

Fine-Scale Water Quality Modeling: Evaluating HAWQS/SWAT Model Estimates at the HUC14 Scale



U.S. National HAWQS
<https://hawqs.tamu.edu/>



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TEXAS A&M
AGRI LIFE
RESEARCH

What is HAWQS?

- A web-based interactive water quantity and quality modeling system using SWAT as its core modeling engine
- Allows analysis at various watershed scales
- Supports simple and complex economic, policy, and impact analyses:
 - Flow, Sediments, Nutrients, pathogens

Benefits of HAWQS

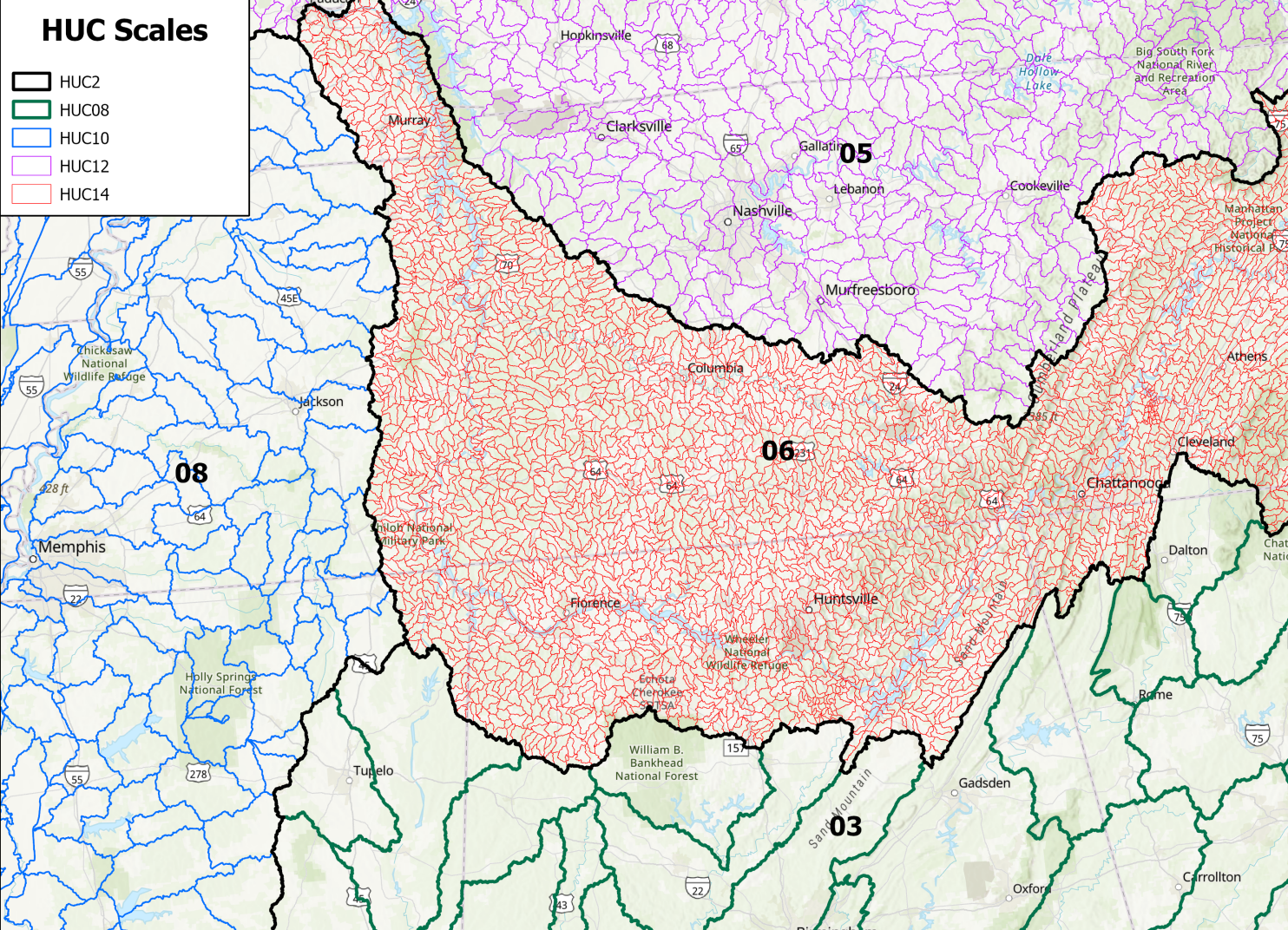
- Public domain databases, tools, and output visualization
- Cloud based interface (accessed by phone/ tablet/ laptop/ desktop)
- No GIS skills required
- Complete input datasets compatible across SWAT versions
- Calibrated models
- Uniformity across projects with model sharing, uploading, and group access
- **More efficient – reduces SWAT modeling time and effort by 90%**

Federally Approved Input Datasets

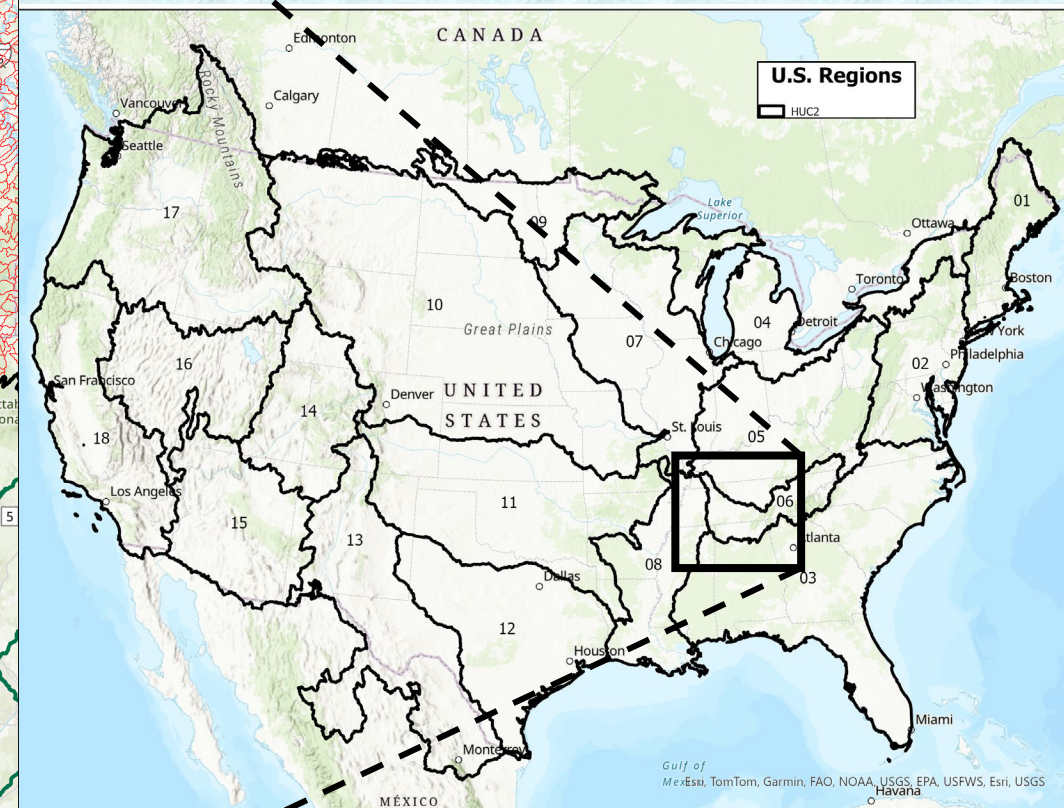
Input Dataset	Source	Specifications
Weather	PRISM	1981 – 2020 (gridded)
	NEXRAD	2005 – 2020 (gridded)
Soil	USDA National Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database	2018
	USDA NRCS State Soil Geographic (STATSGO) Database	2018
Land Use	National Land Cover Database (NLCD)	2016
	USDA National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL)	2014 – 2017
	USDA NASS Fields	2006 – 2010
	U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory (NWI)	2018
Aerial Deposition	National Atmospheric Deposition Program (NADP)	1980 – 2020 (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)	2019
	EPA Integrated Compliance Information System National Pollutant Discharge Elimination System (ICIS-NPDES)	2019
	USDA NRCS crop management zone data	2010
Ponds, Potholes, and Reservoirs	U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID)	2018
	EPA NHDPlus v2	2019
Crop Data	USDA NASS CDL	2014 – 2017
Wetlands	FWS NWI	2018
Water Use	USGS Water Use in the United States	2015

