HAWQS/SWAT as a policy analysis tool: integrating water quality modeling with meta-regression and benefit transfer

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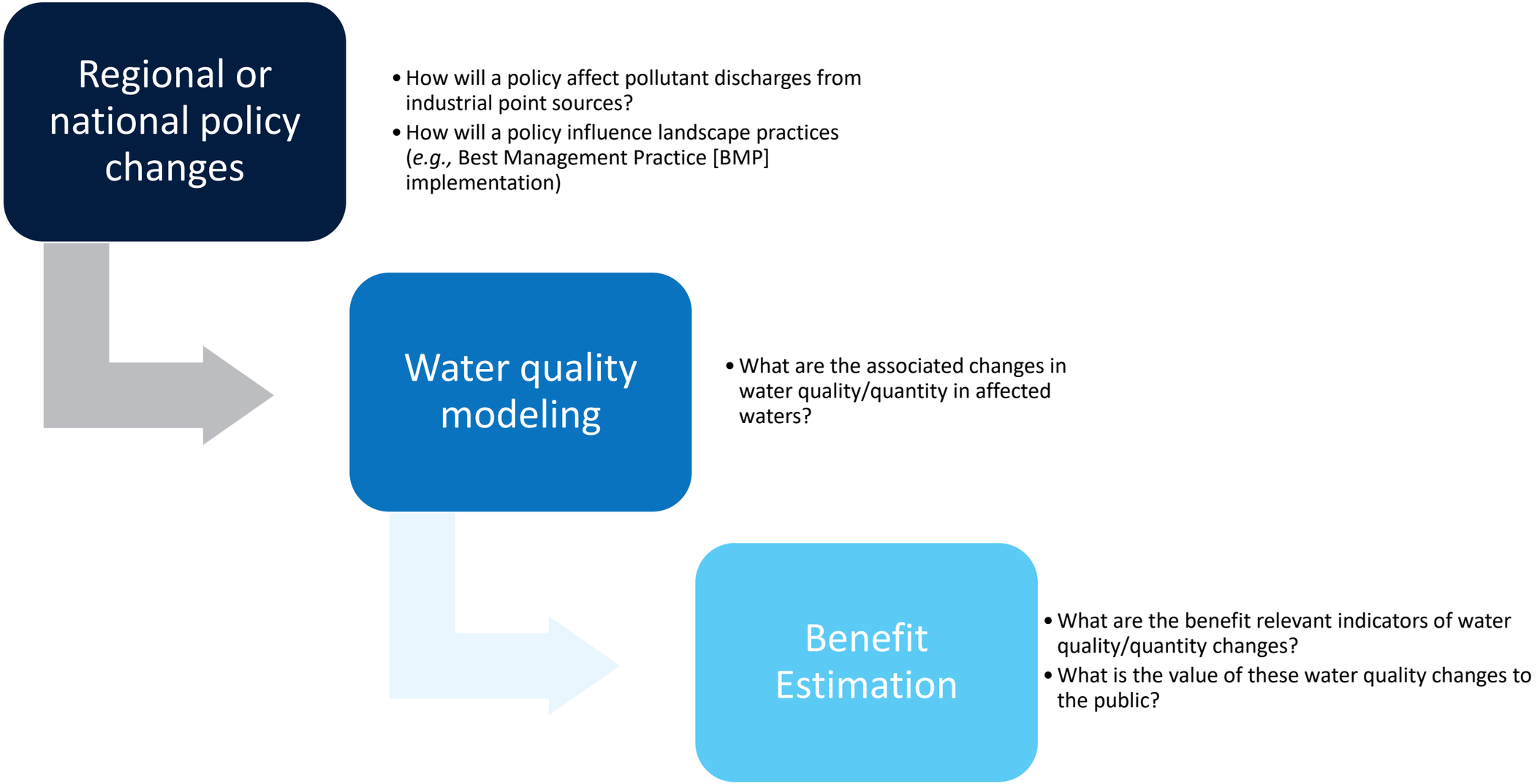
Agenda

- Value of Water Quality Modeling to Policy Analysis
- Soil and Water Assessment Tool (SWAT)
- Hydrologic and Water Quality System (HAWQS)
- Policy Implementation Using HAWQS
  - Three examples
    - Agricultural management practice implementation
    - Wetland area changes
    - Point source changes
- Why HAWQS?

