

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

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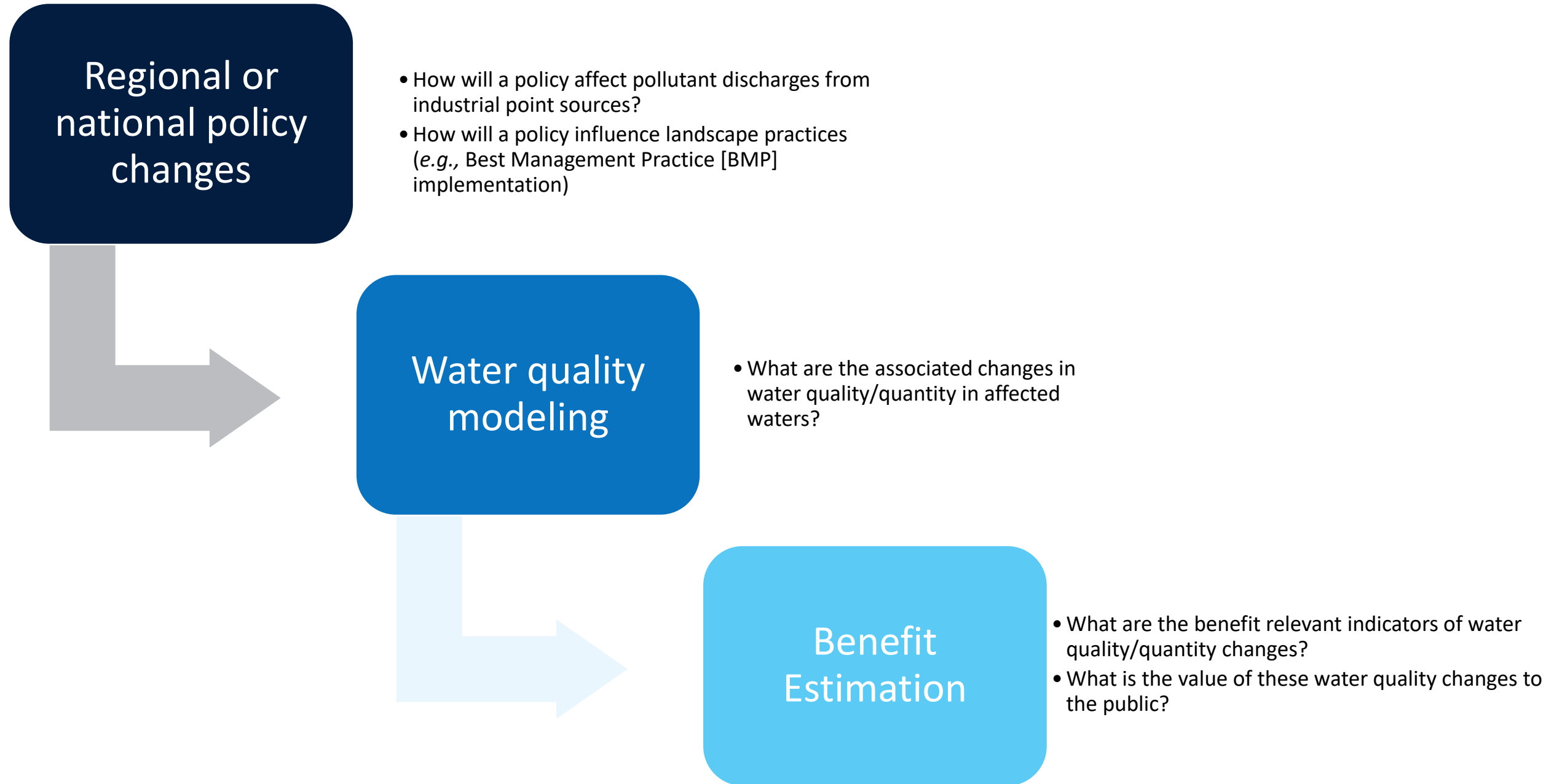
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Agenda