HUC Scales

-  HUC2
-  HUC08
-  HUC10
-  HUC12
-  HUC14



Current Extent of U.S. National HAWQS



Spatial Scale	Total Subbasins	Average Subbasin Area (km ²)	Average Number of HRUs per HUC
HUC8	2,111	3,690	2,920
HUC10	15,300	509	680
HUC12	79,837	98	229
HUC14	352,787	22	89

Why Create HUC14 Dataset?

Objective:

- Create a set of SWAT models for HUC12 watersheds in the conterminous USA
- Use existing HUC12 watershed boundaries and flowlines in existing the HAWQS watersheds and channel networks

Reason:

- Finer detailed management implementation
- Help to get output at close to NHD reaches or local scales
- Effective implementation of off-farm best management practices like checking dams, retention/detention, farm/sedimentation ponds to control and mitigate environmental issues at the local scale

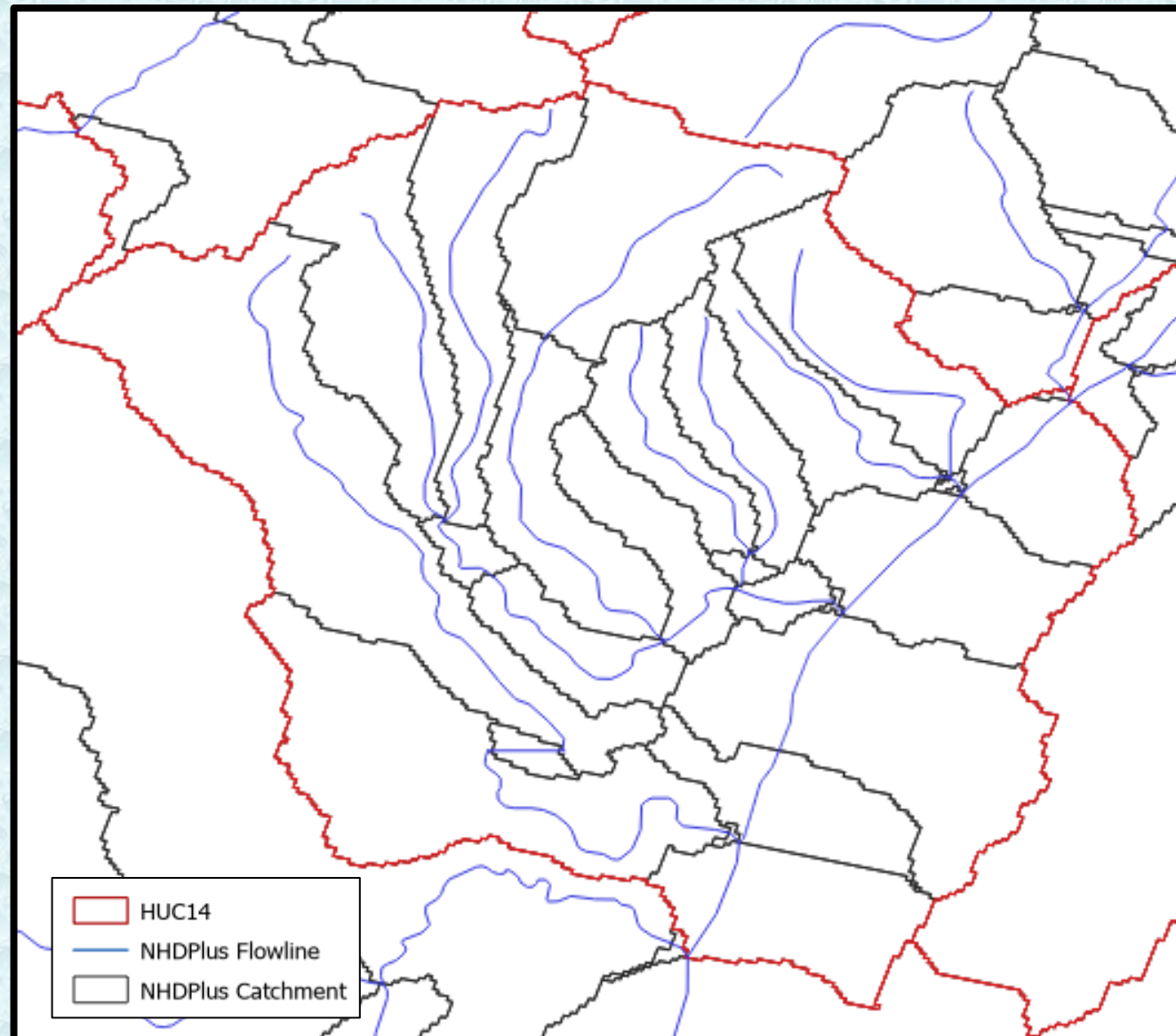
What data was used to create HUC14 boundaries?

Data Used:

- Medium resolution NHDPlus v2 data (2019)
- US Core of Engineers National Inventory of Dams (NID) (2018)
- HAWQS 2.0 HUC12 boundaries (2021)

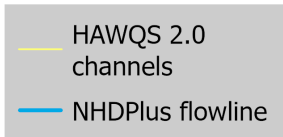
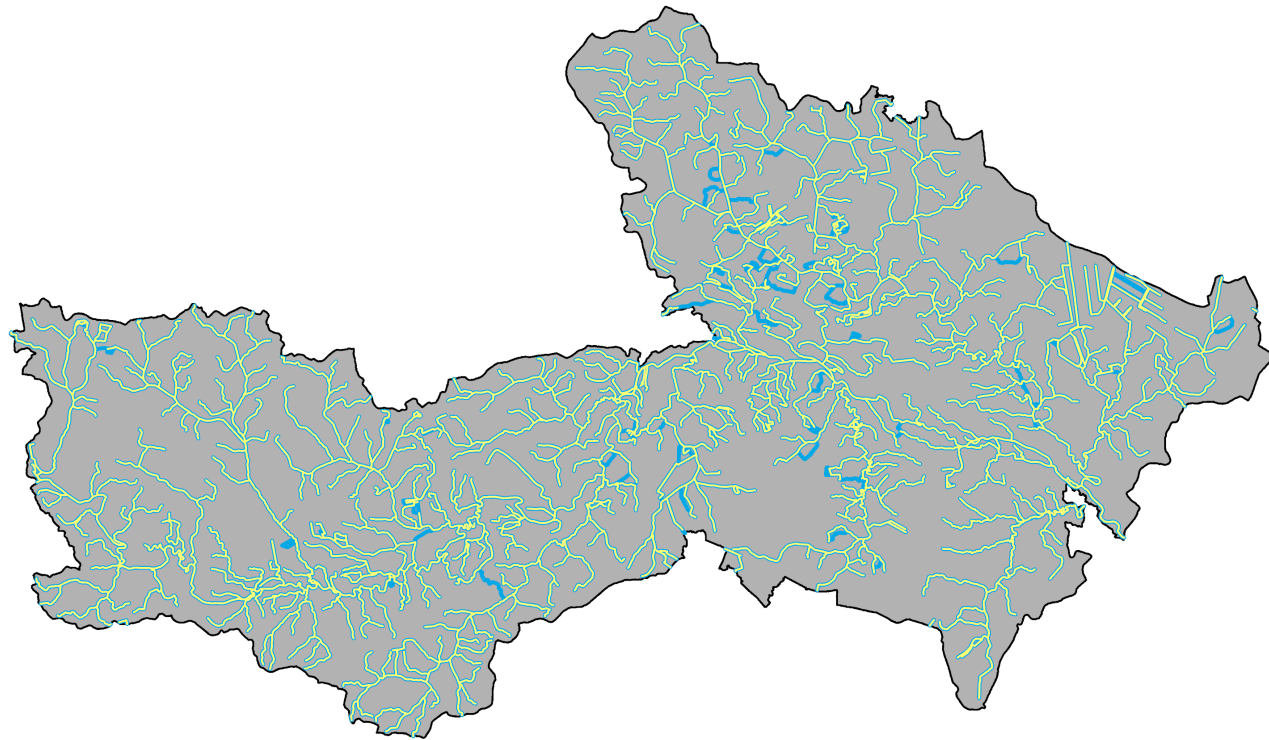
Creation of HUC14 boundaries