Value of Water Quality Modeling to Policy Analysis

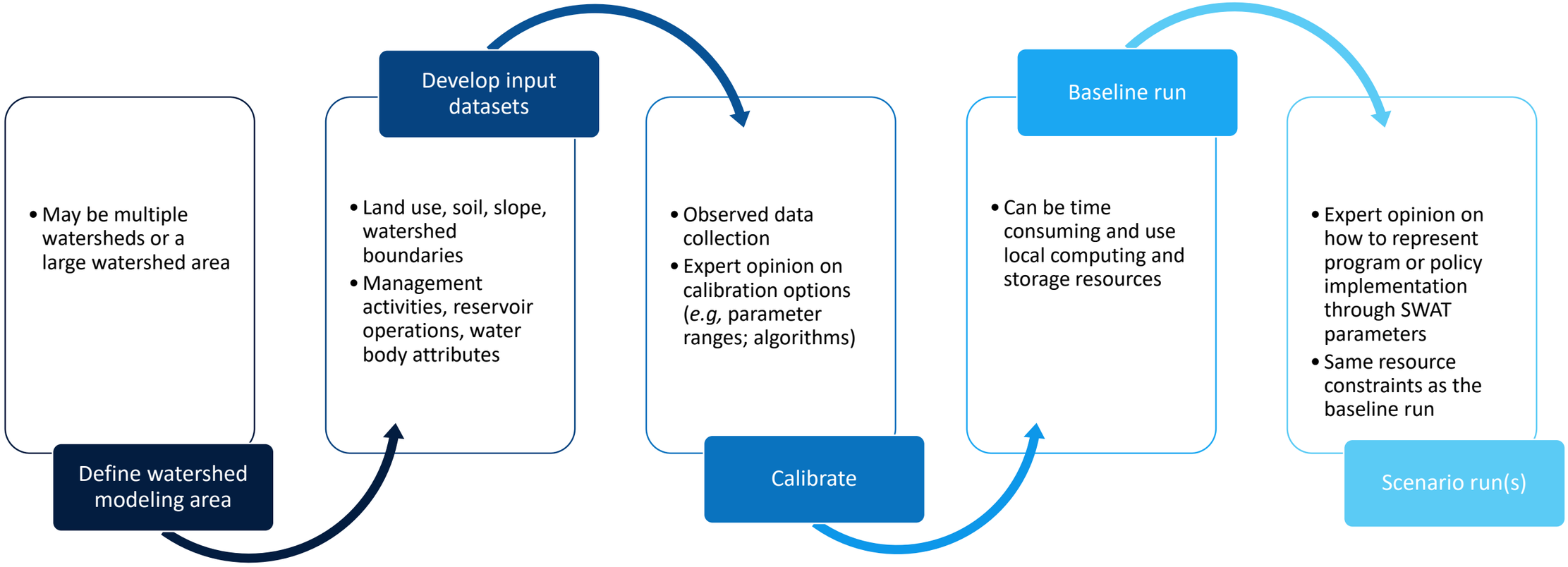


Soil and Water Assessment Tool (SWAT)

Water quality modeling

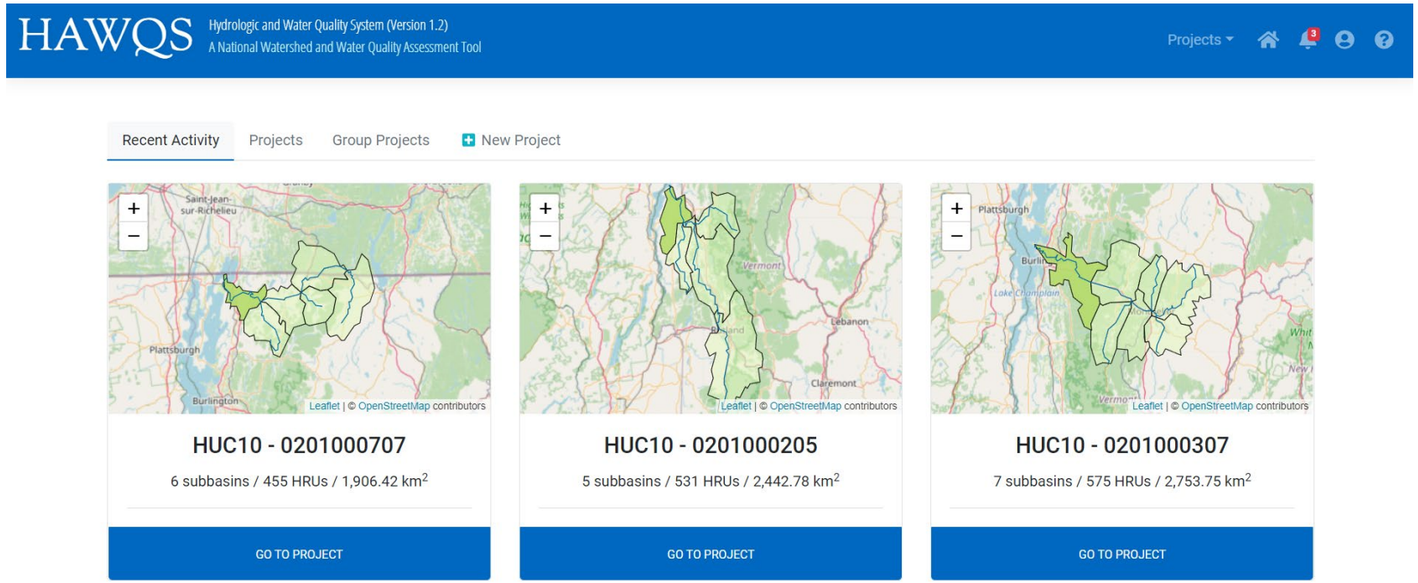
- Widely used in assessing the effects of watershed management practices, including soil erosion prevention and control and non-point source pollution control
- Used to quantify changes in flow and water quality parameters including sediment, nutrients, dissolved oxygen, and pathogens
- Continuous time model which simulates watershed hydrology and stream water quality as a result of land use, land management, and climate change
- Small watershed (HUC12) to river basin-scale (HUC4) model
- US Department of Agriculture (USDA) and Texas A&M University jointly developed SWAT and have actively supported the model for more than 25 years

