HAWQS

HAWQS+

HAWQS and HAWQS+: Recent Updates and Future Direction

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What is HAWQS?

HAWQS

- Web-based interactive water quantity and quality modeling systems using **SWAT** as the core modeling engine
- Supplied with **Federally Approved** Input Dataset
- Allows analysis at various watershed scales
- Supports simple and complex economic, policy, and impact analyses on:
  - Flow, Sediments, Nutrients, pathogens

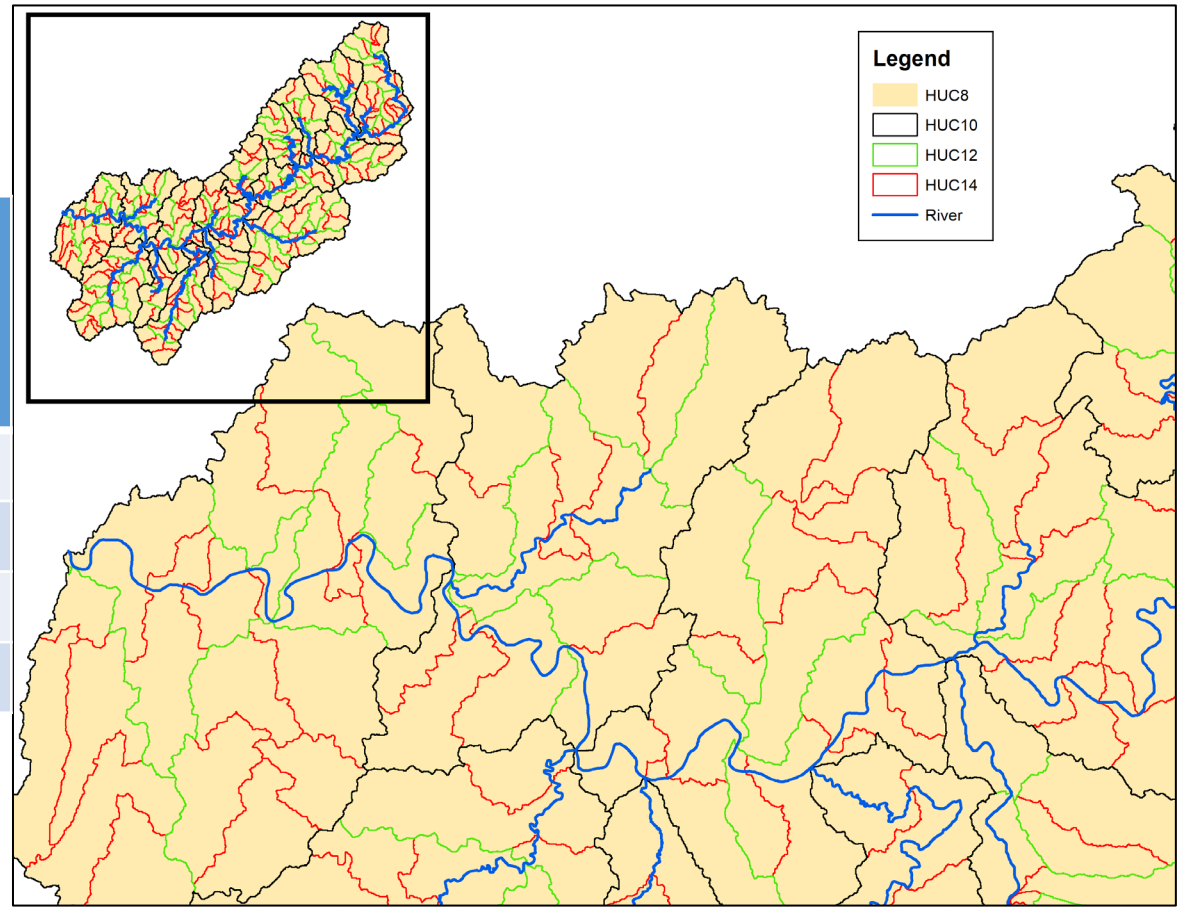
Benefits of HAWQS

HAWQS

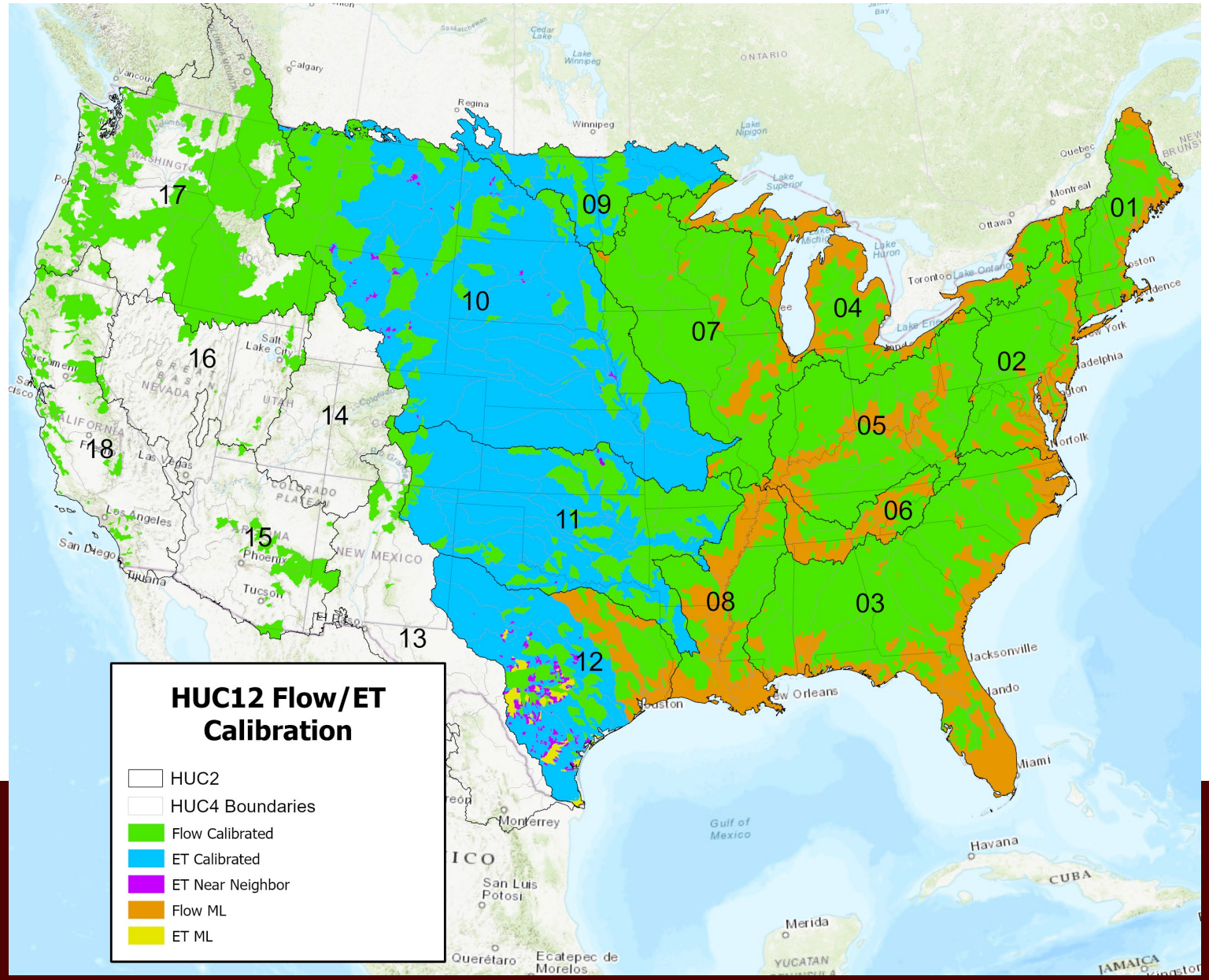
- Datasets, tools, and output visualizations are public domain
- Cloud based interface (accessed by phone/ tablet/ laptop/ desktop)
- Complete input datasets compatible across SWAT versions
- Calibrated models
- Model sharing, uploading, and group access to projects
- Output coupled with other models (CE-QUAL-W2, WMOST, AQUATOX, and others)
- **More efficient – reduces SWAT modeling time and effort by 90%**