- NHDPlus catchments were merged with downstream catchments until the HUC14 area was $\sim 20\text{km}^2$
- Avoid very small huc14 subbasins



Creation of HUC14 Stream Network

- NHDPlus tributaries (divergent values of 2) or any isolated flowlines that did not connect to the outlet were removed leaving only the “major” flowlines.

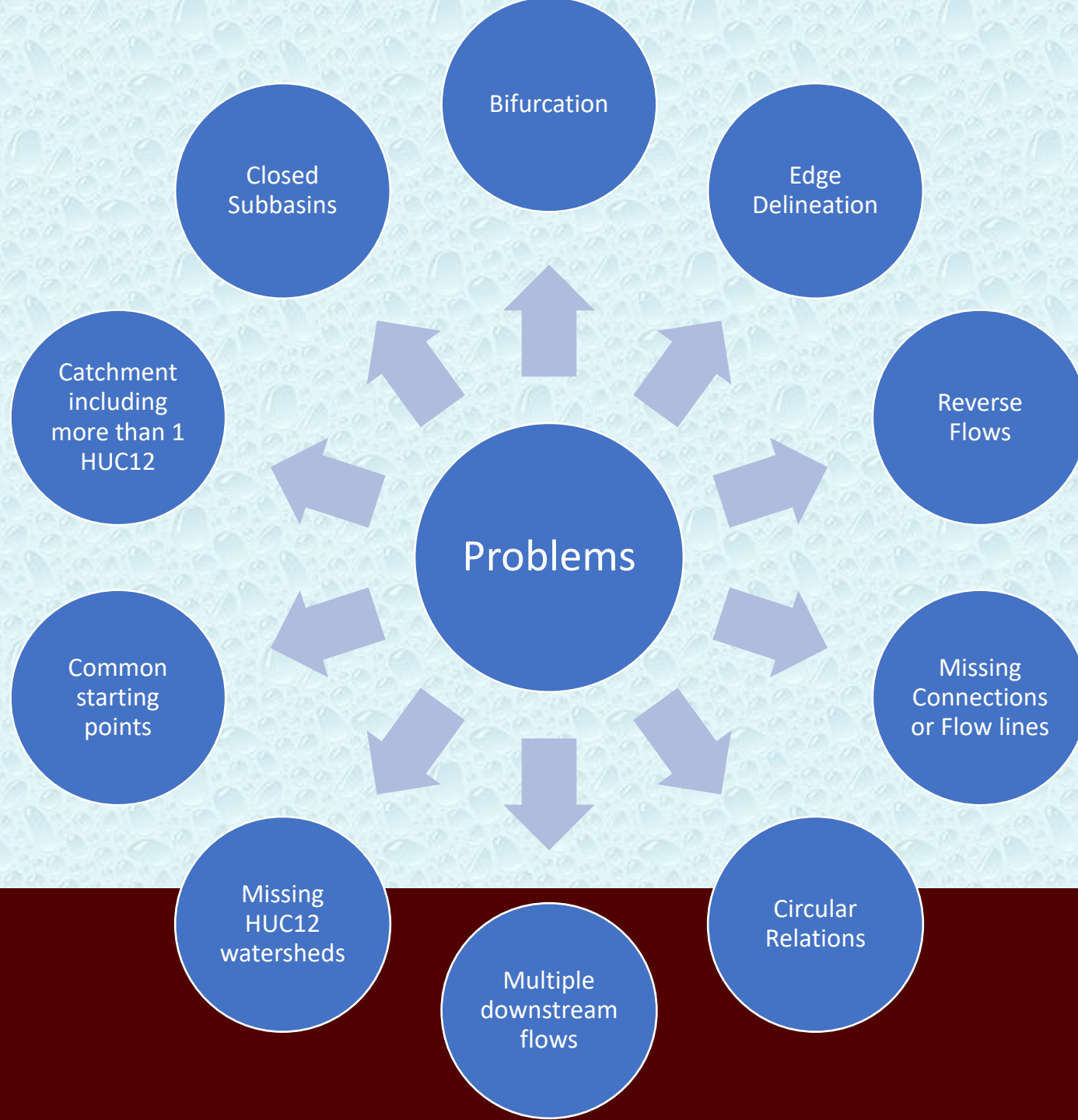


Creation of Other Waterbodies

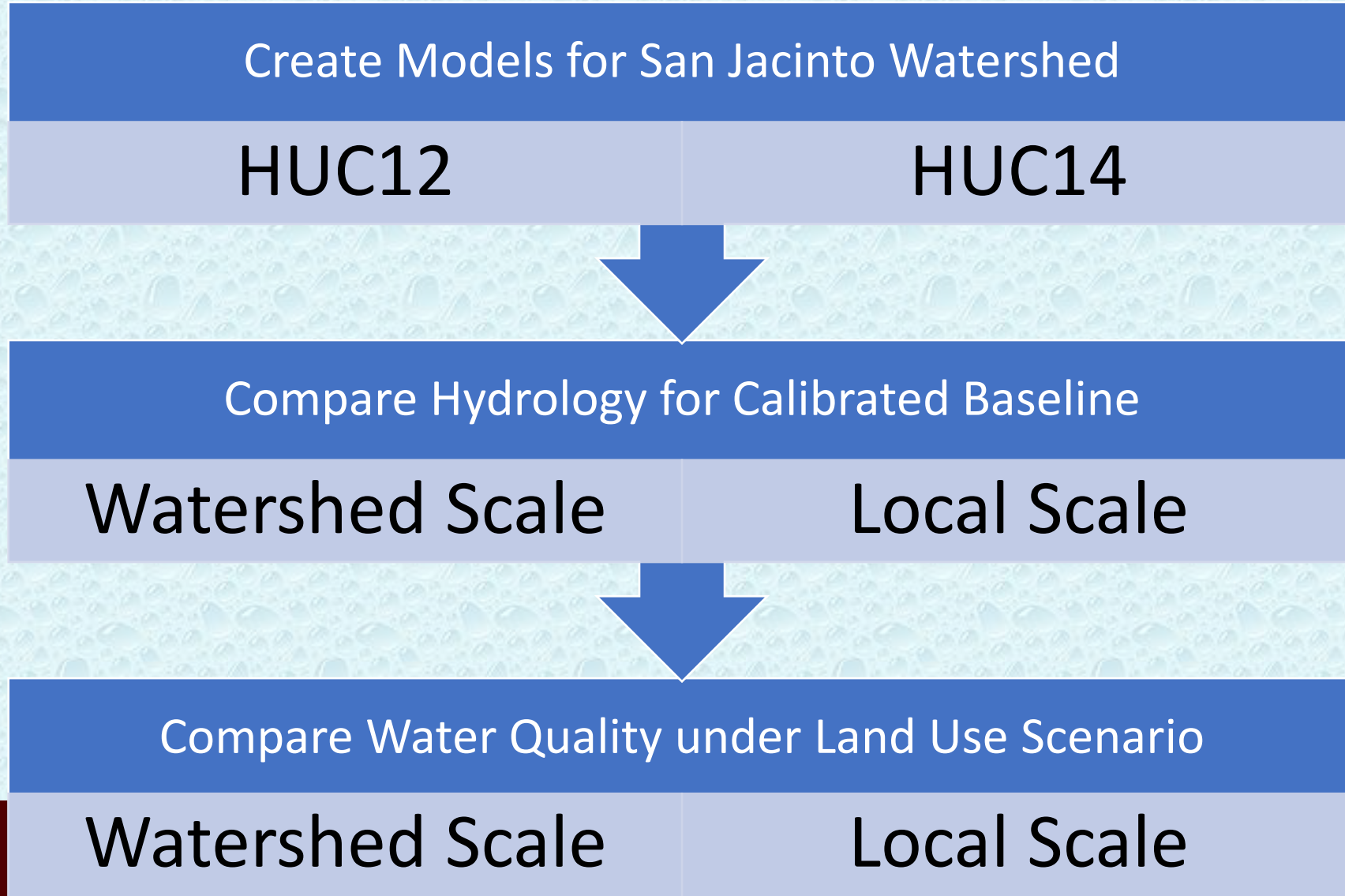
- Used NHDPlus waterbodies and NID dams to create 5 categories of HUC14 waterbodies