Soil and Water Assessment Tool (SWAT)



Hydrologic and Water Quality System (HAWQS)

- Web-based interactive water quantity and water quality system that uses SWAT as its core modeling engine
- Developed to meet the needs of US EPA Office of Water (OW)
- Currently supported and funded by US EPA OW. Texas A&M University Spatial Sciences Laboratory and EPA subject matter experts provide ongoing technical support
- HAWQS 1.2 available to the public: https://hawqs.tamu.edu/#/ with HAWQS 2.0 expected in 2023

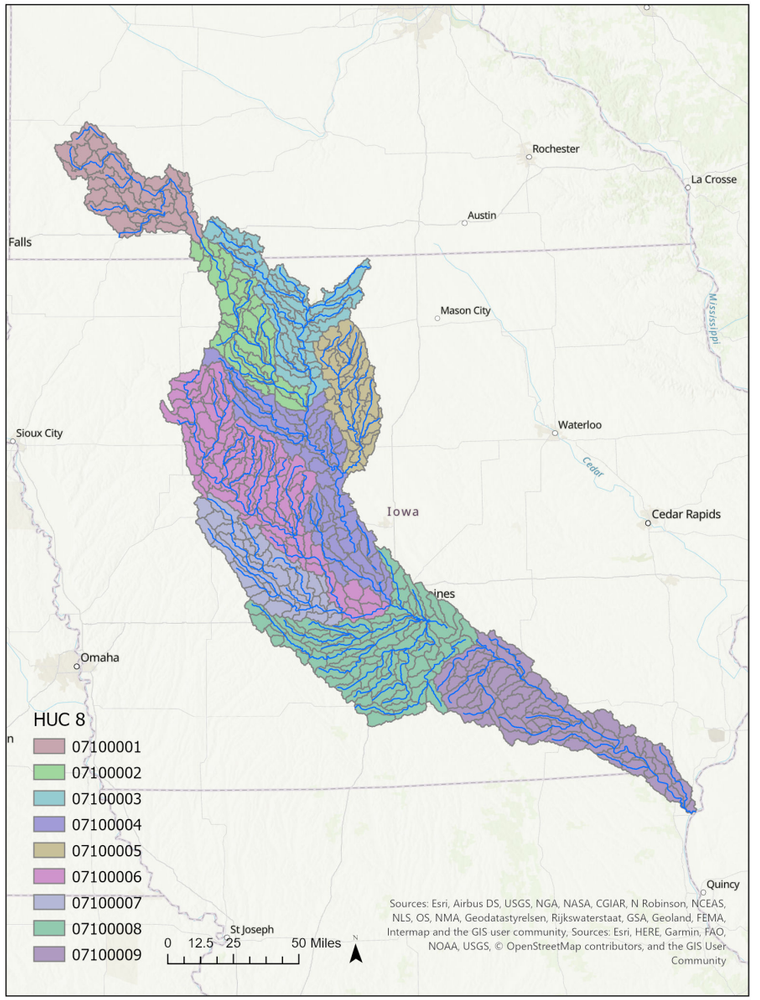


Hydrologic and Water Quality System (HAWQS)