Extent of HAWQS

Spatial Scale	Total HUCs in the CONUS	Average HRU Area		Average Number of HRUs per HUC	Total HRUs in the CONUS
		km^2	mi^2		
HUC8	2,111	3,690	1,425	2,920	6,167,005
HUC10	15,300	509	200	680	10,406,035
HUC12	79,838	98	38	229	18,253,338
HUC14	351,022	22	8	89	31,242,296



HUC12 Flow/ET Calibration for HAWQS



Regions 01 – 08; 11
Available on HAWQS

Region 09 – 10; 12
Pending upload to HAWQS

Region 13 – 18
Pending completion of ET Calibration

Bawa et. al., 2024
Calibration using R-programming and parallel processing at the HUC12 subbasin scale in the Mid-Atlantic region: Development of national SWAT hydrologic calibration

Bawa et. al., 2025
Enhancing hydrological modeling of ungauged watersheds through machine learning and physical similarity-based regionalization of calibration parameters

ET Calibration Manuscript in preparation

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HUC12 Water Quality Calibration for HAWQS

Region	Sediment	TN	TP	Notes
01	45 **(1)**	79 **(37)**	88 **(17)**	Gages available **(Gages Calibrated)**
02	162 **(13)**	256 **(2)**	273	Gages available **(Gages Calibrated)**
03	131	214	335	Gages available
04	133	102	174	Gages available
05	107	95	130	Gages available
06	20	16	19	Gages available
07	154	117	219	Gages available
08	52	33	34	Gages available
09	38	25	53	Gages available
10	186	149	204	Gages available
11	114 **(68)**	107 **(60)**	131 **(52)**	Gages available **(Gages Calibrated)**
12	32	32	37	Gages available
13	26	14	19	Gages available
14	86	81	88	Gages available
15	40	28	31	Gages available
16	28	21	29	Gages available
17	187	87	129	Gages available
18	73	23	32	Gages available

XGBest used on USGS Observations
Automation of Calibration

1. Sediment
2. TN
3. TP

- 20 samples between 1996 – 2020
- Nearby observed discharge location
- Within the US

Superior to LOADEST and WRTDS

Jain et. al., 2025
Enhancing prediction and inference of daily in-stream nutrient and sediment concentrations using an extreme gradient boosting based water quality estimation tool - XGBest

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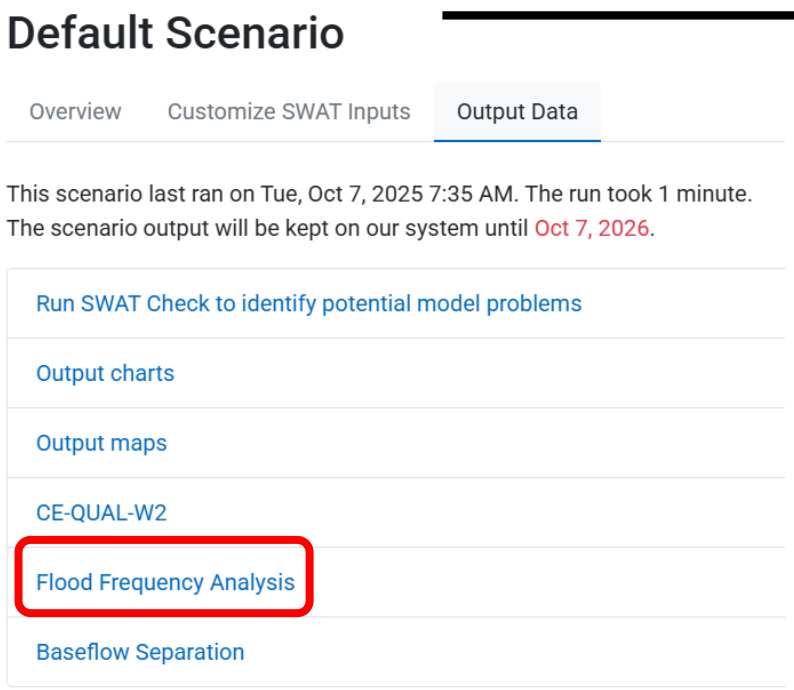
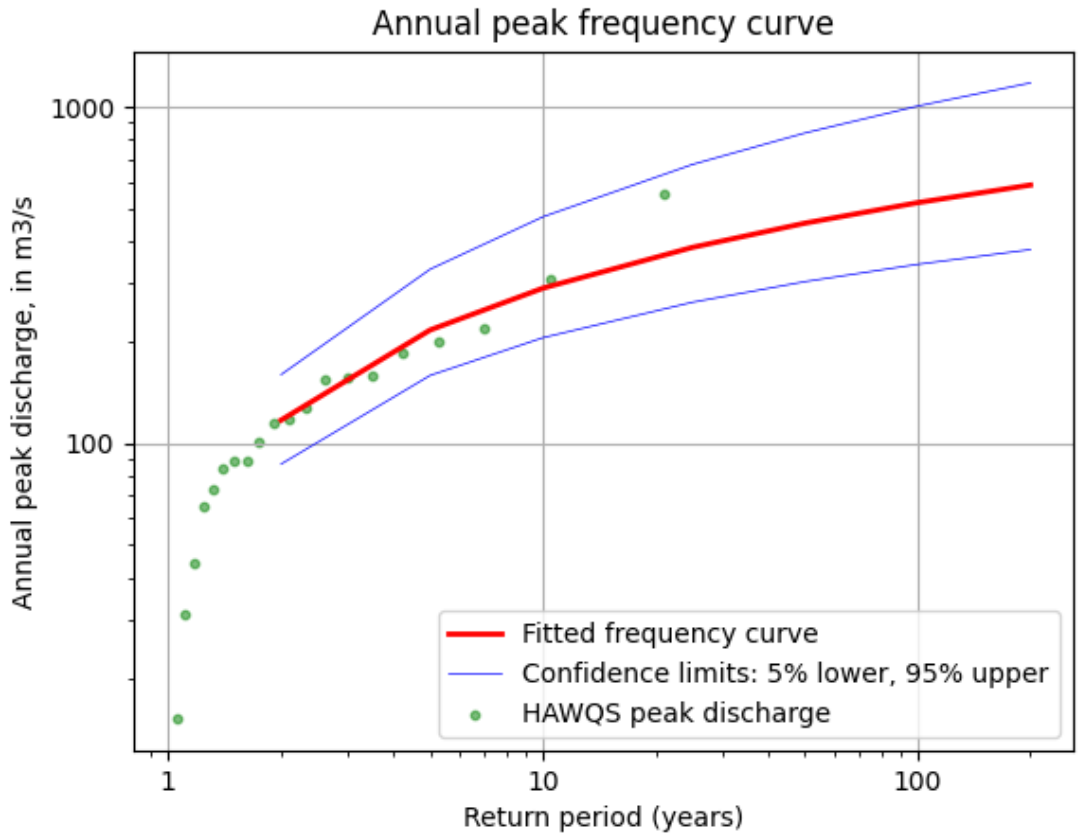
Recent Output Updates to HAWQS



Flood Frequency Analysis



- **Calculates return periods using annual maximum flow at 2-, 10-, 25-, 50-, 100-, and 200-year recurrence intervals**
- **Based on flood frequency studies under the USGS Bulletin 17c guidelines**
- **To avoid substantial bias, it is suggested to have at least 10 years of simulation data**
- **Outputs consist of a data file and a figure for each subbasin selected**

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Recent Output Updates on HAWQS