Waterbodies

1. Reservoirs = NHD water bodies associated with an NID dam storage of at least 25,000 acre-feet
2. Lakes = NHD waterbodies with an estimated volume of at least 25,000 acre-feet and NOT associated with a dam
3. Playa = NHD waterbodies with *Playa* as their FTYPE. They are included in the SWAT models as potholes
4. Wetlands = NHD waterbodies with *SwampMarsh* as their FTYPE
5. Ponds = Any remaining NHD waterbodies

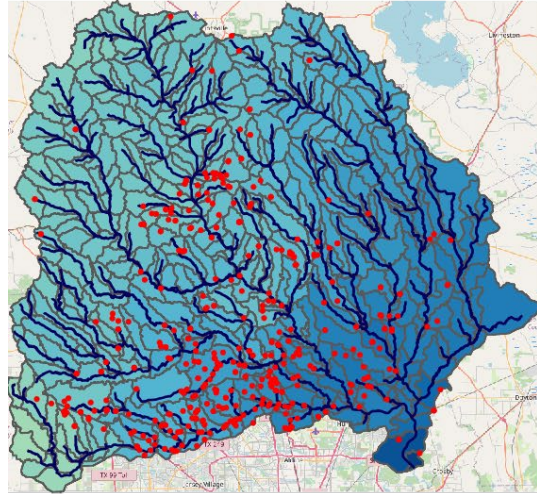


Evaluating the HUC12 and HUC14 Estimates

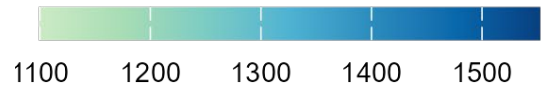


Hydrology Comparison

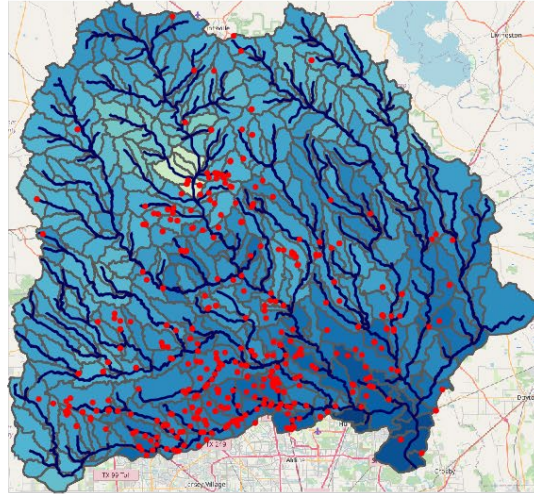
HUC14 Precipitation



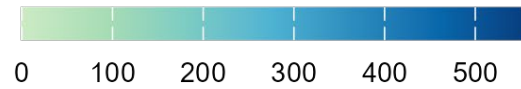
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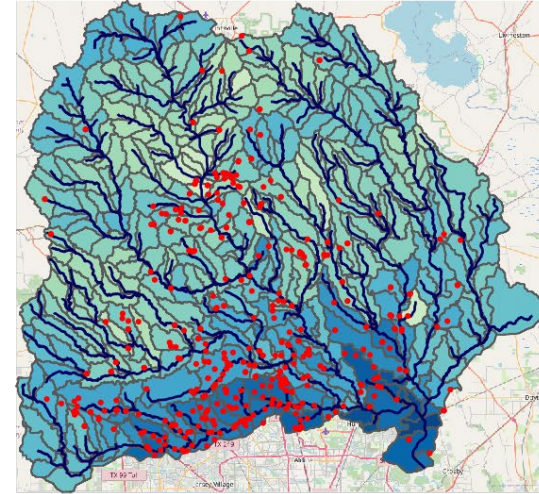
HUC14 Water Yield



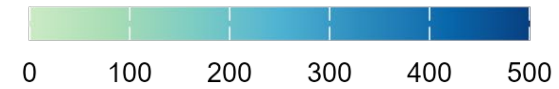
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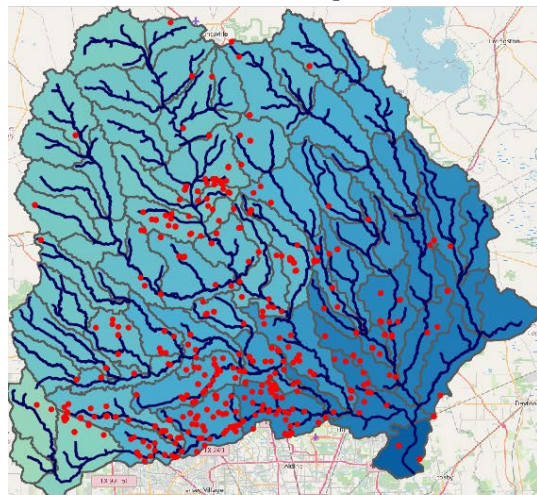
HUC14 Surface Runoff



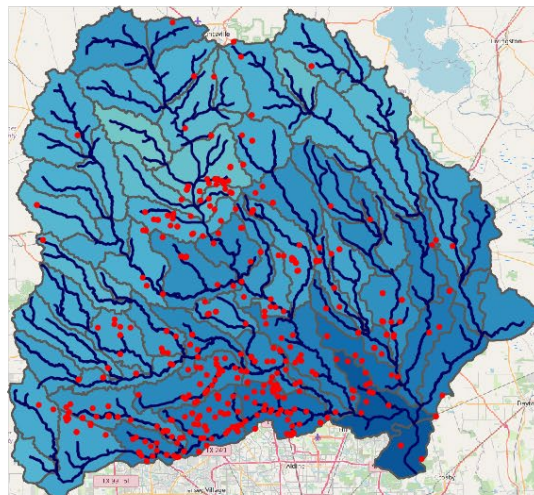
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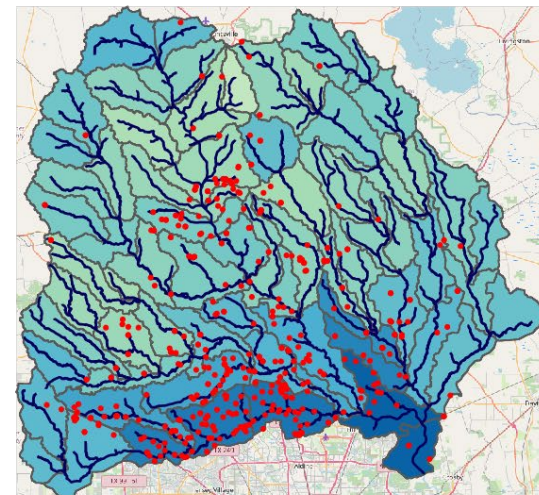
HUC12 Precipitation