Barriers to Using SWAT	Associated HAWQS Functionality
Model runs and output processing for large watersheds or multiple locations can be computationally complex	Run performed on external servers and built-in data processing capabilities
Time consuming to develop all of the necessary inputs	Includes pre-processed datasets for the contiguous United States at different spatial scales (HUC12 to HUC8) across different temporal periods (1981-2018)
Calibration process to ensure model relevancy is time consuming and requires input from water modelers	Calibrated parameters available for many watersheds, with ongoing rolling calibration
SWAT input data and parameters need to be adjusted to represent policy or program implementation	Ability to adjust SWAT input data and parameters through a user-friendly HAWQS interface
Learning curve to setting up and running SWAT models	Organizes and translates model setup and execution through an intuitive interface to accomplish most common modeling tasks

Policy Implementation Using HAWQS – Agricultural Management Practices

- Des Moines watershed (HUC 0710)
- Average model run time ~16 hours
- Majority of the watershed area (nearly 88%) used for soybean, corn, and hay production
- 2009 Water Quality Improvement Plan for the Des Moines River and 2021 Total Maximum Daily Load (TMDL) for the Des Moines River Basin Watersheds
- Nutrient management through reductions in fertilizer application and conservation tillage



Policy Implementation Using HAWQS – Agricultural Management Practices

Operations management

Read the SWAT2012 IO documentation chapter on MGT inputs for more information about management variable

Selected HRU: 071000091101 / CORN / 2962202 / 0-2

Select another HRU

Scheduling

Operations may be scheduled by date or heat units. Heat unit scheduling is explained in Chapter 5:1 of the theore

Schedule by heat units | Schedule by date

Operations

Edit	Year	Month	Day	Operation	Crop	Remove
	1	4	30	6 - Tillage operation		×
	1	4	30	6 - Tillage operation		×
	1	5	1	6 - Tillage operation		×
	1	5	1	8 - Kill/end of growing season		×
	1	5	2	1 - Planting/beginning of growing season	CORN - Corn	×
	1	5	3	3 - Fertilizer application		×
	1	5	3	3 - Fertilizer application		×
	1	9	15	7 - Harvest only operation		×
	1	11	1	6 - Tillage operation		×

Add an operation | Sort operations | View default operations | Import/export operations

Apply your changes

Apply to all HRUs

Edit operation

Year of rotation: 1

Month: April

Day: 30

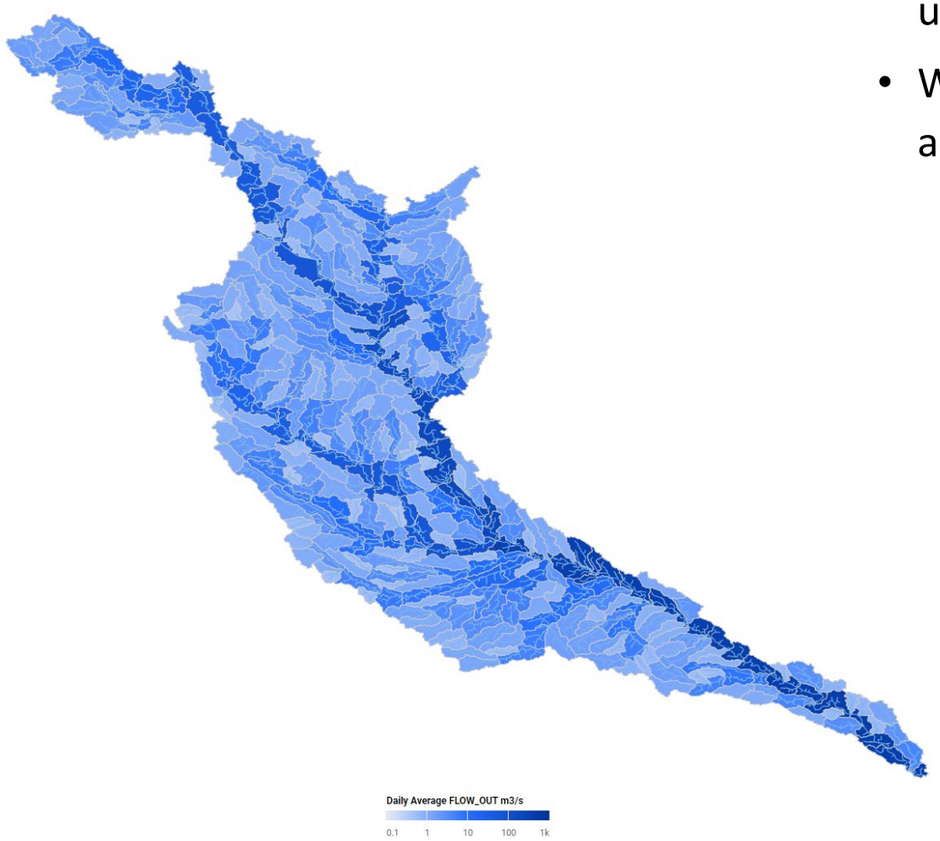
Operation: 6 - Tillage operation

Tillage implement code: Generic Conservation Tillage

CNOP: SCS runoff curve number for moisture condition II: 0

Ok

Policy Implementation Using HAWQS – Agricultural Management Practices



- Daily SWAT modeling results for baseline and conservation tillage scenario were used to calculate Water Quality Index (WQI) values
- WQI value implicitly includes a variety of benefit relevant effects (*e.g.,* aesthetics, ecological condition, etc…)