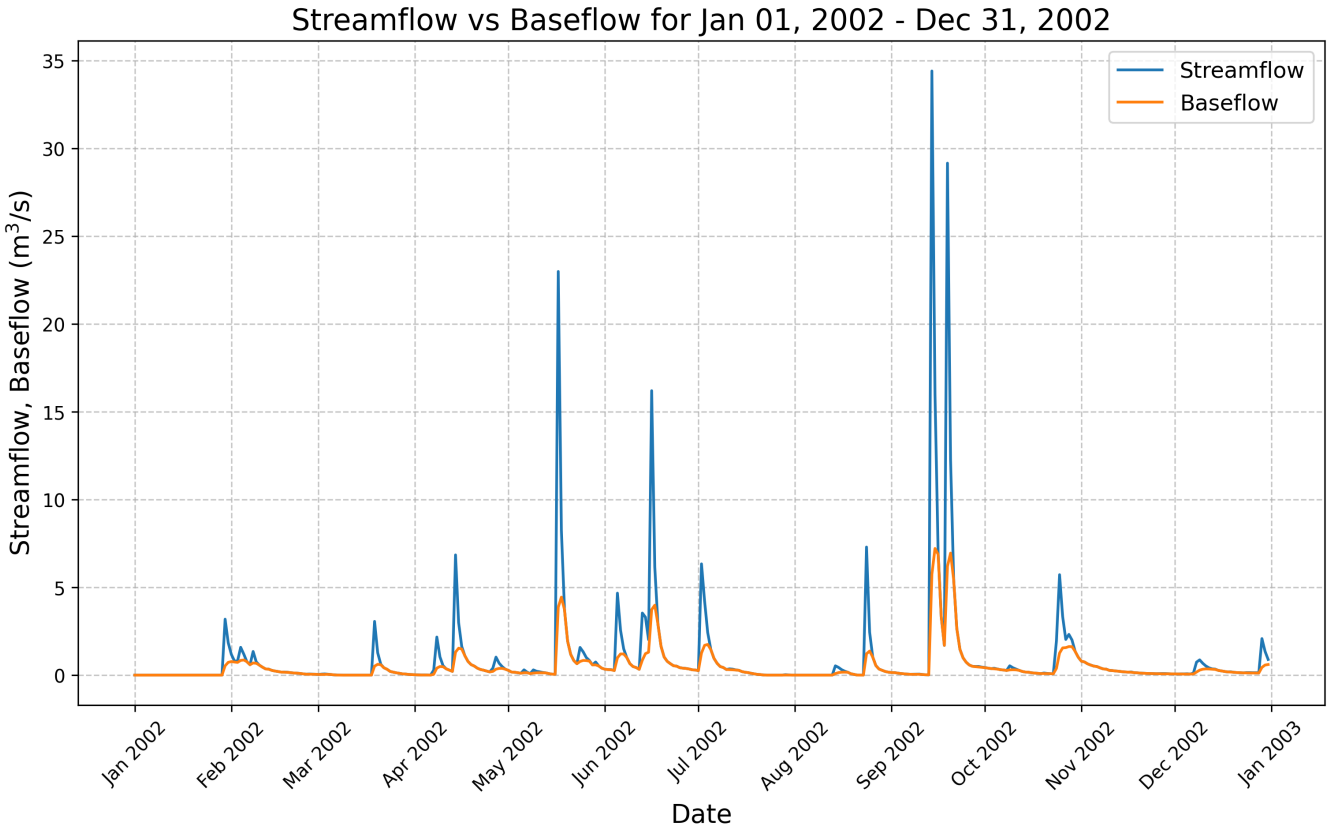
Default Scenario

Overview | Customize SWAT Inputs | Output Data

This scenario last ran on Tue, Oct 7, 2025 7:35 AM. The run took 1 minute.
The scenario output will be kept on our system until Oct 7, 2026.

- Run SWAT Check to identify potential model problems
- Output charts
- Output maps
- CE-QUAL-W2
- Flood Frequency Analysis
- Baseflow Separation

Baseflow Separation



- **Estimates Daily baseflow values using Echkardt two-parameter recursive digital filter**
- **Suggested values for BFI max based on watershed characteristics:**
  - **0.8 for perennial streams with porous aquifers**
  - **0.5 for ephemeral streams with porous aquifers**
  - **0.25 for perennial streams with hard rock aquifers**
- **Suggested value for the Filter Parameter is 0.98**

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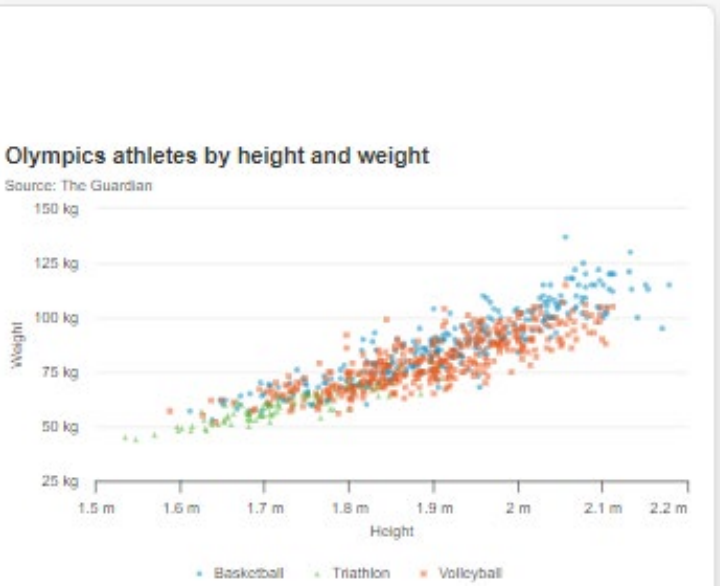
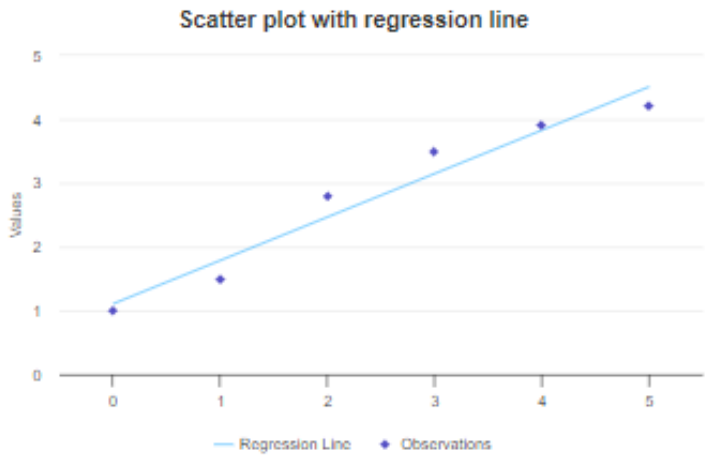
Future Output Updates on HAWQS



Scatter plot

- Generate scatter plot of 2 or more variables (ability to select x and y axis variables) in linear/log/ or semi-log scales
- Add regression line



