli*

5	Level of Expertise/Training	Beach manager reads results compared to state's recreational standards and make decisions on swimming. Knowledge of required parameters measured at the beach and entered into the modeling software requires training.
6	Model Outputs	Digital report of percent chance of exceeding a state's recreational *E. coli* exposure standard
7	Data Requirements	Parameters needed include turbidity (water clarity), rainfall, wave height, water temperature, day of the year, and lake level.
8	Funding Source	GLRI, USGS
9	Model Administrator	USGS
10	Legislated or Required Use	No
11	Developer of Tool	USGS with support from local, state, and federal partners
12	Sub Models	A multivariate statistical model is used to develop relationships between bacterial concentrations and parameters that influence them. Additional tools to compile data include software for creating predictive models (Virtual Beach) developed by U.S. Environmental Protection Agency; software to process weather data from the nearest National Weather Service airport site (PROCESSNOAA); and a spreadsheet to process lake-level data from the National Oceanic and Atmospheric Administration (NOAA).
13	Purpose of Tool	Provides near real-time *E. coli* concentration forecasts for beach managers to assess the safety of recreation contact
14	Software Requirements	Internet connection and web browser and software for data input
15	Target User	Beach managers and the public

Summary

There are a number of customized tools available to agricultural and water quality practitioners in the Great Lakes region that help in forecasting, measuring, and estimating pollutant loads and water quality changes. There have been significant investments in financial and human resources to develop, adopt, and promote these systems. In exploring opportunities to move water quality practitioners toward a unified modeling approach it is import to recognize that: 1) not all of the water quality tools address the same pollutants, 2) significant investments have been made in creation and adoption of particular models that drive these tools, and 3) when water quality tools are successful it is often because they have simple user requirements and are focused in their design. The combination of these factors present significant challenges in promoting a unified approach in modeling water quality improvements.

These challenges may include building or using tools that address too many different pollutants in one interface. These tools often overwhelm users with choices and may become too complex with the number of input requirements from the user. Additionally, “favorite” models or preexisting investments in model development make it very difficult to select a different model that might fit into a more unified modeling approach.

One approach to address some of the challenges mentioned above is to develop a common delivery platform that provides basemaps, visualization, and common mapping requirements that many of these tools discussed utilize. The platform would not be bound to any particular model but could utilize outputs from any model of choice. The Great Lakes Watershed Management System, which is one example of this, is not tied to a particular model but can utilize results from any number of models. In many cases this type of platform can be used to deliver model results from models that water quality practitioners are currently using.

In summary there are potential benefits to using a unified water quality modeling approach, however, there are several significant challenges that need to be addressed. Exploring the use of platforms or interfaces that do not require users to abandon currently used models, and that do not overwhelm users with too many input requirements or choices are likely to yield the best results.

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