HUC12 Water Yield

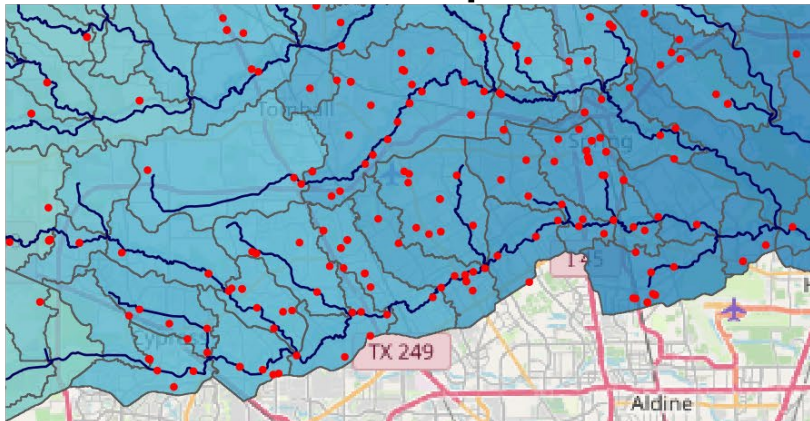


HUC12 Surface Runoff

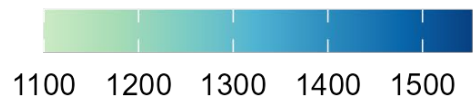


Differences in Precision near Cypress, Texas

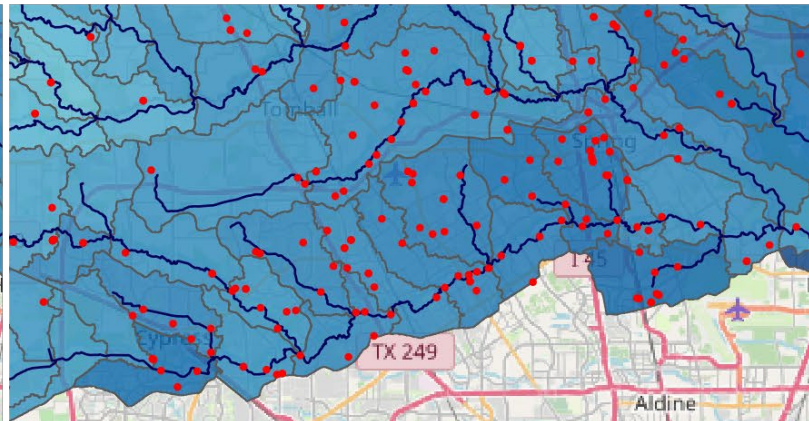
HUC14 Precipitation



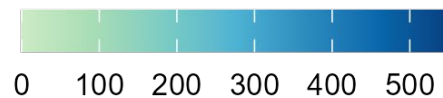
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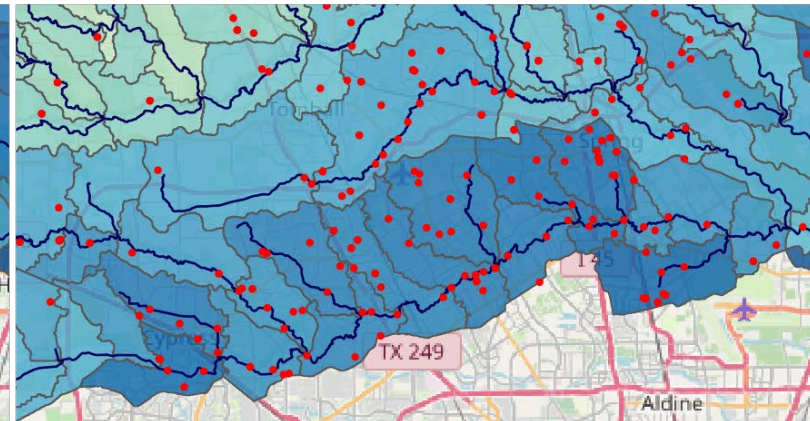
HUC14 Water Yield



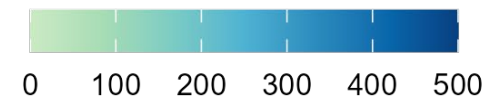
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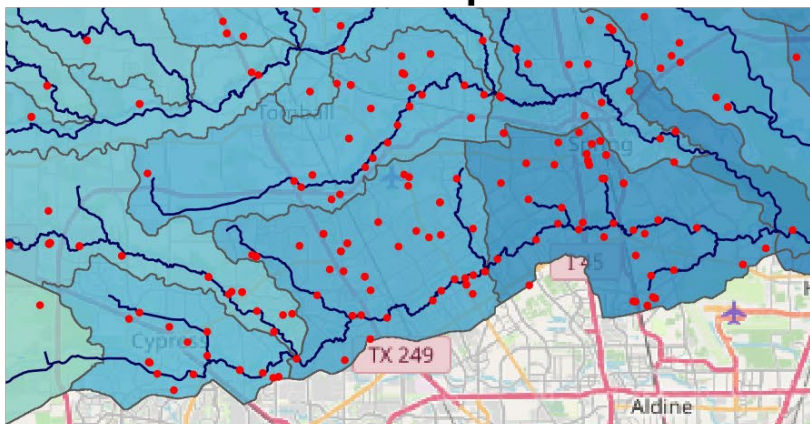
HUC14 Surface Runoff



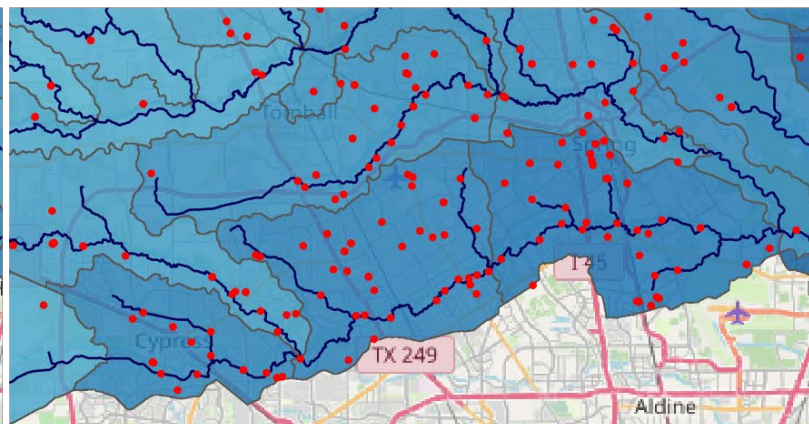
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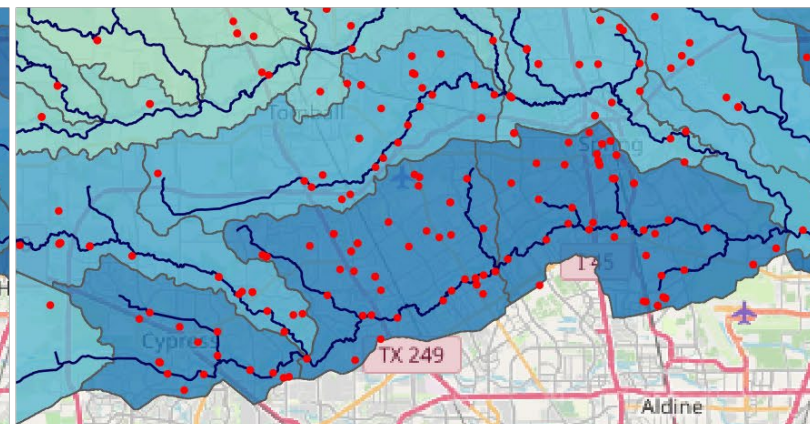
HUC12 Precipitation