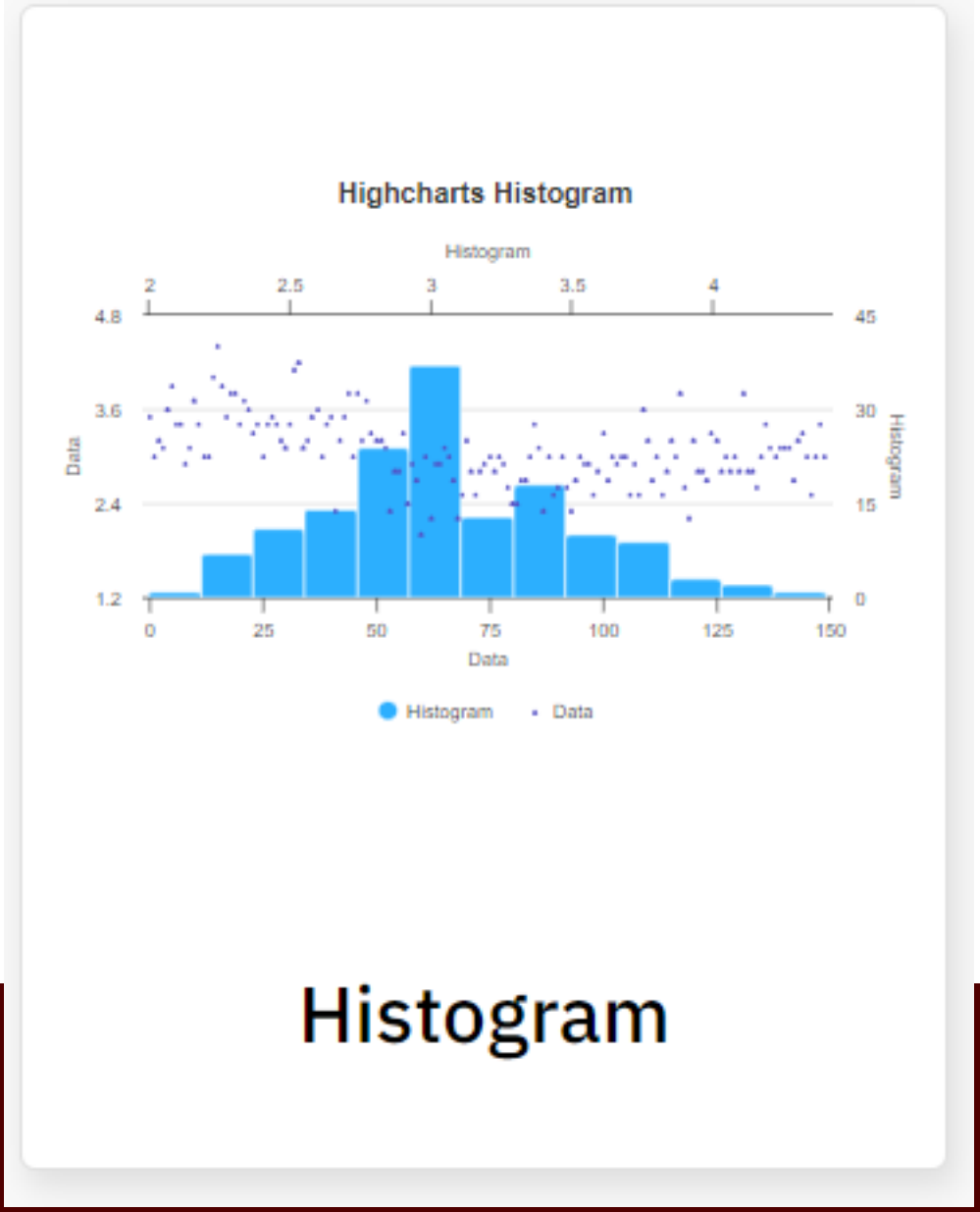
Scatter with regression line

Future Output Updates on HAWQS

HAWQS

- Display tables to accompany LDC/FDC plots
- Plotting monthly (possibly seasonal) plots in addition to entire time period plots.
- Ability to have side by side plots/boxplots to compare selected reaches/subbasins or months/seasons in same display

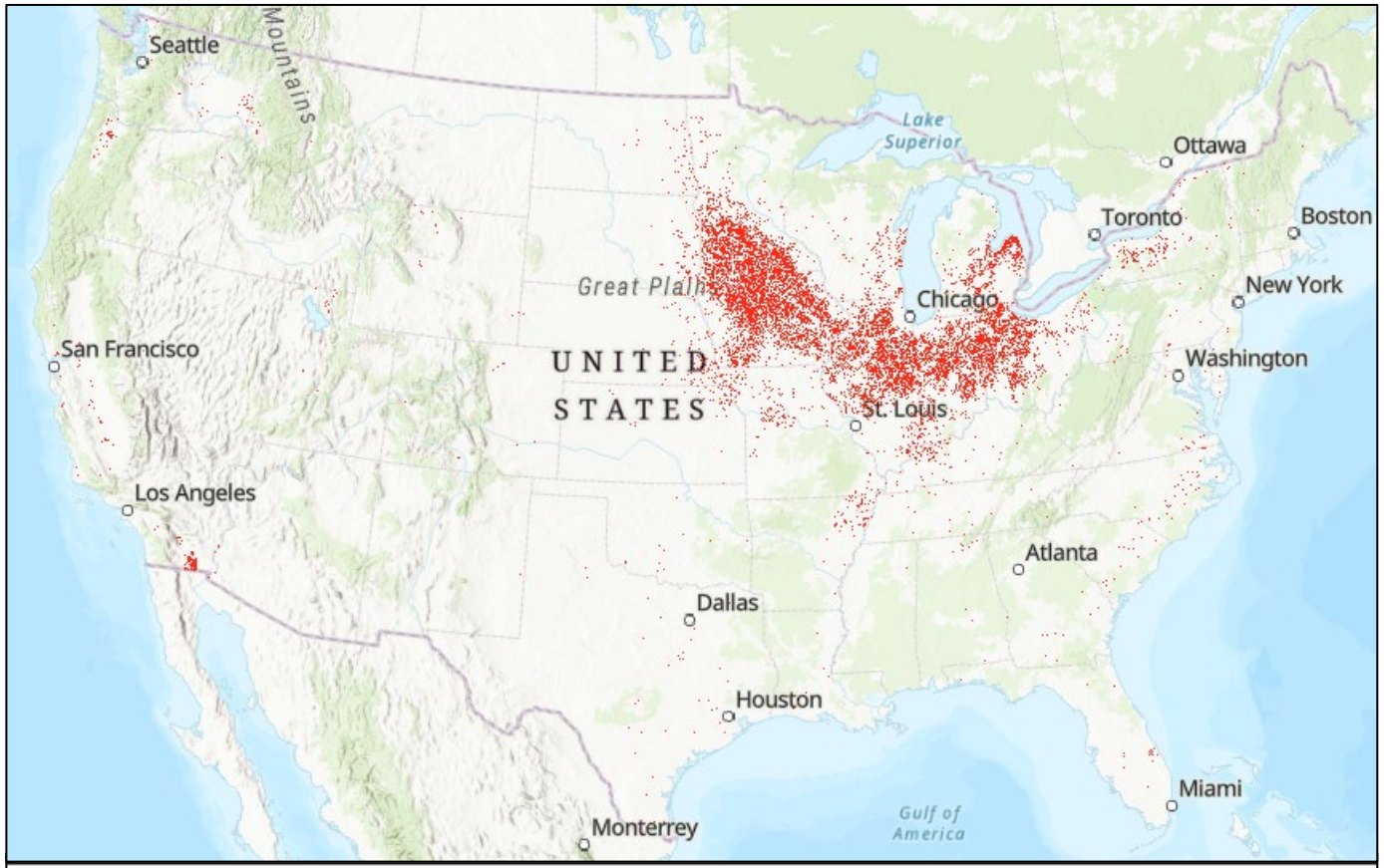
Future Output Updates on HAWQS



Histogram

- Ability for user to upload observed data in formatted file to optionally display with output data in charts

Future Updates to Datasets on HAWQS



HRUs with Tile Applied - 163,118.5 km²

AgTile-US Tile Drains (2017)

>163,000 km² of tile drains added

HRUs selected:

- Crop land
- Slopes <= 8%
- Soils in hydrologic group C or D
- >50% of hru had irrigation

Valayamkunnath, P., Barlage, M., Chen, F., Gochis, D.J., and Franz, K.J., 2020, Mapping of 30-meter resolution tile-drained croplands using a geospatial modeling approach: Scientific Data, v. 7, no. 1, https://doi.org/10.1038/s41597-020-00596-x

Valayamkunnath, Prasanth; Barlage, Michael; Chen, Fei; Gochis, David; Franz, Kristie (2020). AgTile-US. figshare. Dataset. https://doi.org/10.6084/m9.figshare.11825742.v1

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Future Updates to Datasets on HAWQS

Input Dataset	Source	Specifications
Weather/Climate	PRISM	1981 – **2024** (gridded)
	NEXRAD	2005 – **2024** (gridded)
	CMIP6	**2020**
Soil	USDA National Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO)	2018
	USDA NRCS State Soil Geographic (STATSGO) Database	2018
Land Use	National Land Cover Database (NLCD)	**2024**
	USDA National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL)	**2021 – 2024**
	USDA NASS Fields	2006 – 2010
	U.S. Fish and Wildlife Service (FWI) National Wetlands Inventory (NWI)	2018
Aerial Deposition	National Atmospheric Deposition Program (NADP)	1980 – **2024** (monthly)
Watershed Boundaries	EPA NHDPlus v2	2019
Stream Networks	EPA NHDPlus v2	2019
Elevation	USGS National Elevation Dataset (NED)	2018 (10-meter DEM)
Point Sources	EPA Hypoxia Task Force (HTF)	**2023**
	EPA Integrated Compliance Information System National Pollutant Discharge Elimination System (ICIS-NPDES)	**2023**
Management Data	USDA NRCS crop management zone data	**2022**
Ponds, Potholes, and Reservoirs	U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID)	2018
	EPA NHDPlus v2	2019
Water Use	USGS Water Use in the United States	**2000-2020**