- 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

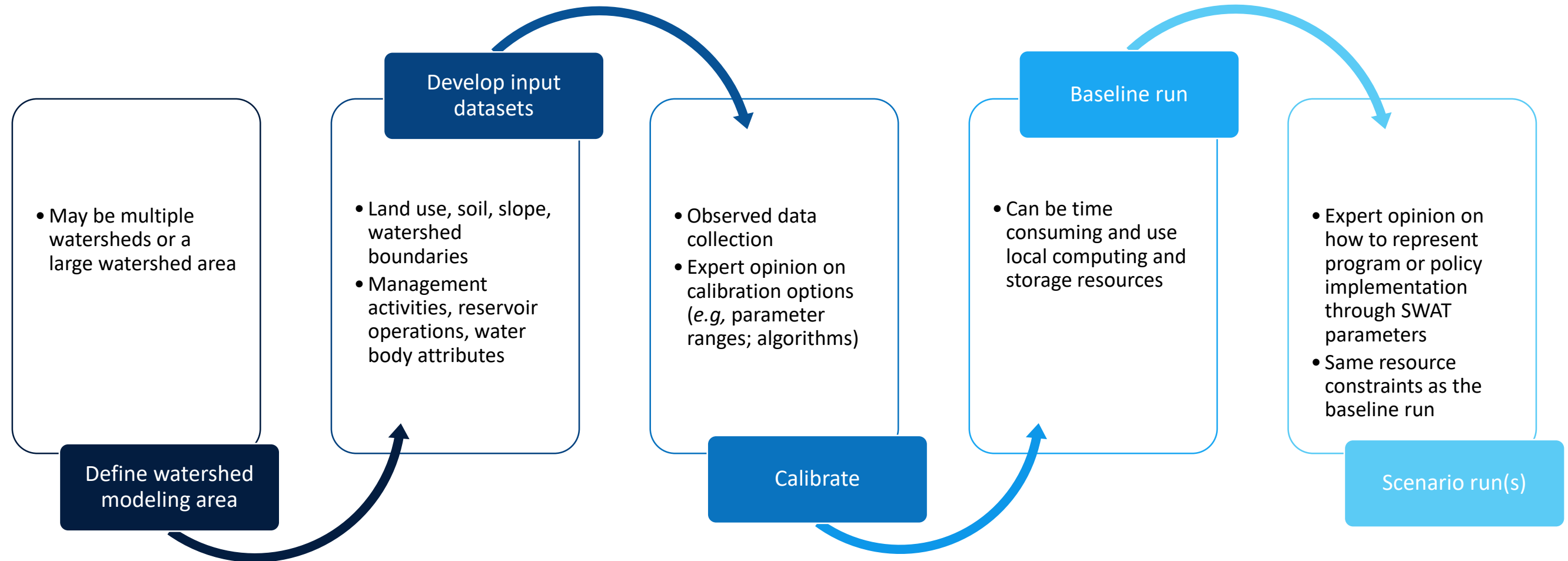


Soil and Water Assessment Tool (SWAT)

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

The screenshot displays the HAWQS web application interface. At the top, a blue navigation bar contains the HAWQS logo, the text "Hydrologic and Water Quality System (Version 1.2) A National Watershed and Water Quality Assessment Tool", and navigation icons for "Projects", home, notifications, and help. Below the navigation bar, a menu bar includes "Recent Activity", "Projects", "Group Projects", and a "New Project" button. The main content area features three project cards, each with a map of a watershed and associated data:

| HUC10 ID | Subbasins | HRUs | Area (km ²) |
|------------|-----------|------|-------------------------|
| 0201000707 | 6 | 455 | 1,906.42 |
| 0201000205 | 5 | 531 | 2,442.78 |
| 0201000307 | 7 | 575 | 2,753.75 |