HUC12 Water Yield



HUC12 Surface Runoff



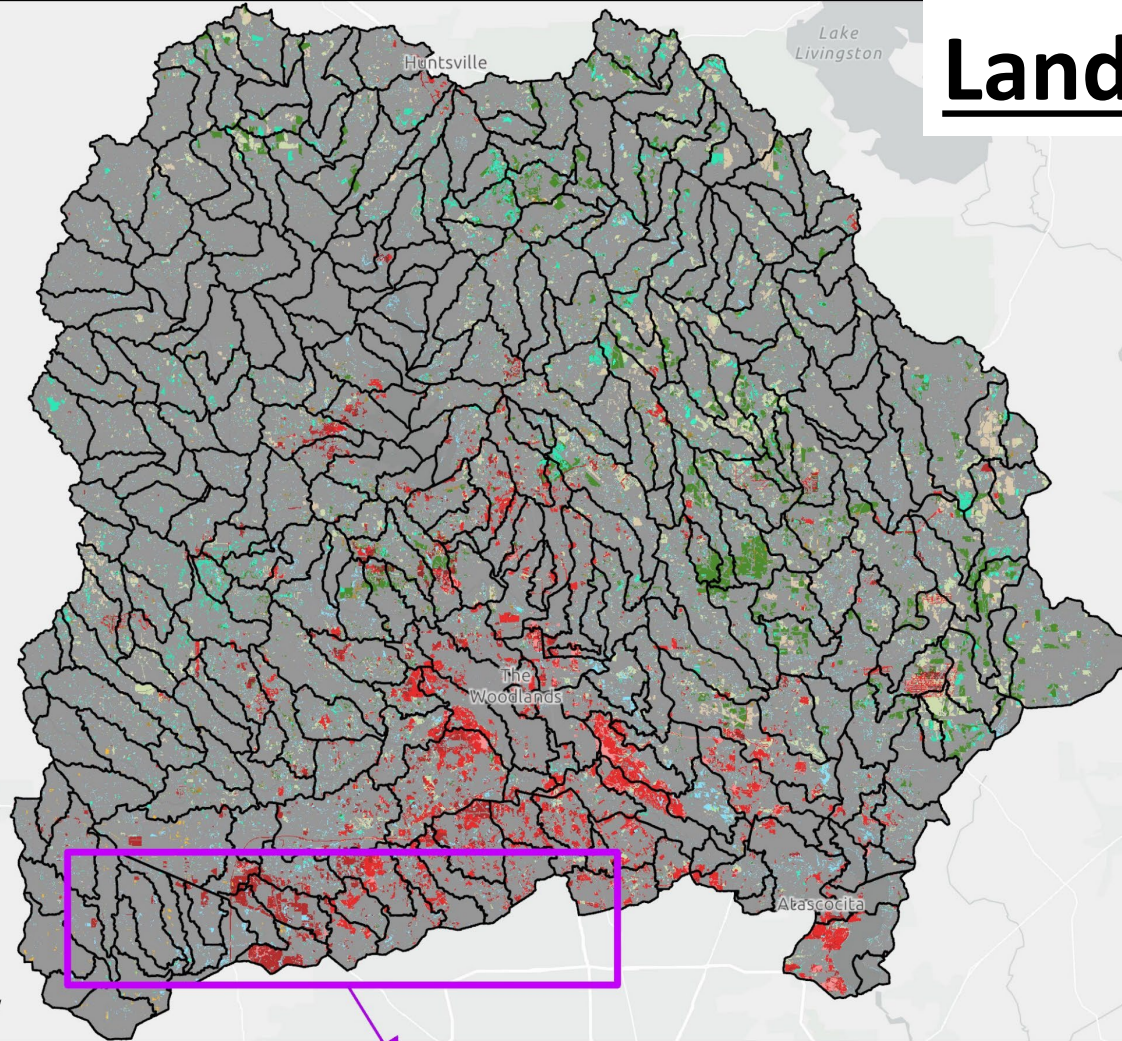
Land Use Change Scenario

Land Use Change Categories

- Hay/Pasture to Developed
- Forest to Developed
- Wetlands to Developed
- Hay/Pasture to Wetlands
- Hay/Pasture to Cultivated Crops
- Herbaceous to Forest
- Shrub/Scrub to Forest
- Hay/Pasture to Forest
- Herbaceous to Shrub/Scrub
- Wetlands to Shrub/Scrub
- Forest to Shrub/Scrub
- Forest to Herbaceous
- Other
- Unchanged

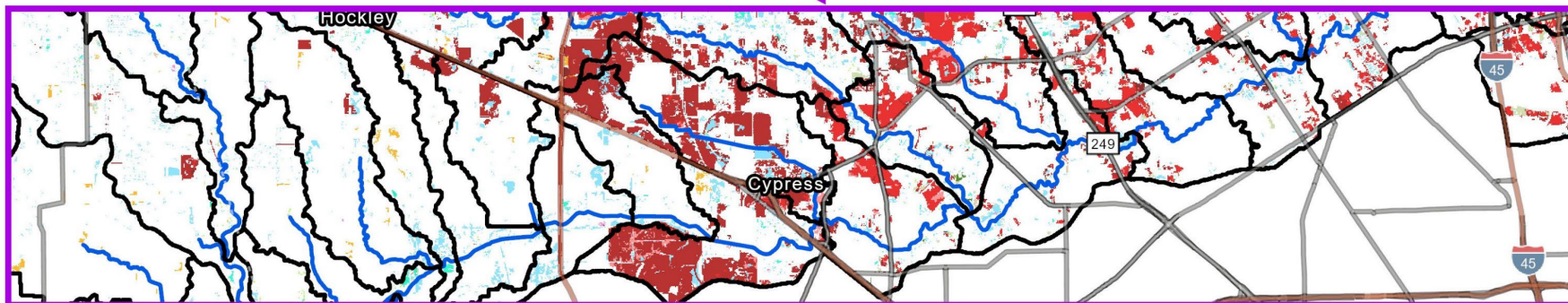
Total Area: 7,338.81 sq km

Total Changed: 1,623.22 sq km



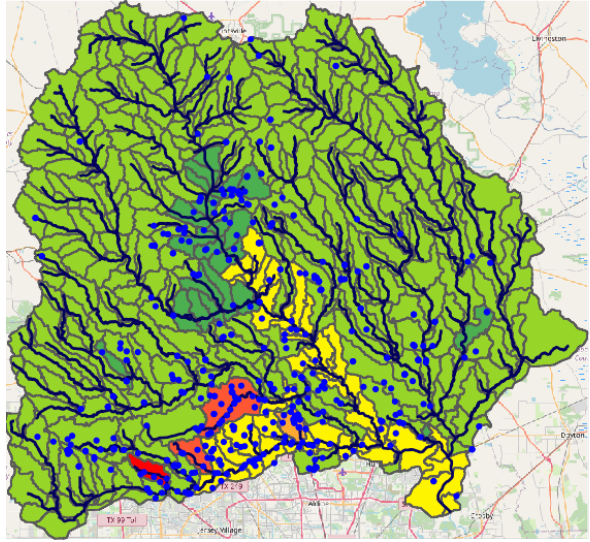
- Change between 2001 and 2016
- Urban Development
 - 8.4% in watershed
 - 36.8% near Cypress, TX
- Point sources adjusted proportionately with urban development by subbasin