$$WQI = \prod_{i=1}^{6} Q_i^{W_i}$$

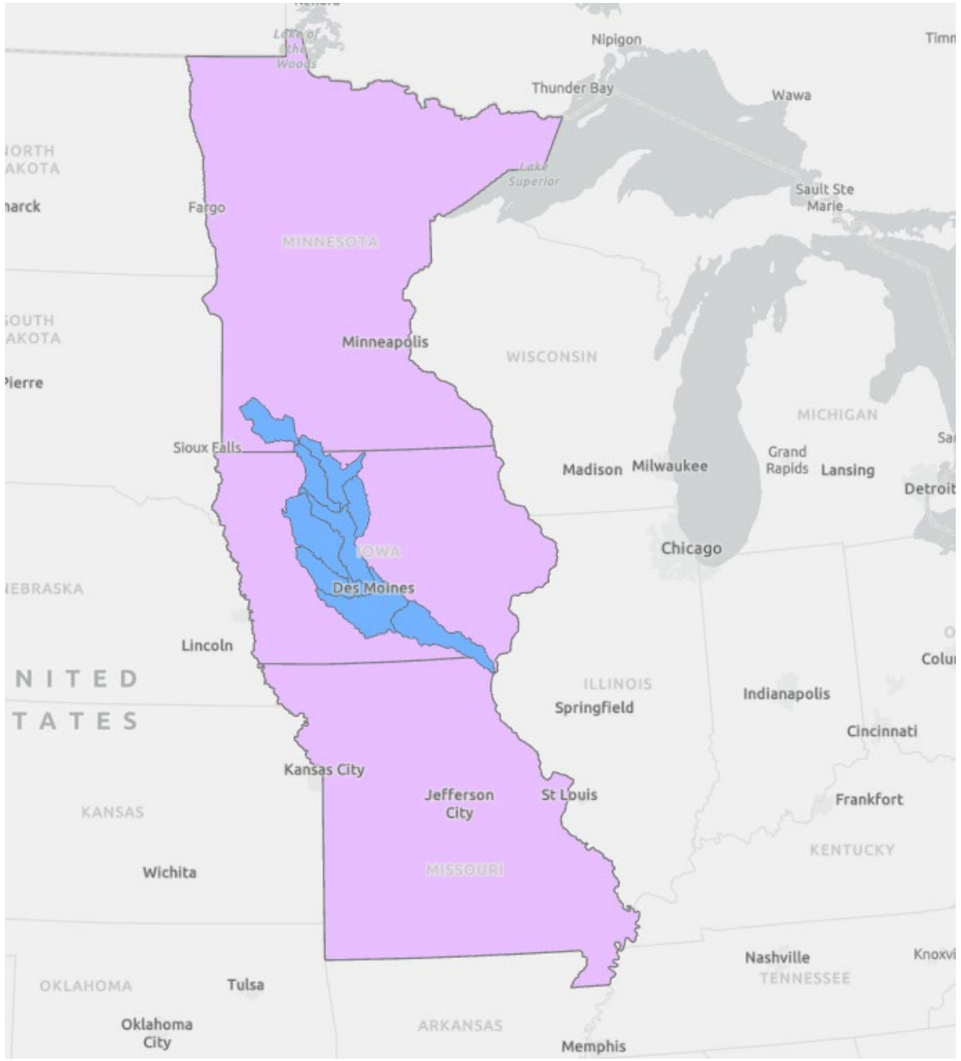
Where:

WQI =		Water quality index
Q_i	=	Subindex for parameter *i*
W_i	=	Weight assigned to parameter *i*

Scenario[1]	Flow-weighted Average WQI
Baseline	41.1
Conservation Tillage	44.0
WQI Change	2.9