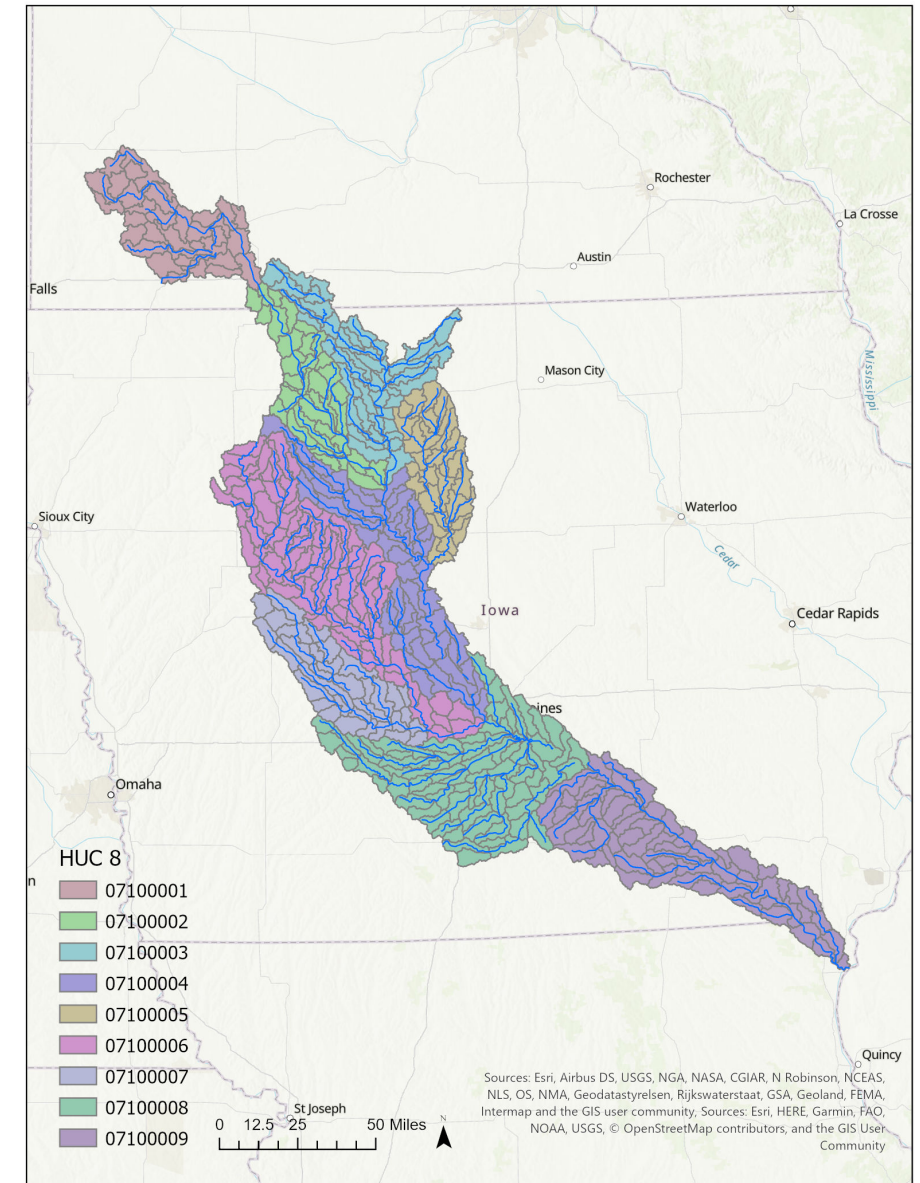
Each card includes a "GO TO PROJECT" button at the bottom.