City of Houston, Texas Parks & Wildlife, CONANP, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS, DETCOG, Montgomery County, TX GIS Office, Texas Parks & Wildlife, CONANP, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USFWS

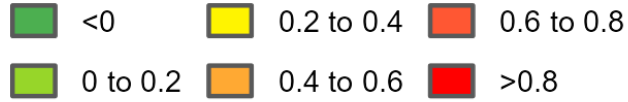


Water Quality Change (%) from 2001 to 2016

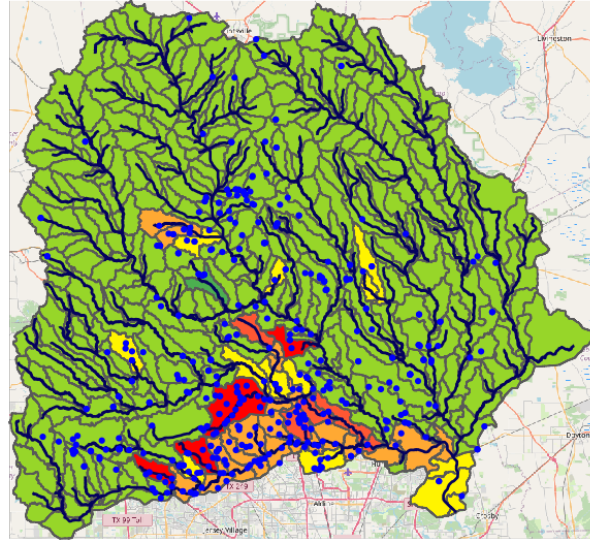
HUC14 Sediment



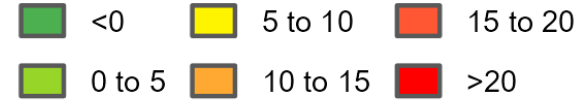
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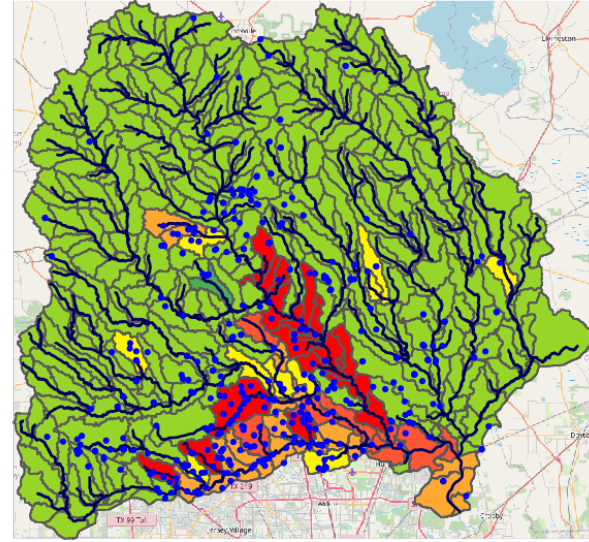
HUC14 Total Phosphorus



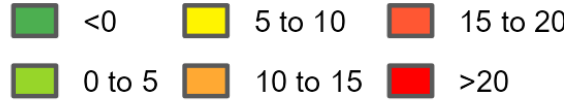
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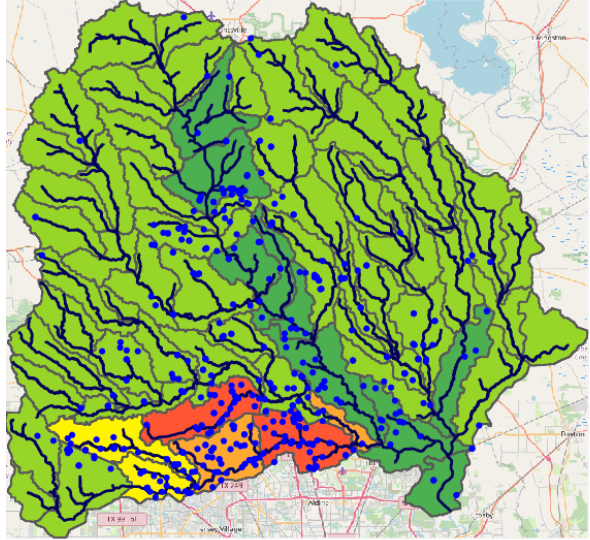
HUC14 Total Nitrogen



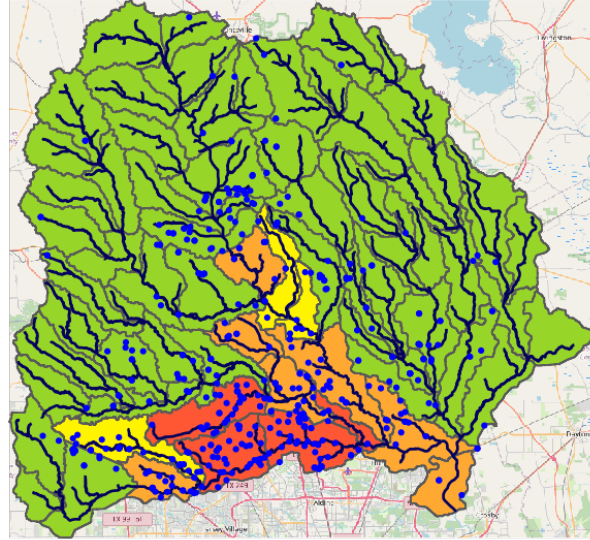
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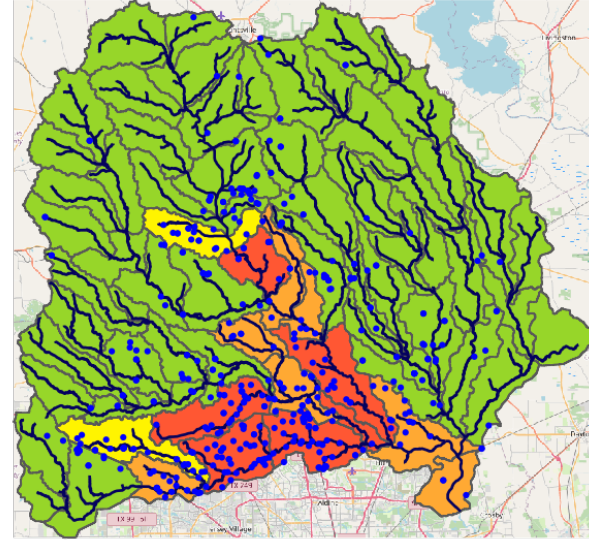
HUC12 Sediment