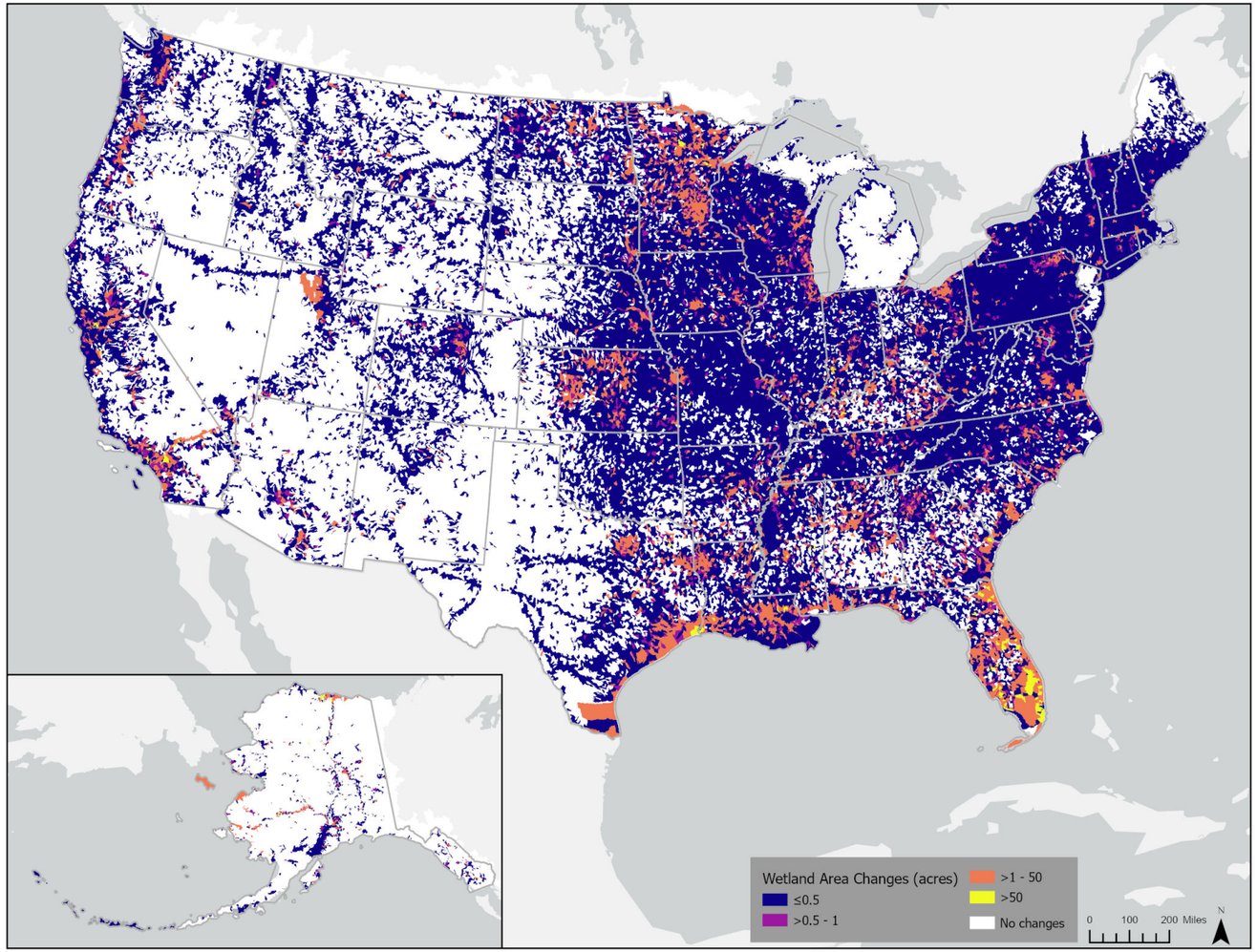
[1] Results for these scenarios were derived from a pre-release version of HAWQS 2.0.

Policy Implementation Using HAWQS – Agricultural Management Practices

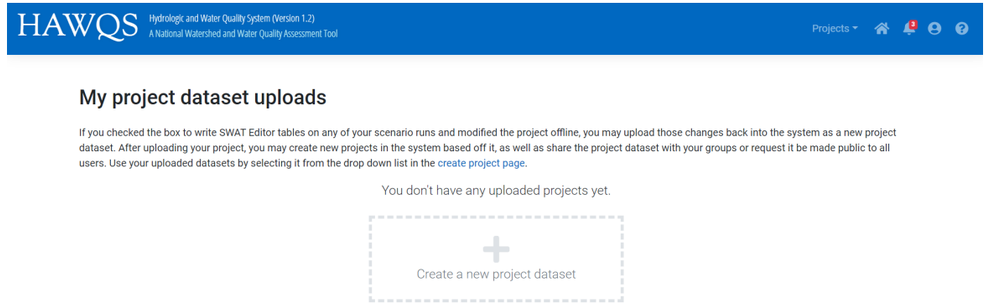


- Economic value of clean water and associated healthy ecosystems estimated based on a benefit transfer approach
- Meta-regression model used to assess annual household willingness-to-pay (WTP) for water quality improvements (changes in WQI value).
- The estimated per household WTP is aggregated over all households within the specified market area to estimate a total population-level value.