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Future Direction of HAWQS

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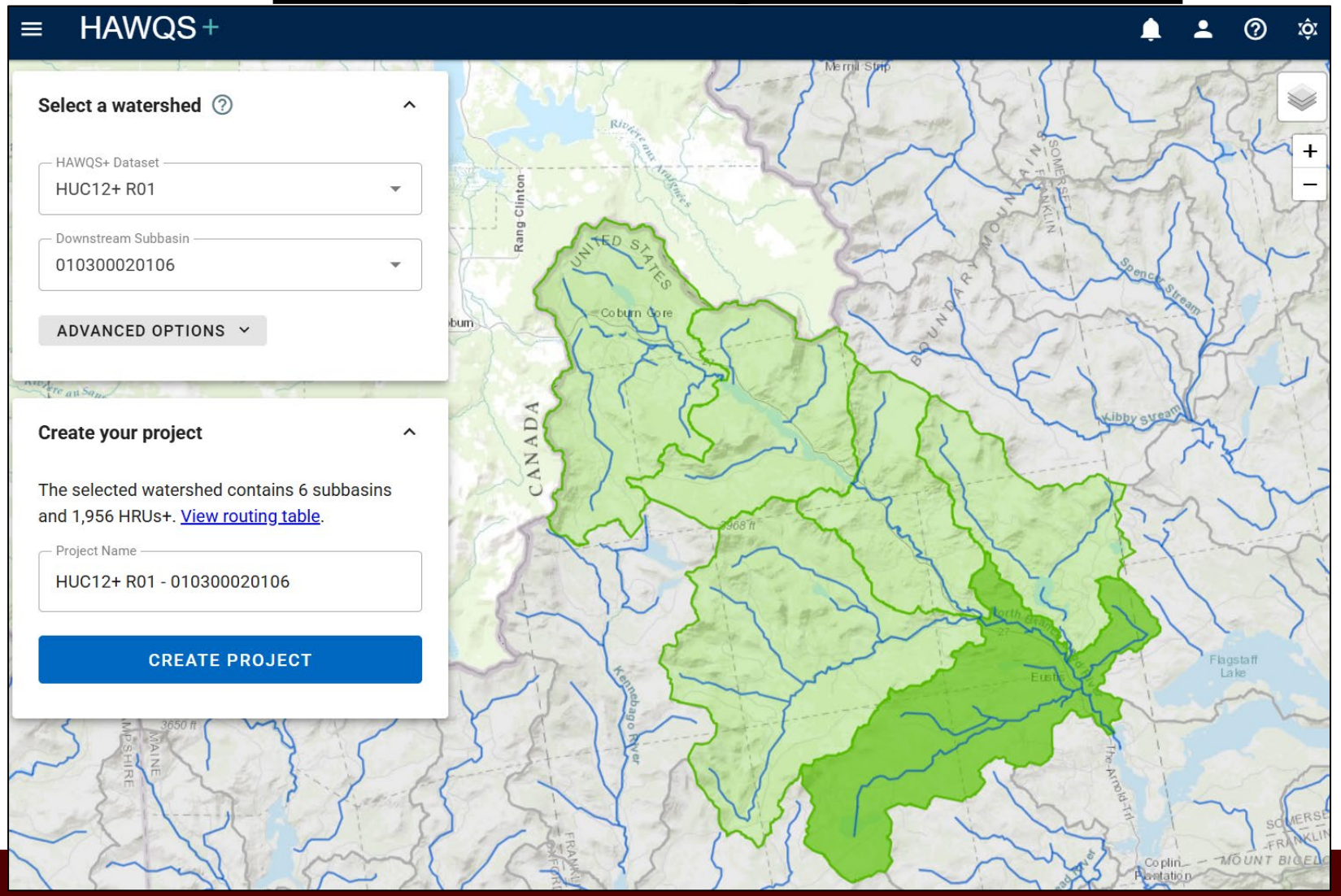
- Use same updated input datasets
- Available at all 4 HUC scales (8/10/12/14)
- Same familiar interface structure
- Includes all the advancements of the SWAT+ model
  - ✓ Uplands and floodplains
  - ✓ Connections between spatial objects (HRU – pond – channel)
  - ✓ Fully distributed storage and routing of water, sediment, nutrient
  - ✓ Flexible management on land units and water transfers

Introducing HAWQS+



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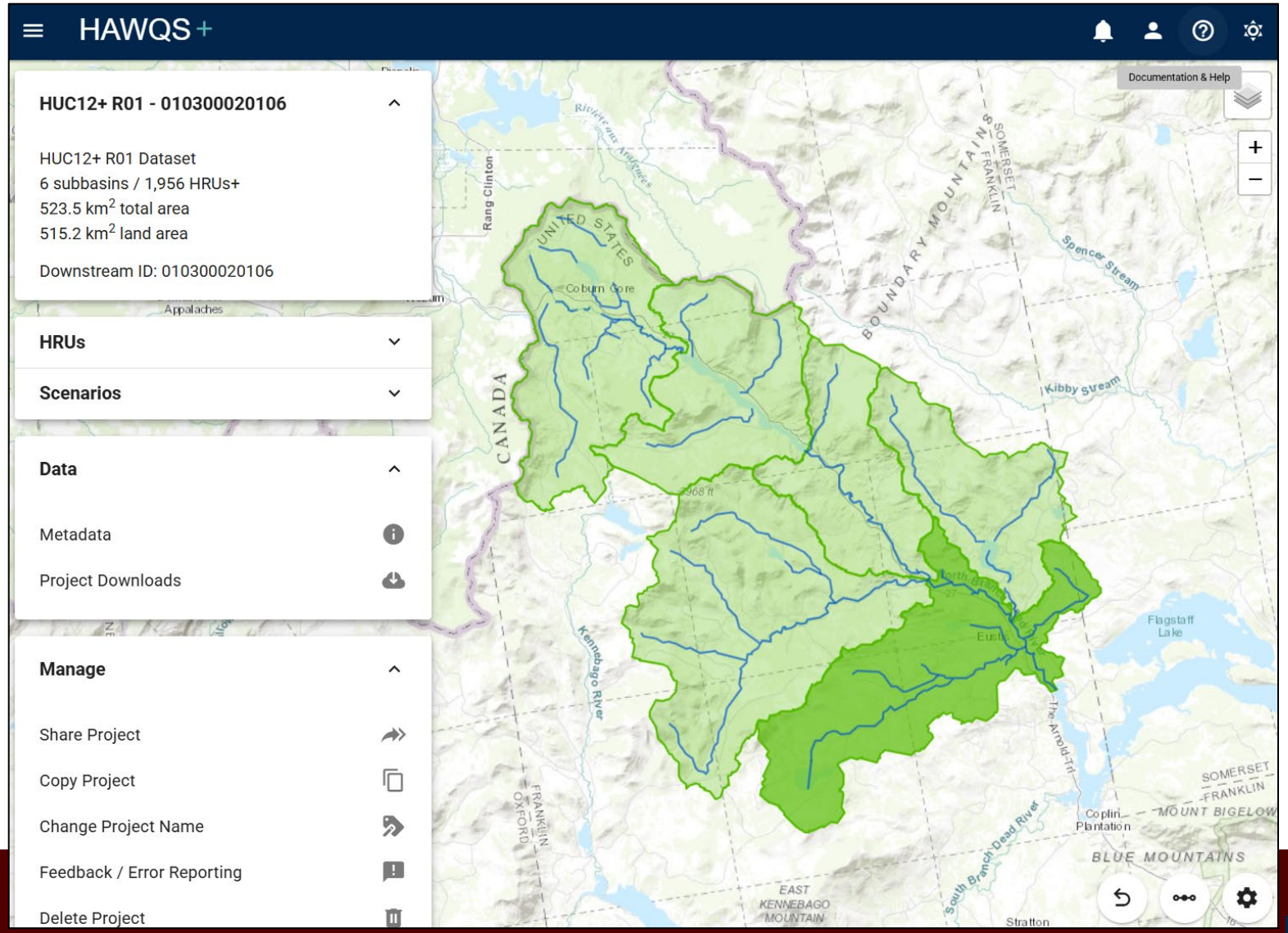