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

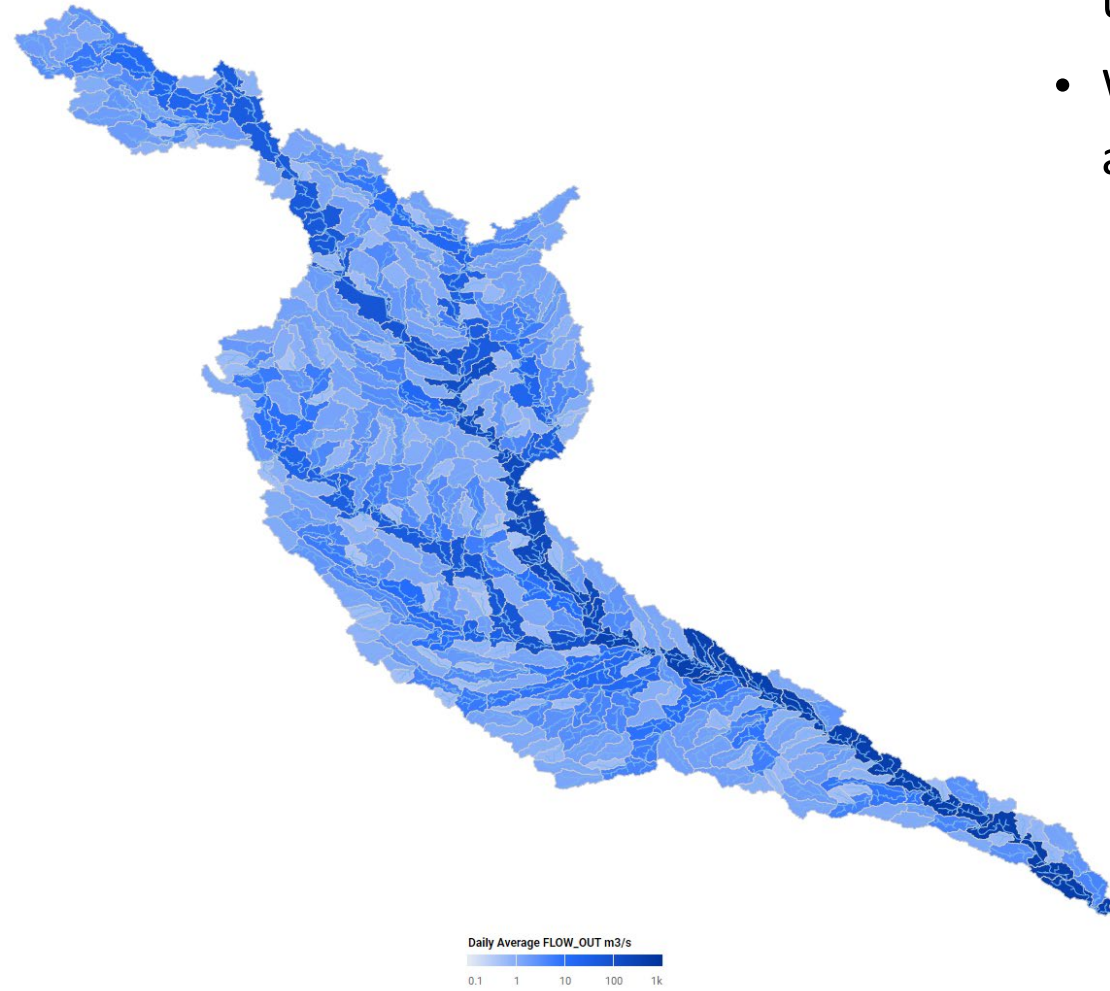
CNOP: SCS runoff curve number for moisture condition II