Policy Implementation Using HAWQS – Wetland Area Changes



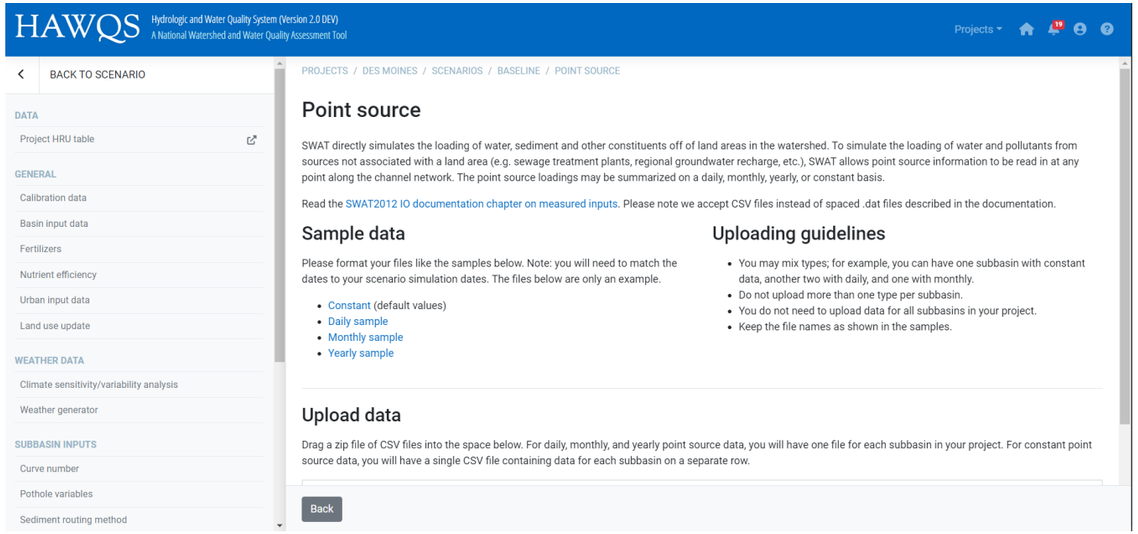
- Evaluate the effects of wetland area changes due to proposed revisions to the types of waters protected under the Clean Water Act in select case study locations
- Can upload updated model databases to HAWQS to use external computing and storage resources and facilitate collaboration