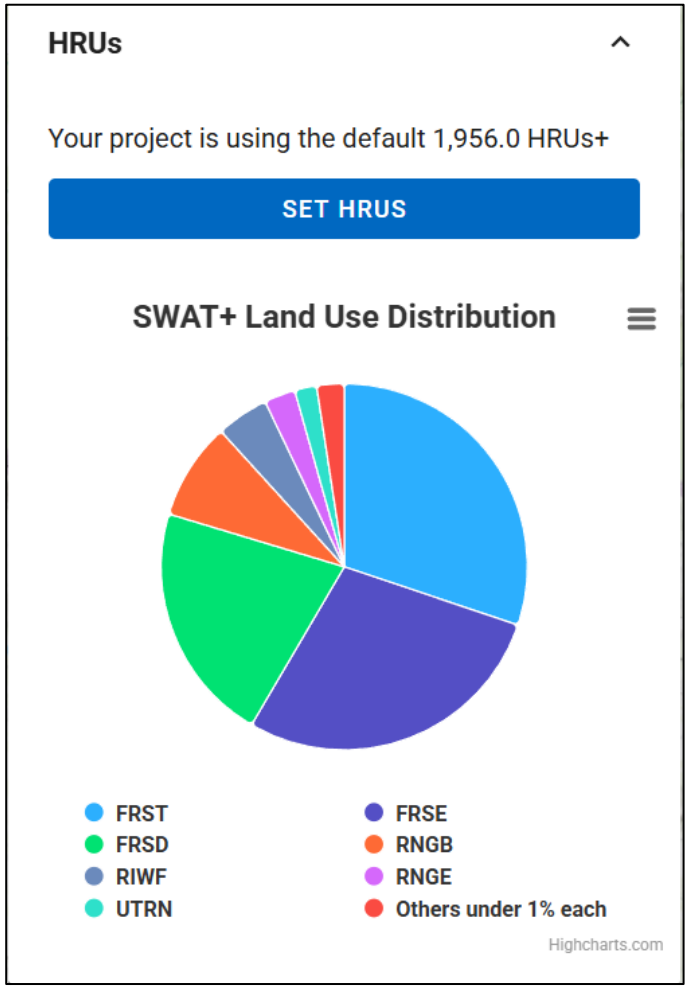

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Introducing HAWQS+

Set Project HRUs

Reduce the number of HRUs in your project for faster simulation runs. Your project has **6** subbasins and **1,956** HRUs+ covering a land area of **515.187 km²**. Read the documentation on HRU aggregation.

Select a method for reducing HRUs

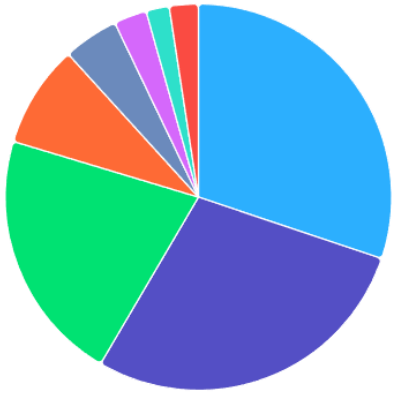
Set by area

Enter a minimum area threshold. HRUs with an area less than this threshold will be removed.

0.5 km2

Please note: one HRU per subbasin will always be retained.

SWAT+ Land Use Distribution



SAVE CHANGES BACK SKIP & CREATE A SCENARIO

In the table below, check the box in the "Exempt" column for any land use that you would like to exempt from elimination. Check the "Retain Area" column next to any land use you do not want to redistribute area to during HRU elimination (e.g., if you have a WATR HRU with area of 10km², if you check the "Retain Area" box, it will remain 10km²; if you do not check the box, the area will increase proportionally based on its fraction of total area in the subbasin).

Any water and wetland land use are exempt and retained by default.

EXEMPT	RETAIN AREA	LAND USE	DESCRIPTION	AREA	% OF TOTAL AREA
☐	☐	FRST	Forest-Mixed	155.40 km²	30.164 %
☐	☐	FRSE	Forest-Evergreen	145.77 km²	28.294 %
☐	☐	FRSD	Forest-Deciduous	109.18 km²	21.193 %
☐	☐	RNGB	Range-Brush	44.25 km²	8.590 %
☑	☑	RIWF	Riparian Wetlands-Forested	23.91 km²	4.641 %
☐	☐	RNGE	Range-Grasses	14.17 km²	2.750 %
☐	☐	UTRN		9.96 km²	1.934 %
☐	☐	WETW		3.50 km²	0.679 %
☑	☑	RIWN	Riparian Wetlands-Non-Forested	3.37 km²	0.653 %
☑	☑	UPWF	Isolated Wetlands-Forested	2.99 km²	0.581 %
☐	☐	URLD		1.56 km²	0.303 %
☐	☐	URMD		0.59 km²	0.115 %
☐	☐	NONE	None/Barren	0.22 km²	0.043 %
☐	☐	URTR		0.18 km²	0.035 %
☑	☑	UPWN	isolated Wetlands-Non-Forested	0.07 km²	0.014 %
☐	☐	URHD		0.06 km²	0.011 %

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LAND USE | SOIL | SLOPE CLASS

(after thresholds applied)

SLOPE CLASS	AREA	% OF TOTAL AREA
8-9999	396.14 km^2	76.892 %
2-8	82.07 km^2	15.931 %
0-2	32.26 km^2	6.262 %

Distribution Comparison Tables

LAND USE | SOIL | SLOPE CLASS

		WITH THRESHOLDS APPLIED		ORIGINAL	
LAND USE	DESCRIPTION	AREA	% OF TOTAL AREA	AREA	% OF TOTAL AREA
FRST	Forest-Mixed	164.30 km^2	31.892 %	155.40 km^2	30.164 %
FRSE	Forest-Evergreen	164.65 km^2	31.959 %	145.77 km^2	28.294 %
FRSD	Forest-Deciduous	109.54 km^2	21.262 %	109.18 km^2	21.193 %
RNGB	Range-Brush	32.94 km^2	6.394 %	44.25 km^2	8.590 %
RIWF	Riparian Wetlands-Forested	23.91 km^2	4.641 %	23.91 km^2	4.641 %
RNGE	Range-Grasses	5.99 km^2	1.163 %	14.17 km^2	2.750 %
UTRN		0.78 km^2	0.152 %	9.96 km^2	1.934 %
WETW		1.92 km^2	0.373 %	3.50 km^2	0.679 %
RIWN	Riparian Wetlands-Non-Forested	3.37 km^2	0.653 %	3.37 km^2	0.653 %
UPWF	Isolated Wetlands-Forested	2.99 km^2	0.581 %	2.99 km^2	0.581 %
URLD		-	-	1.56 km^2	0.303 %
URMD		-	-	0.59 km^2	0.115 %
NONE	None/Barren	-	-	0.22 km^2	0.043 %
URTR		-	-	0.18 km^2	0.035 %
UPWN	isolated Wetlands-Non-Forested	0.07 km^2	0.014 %	0.07 km^2	0.014 %
URHD		-	-	0.06 km^2	0.011 %

413 / 1,956 HRUs remain

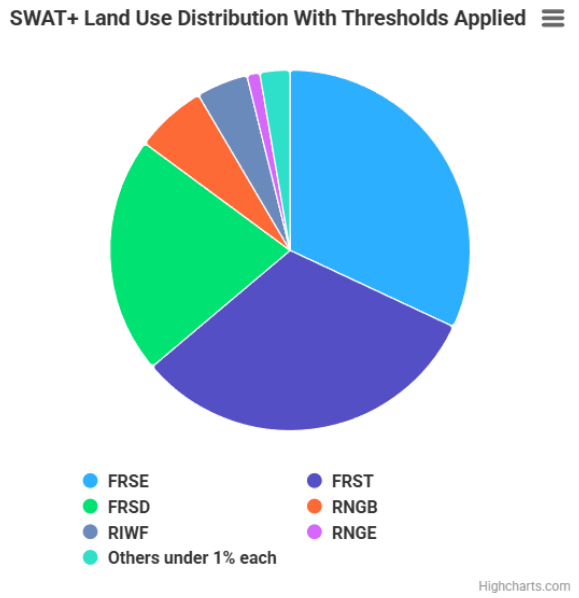
You removed HRUs with an area less than **0.50 km^2**