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

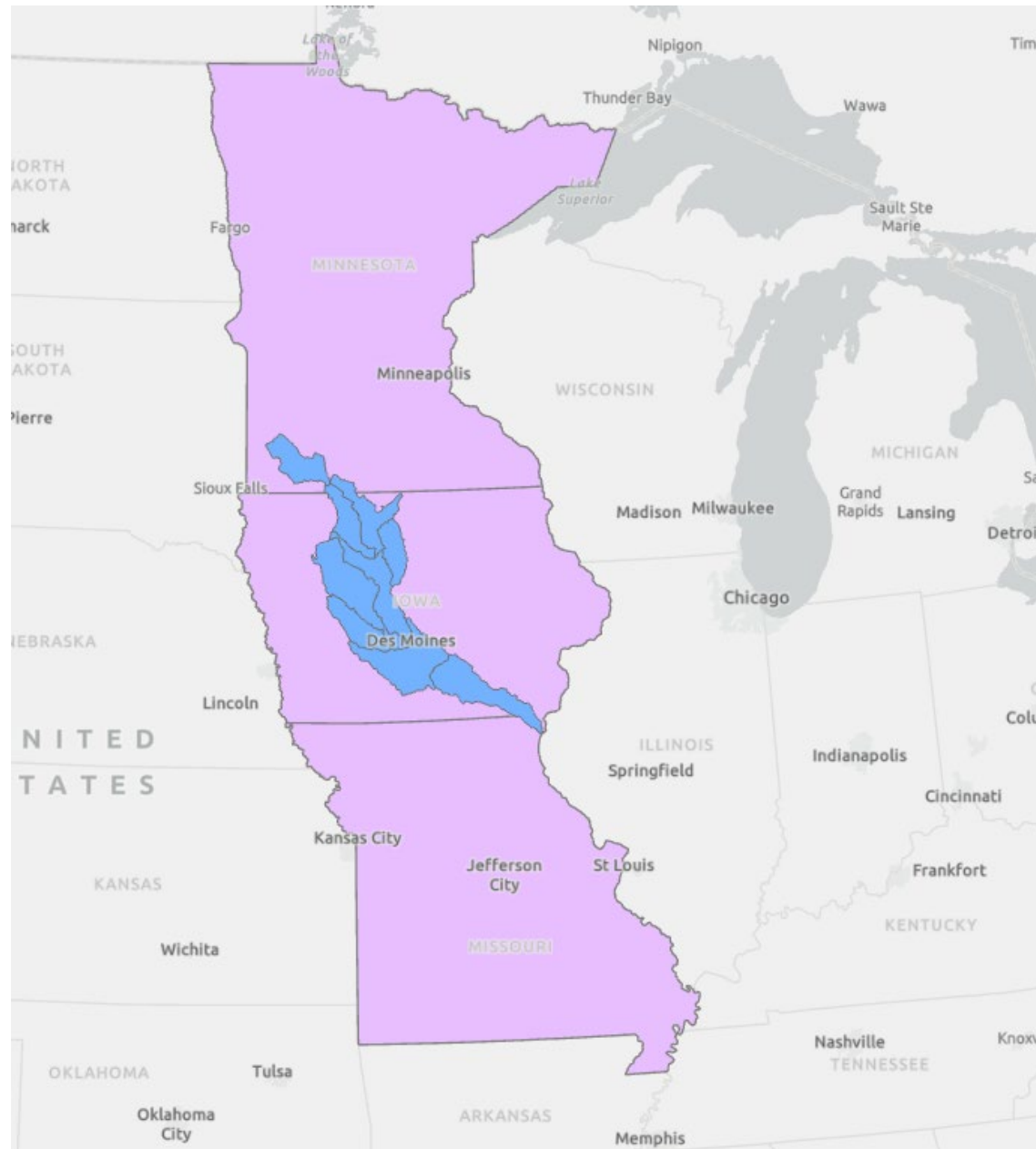
Q_i = Subindex for parameter i

W_i = Weight assigned to parameter i

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

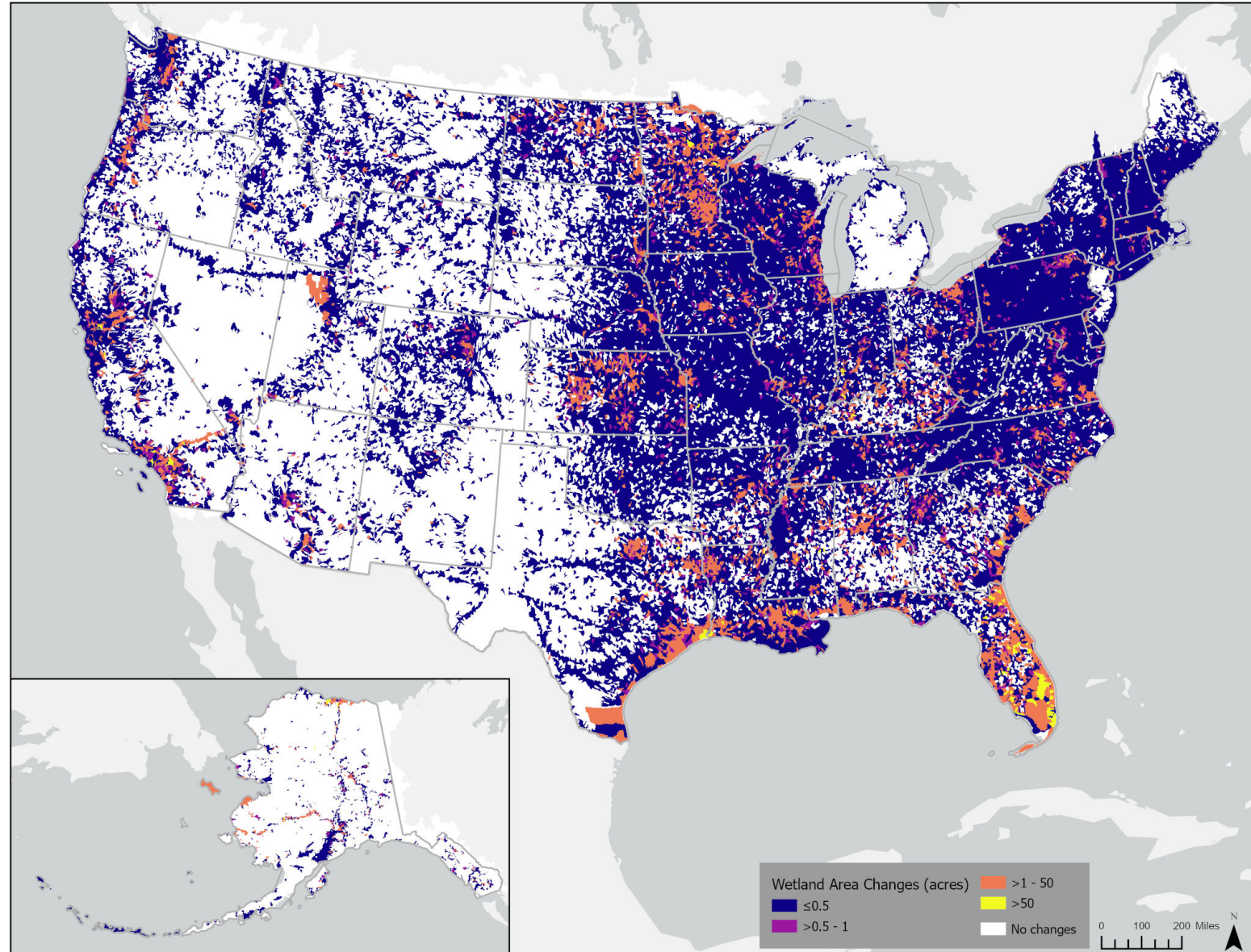
¹ Results for these scenarios were derived from a pre-release version of HAWQS 2.0.

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



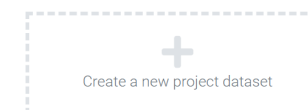
- Evaluate the effects of wetland area changes due to proposed revisions to the types of waters protected under the Clean Water Act in select case study locations
- Can upload updated model databases to HAWQS to use external computing and storage resources and facilitate collaboration

HAWQS Hydrologic and Water Quality System (Version 1.2)
A National Watershed and Water Quality Assessment Tool

My project dataset uploads

If you checked the box to write SWAT Editor tables on any of your scenario runs and modified the project offline, you may upload those changes back into the system as a new project dataset. After uploading your project, you may create new projects in the system based off it, as well as share the project dataset with your groups or request it be made public to all users. Use your uploaded datasets by selecting it from the drop down list in the [create project page](#).

You don't have any uploaded projects yet.