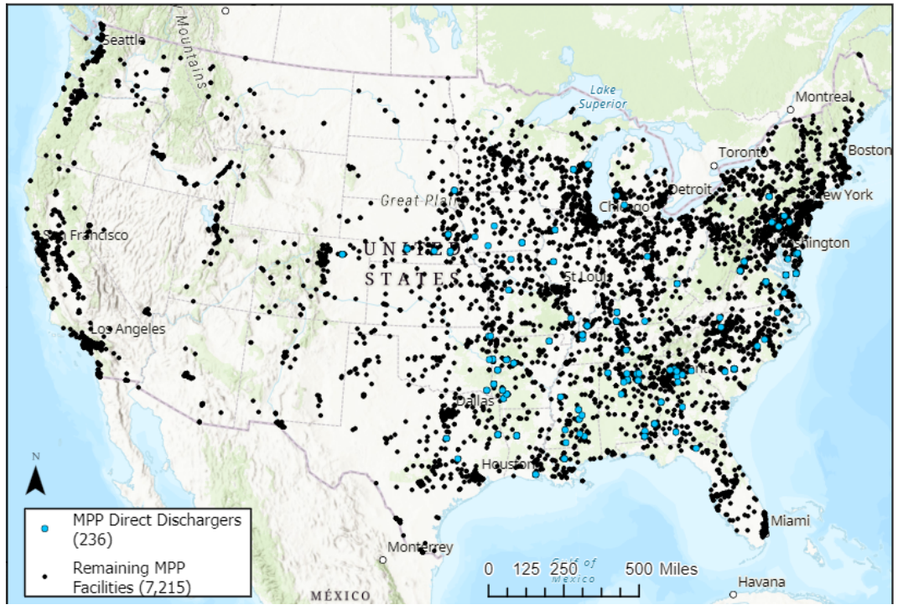


Policy Implementation Using HAWQS – Point Source Changes

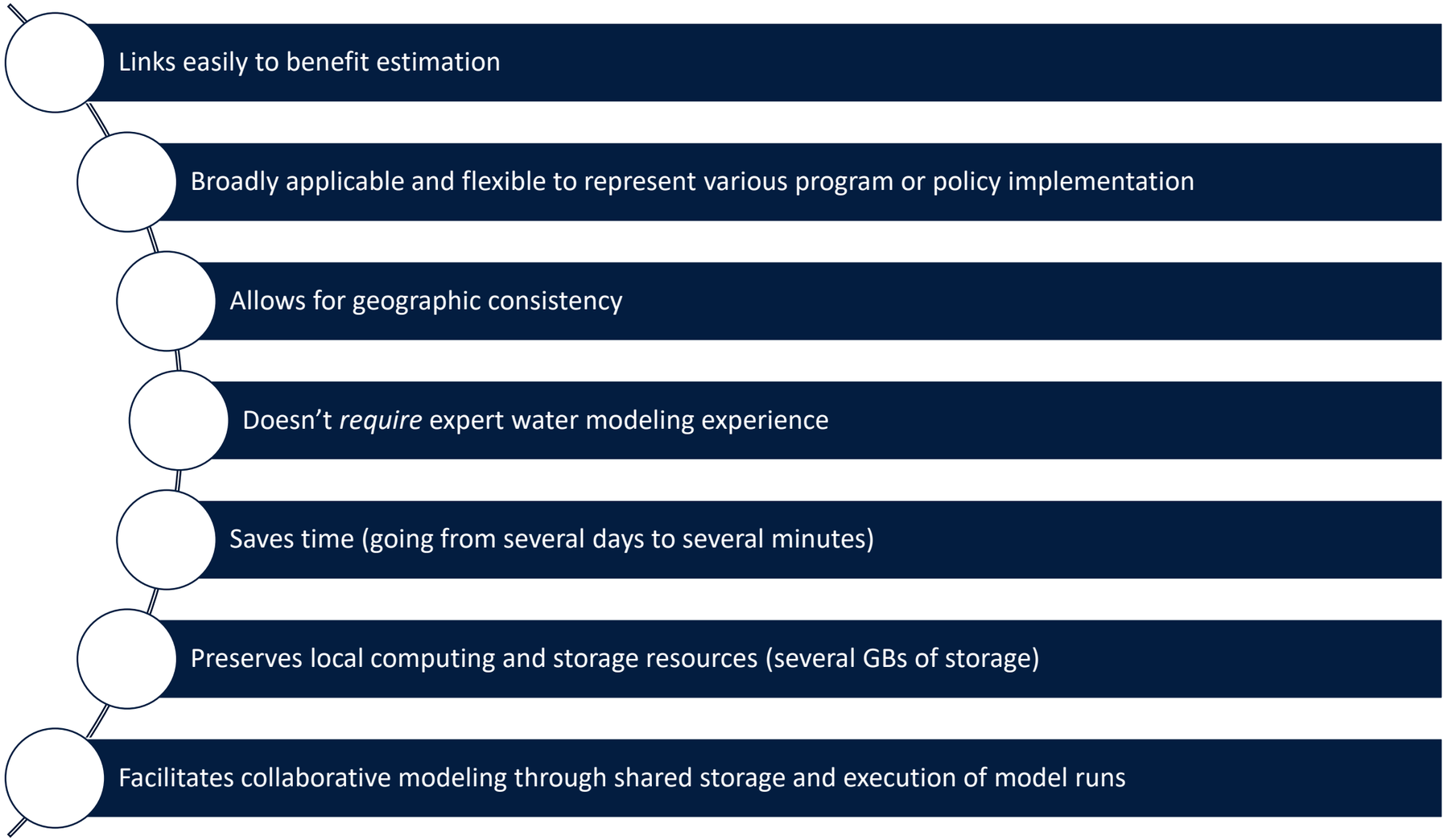
- Relevant for Effluent Guidelines, national regulatory standards for wastewater discharged to surface waters and municipal sewage treatment plants
  - Evaluate the effects of changes to point source discharges from various industries (Meat and Poultry Product facilities)

- Potential to support analyses of other benefits of water quality improvements
  - Reduced water treatment costs or dredging costs due to sediment reductions
  - Health benefits from reduced nitrate concentrations





Why HAWQS?


Links easily to benefit estimation
Broadly applicable and flexible to represent various program or policy implementation
Allows for geographic consistency
Doesn’t *require* expert water modeling experience
Saves time (going from several days to several minutes)
Preserves local computing and storage resources (several GBs of storage)
Facilitates collaborative modeling through shared storage and execution of model runs