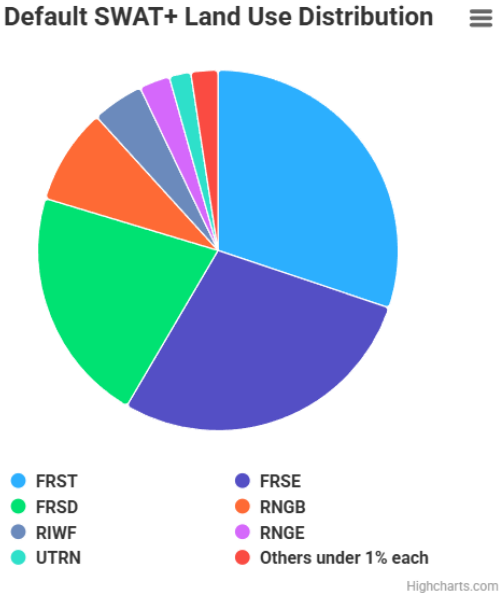
Exempting land uses: AGWF, AGWR, AGWT, RIWF, RIWN, UPWF, UPWN, WATR, WETF, WETL, WETN

191.11 km^2 of your project area was redistributed

Land uses exempt from area redistribution: AGWF, AGWR, AGWT, RIWF, RIWN, UPWF, UPWN, WATR, WETF, WETL, WETN

DOWNLOAD HRUS | DOWNLOAD ORIGINAL HRUS





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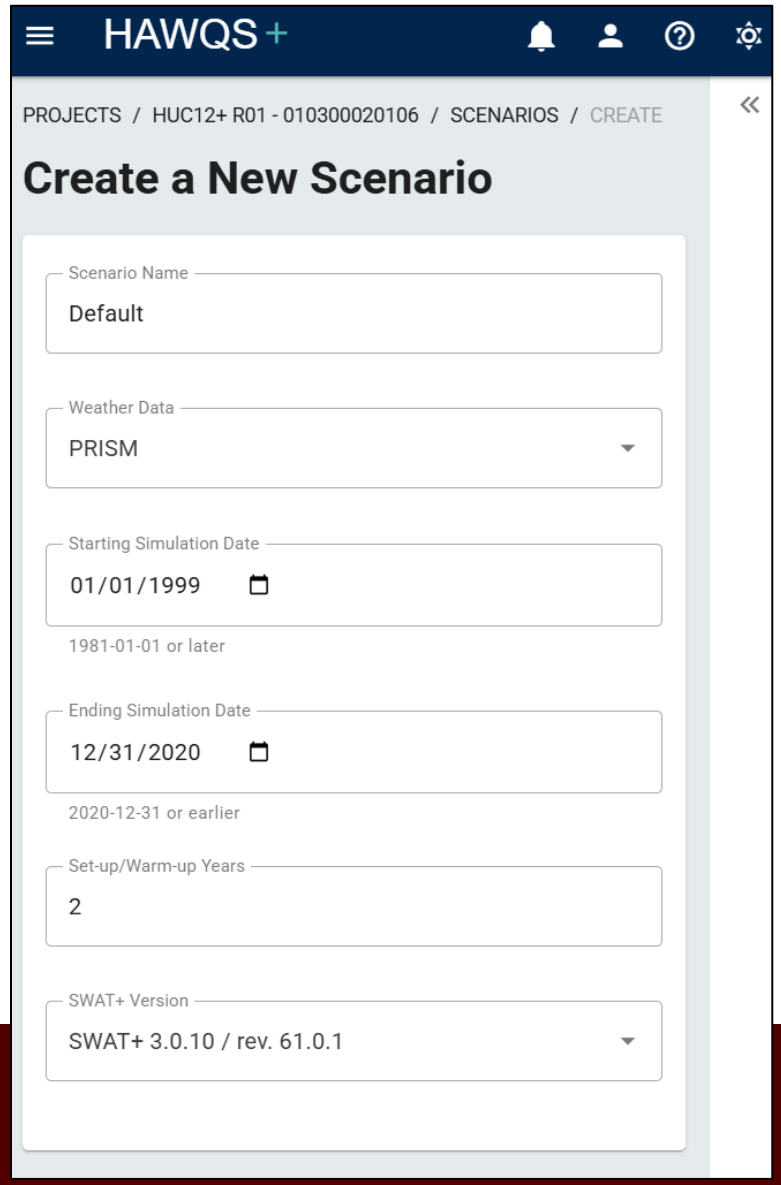