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

HAWQS Hydrologic and Water Quality System (Version 2.0 DEV)
A National Watershed and Water Quality Assessment Tool

PROJECTS / DES MOINES / SCENARIOS / BASELINE / POINT SOURCE

Point source

SWAT directly simulates the loading of water, sediment and other constituents off of land areas in the watershed. To simulate the loading of water and pollutants from sources not associated with a land area (e.g. sewage treatment plants, regional groundwater recharge, etc.), SWAT allows point source information to be read in at any point along the channel network. The point source loadings may be summarized on a daily, monthly, yearly, or constant basis.

Read the [SWAT2012 IO documentation chapter on measured inputs](#). Please note we accept CSV files instead of spaced .dat files described in the documentation.

Sample data

Please format your files like the samples below. Note: you will need to match the dates to your scenario simulation dates. The files below are only an example.

- Constant (default values)
- Daily sample
- Monthly sample
- Yearly sample

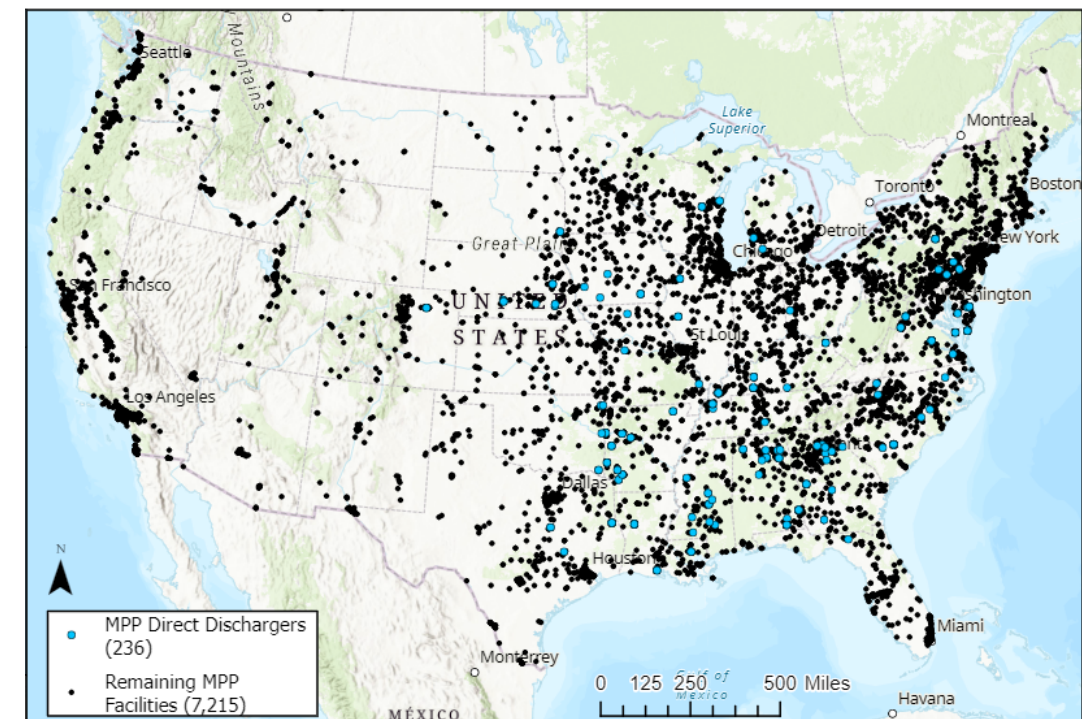
Uploading guidelines

- You may mix types; for example, you can have one subbasin with constant data, another two with daily, and one with monthly.
- Do not upload more than one type per subbasin.
- You do not need to upload data for all subbasins in your project.
- Keep the file names as shown in the samples.

Upload data

Drag a zip file of CSV files into the space below. For daily, monthly, and yearly point source data, you will have one file for each subbasin in your project. For constant point source data, you will have a single CSV file containing data for each subbasin on a separate row.

Back



Why HAWQS?