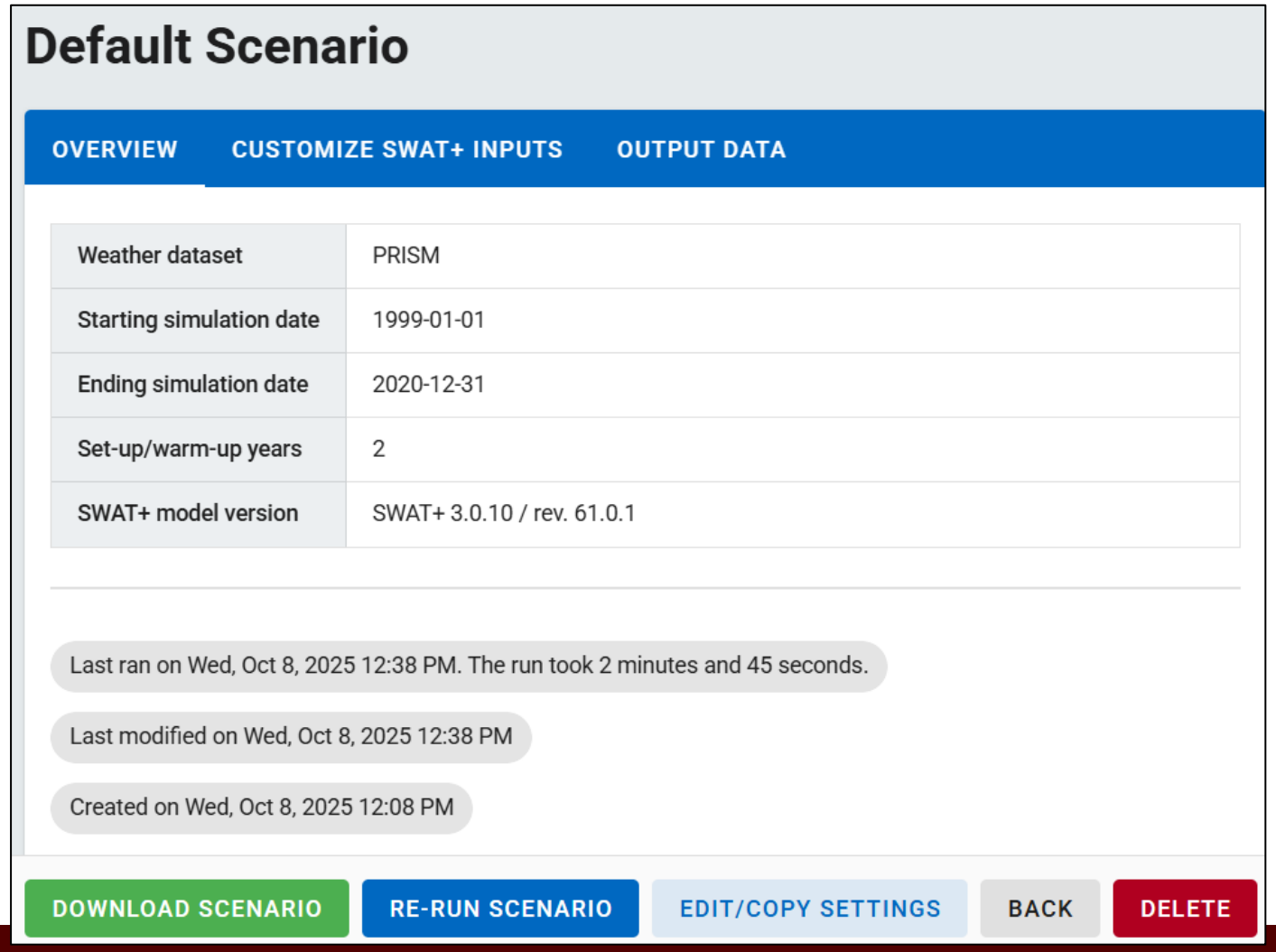

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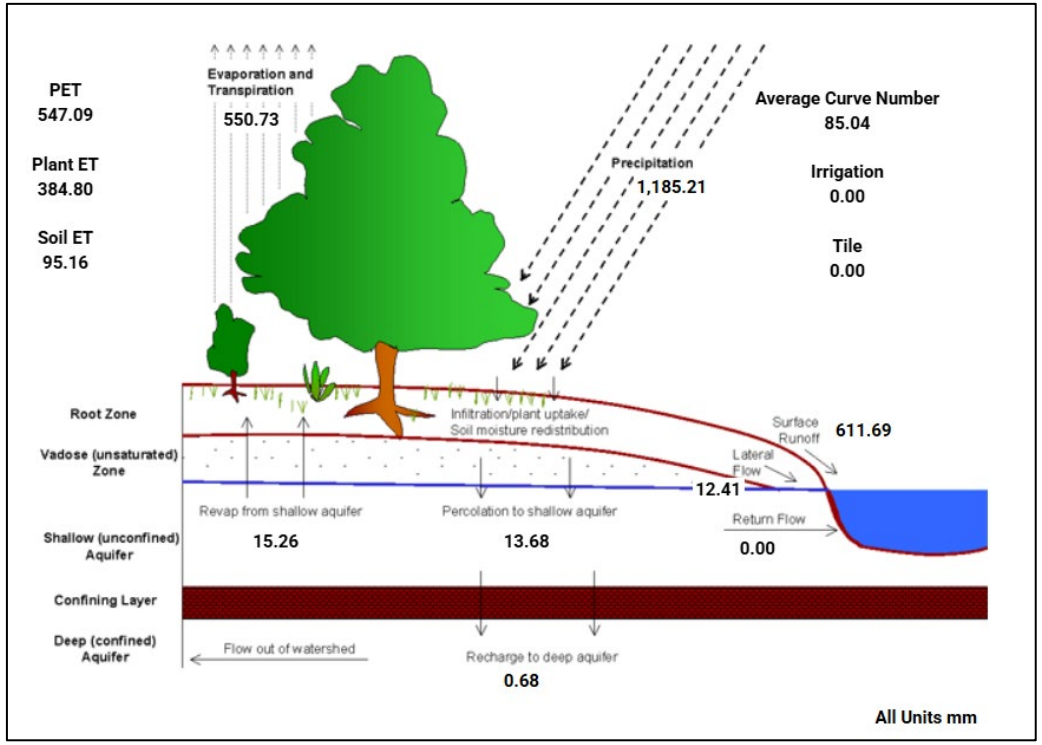
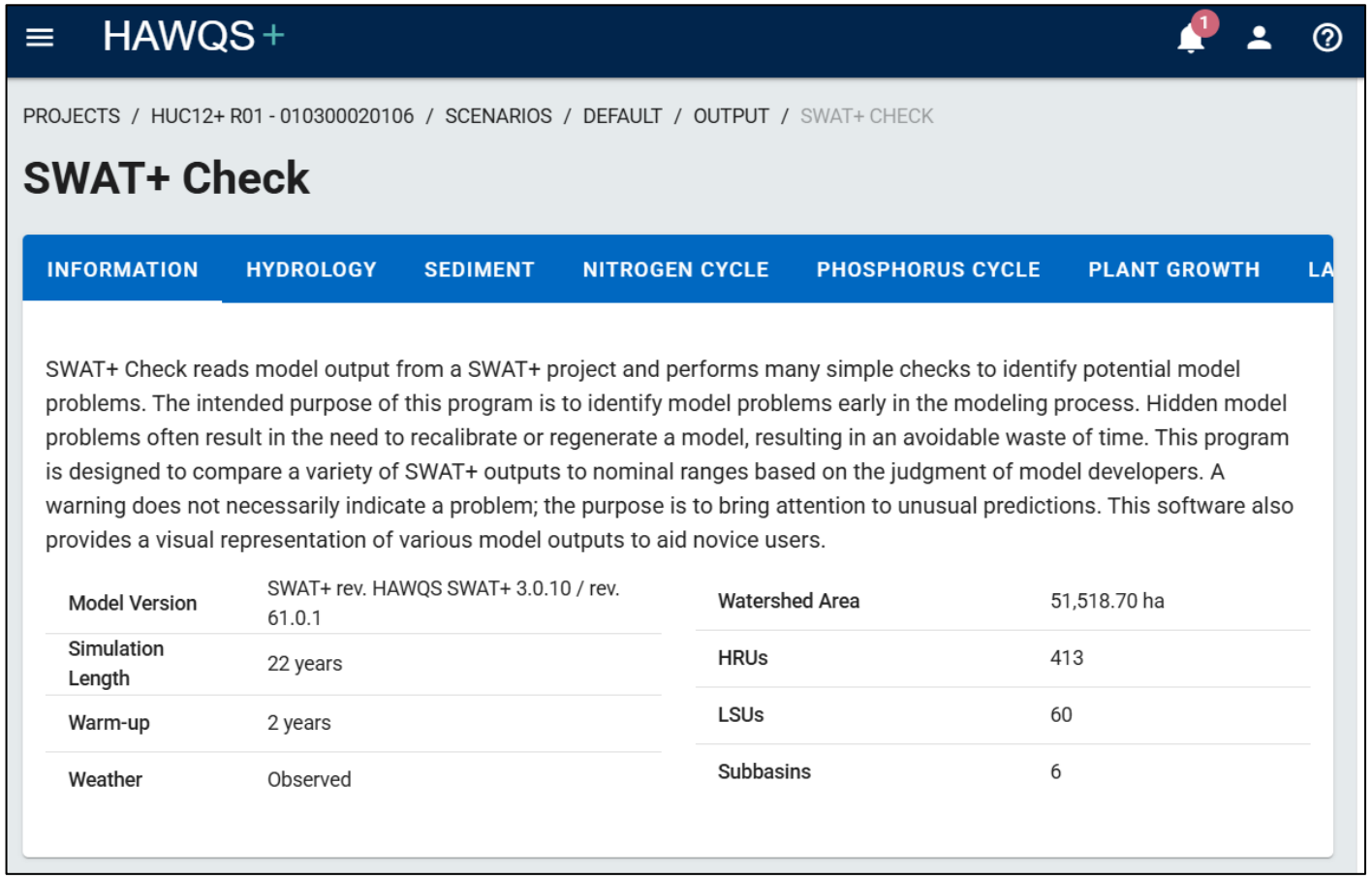


Water Balance Ratios	
Streamflow/Precipitation	0.53
Baseflow/Total Flow	0.02
Surface Runoff/Total Flow	0.98
Percolation/Precipitation	0.01
Deep Recharge/Precipitation	0.00
ET/Precipitation	0.46



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ADDITIONAL US HAWQS PLATFORMS

State and Regional

(##).hawqs.tamu.edu

- Texas (TX)
- Oklahoma (OK)
- South Carolina (SC)
- Trinity River Authority (TRA)
- Tarrant Regional Water District (TRWD)
- Lower Colorado River Authority (LCRA)
- North Texas Municipal Water District (NTMWD)
- Meskwaki Nation (Meskwaki)
- Coming Soon: Kansas (KS)

INTERNATIONAL HAWQS PLATFORMS

- South Africa (HAMSA)
  [hamsa.hawqs.tamu.edu]
- Pernambuco Brazil (SUPer)
  [super.hawqs.tamu.edu]
- Hydrologic Unit Model for InDia (HUMID)
  [bhuvan.nrcs.gov.in]
- Global HAWQS (Ukraine, Nepal)
  [global.hawqs.tamu.edu]
- Coming Soon: South Korea, Spain

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Global HAWQS

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Questions?

Comments?

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