HUC12 Total Phosphorus

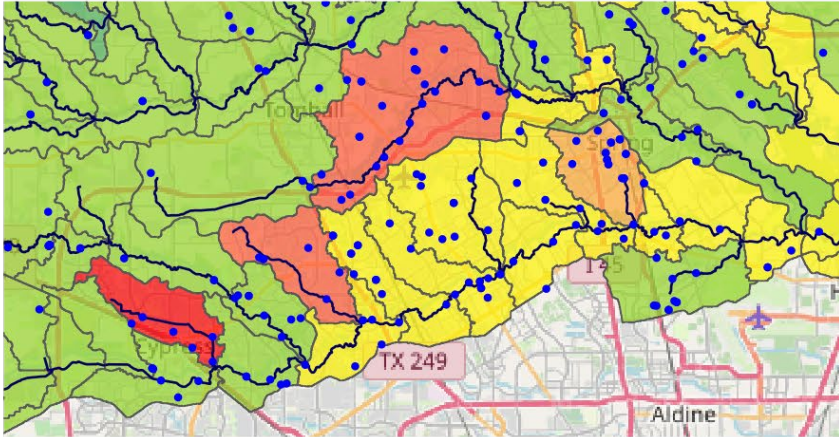


HUC12 Total Nitrogen



Differences in Precision near Cypress, Texas

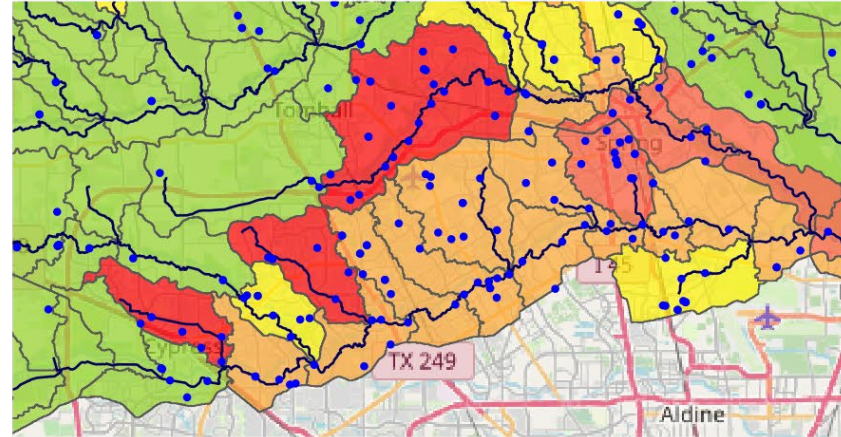
HUC14 Sediment



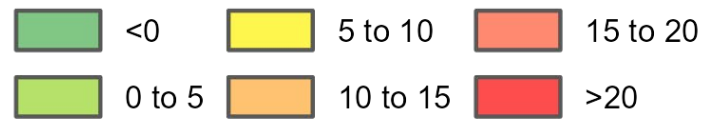
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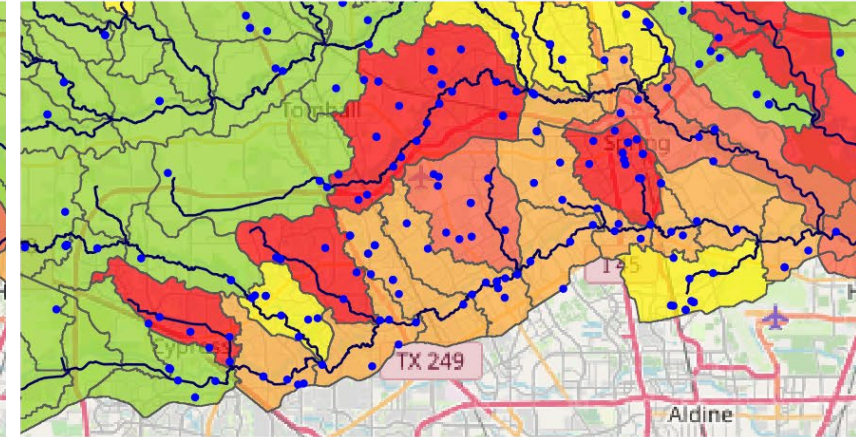
HUC14 Total Phosphorus



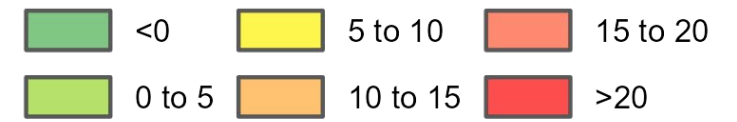
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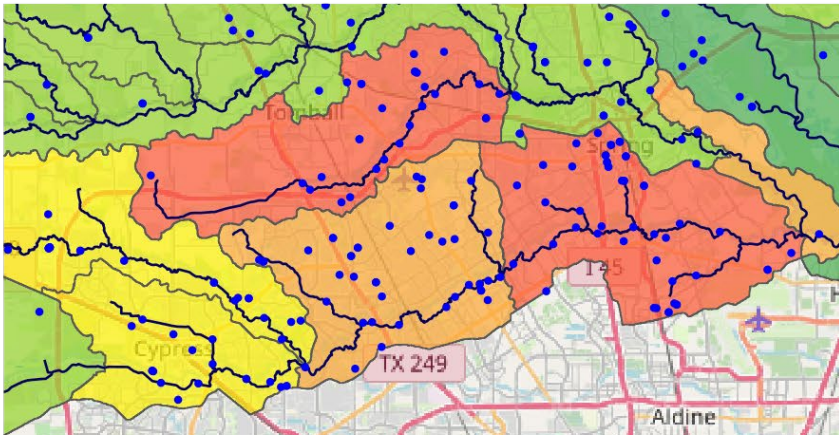
HUC14 Total Nitrogen



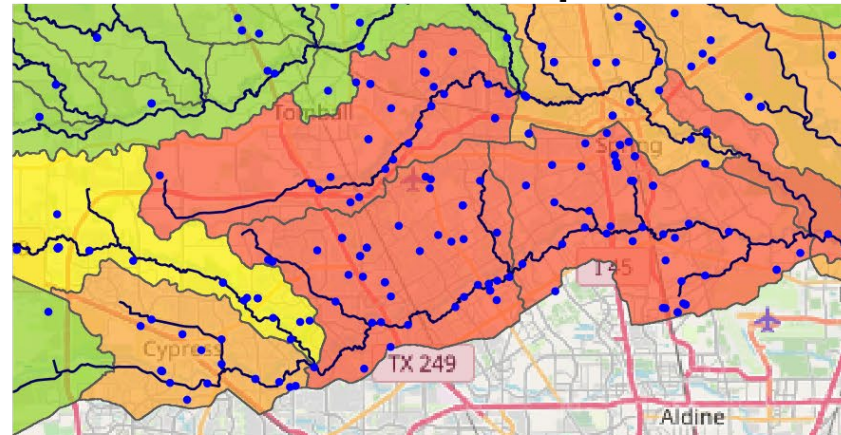
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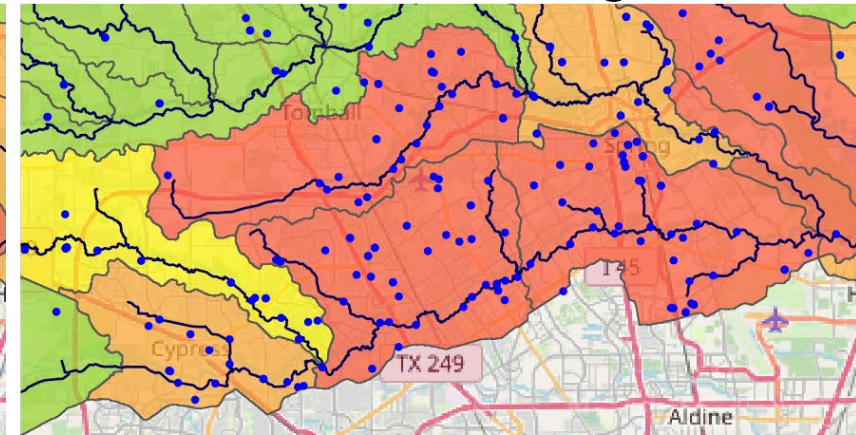
HUC12 Sediment



HUC12 Total Phosphorus



HUC12 Total Nitrogen



Conclusion

- **Hydrology between the HUC12 and HUC14 models provide spatially similar results across the watershed**
- **Water Quality between the HUC12 and HUC14 models provide similar results however HUC14 model better represents the variations in results spatially**
- **HUC12 models provide acceptable results for the watershed**
- **HUC14 finer resolution dataset can better pinpoint impacts of land use changes and other management scenarios**

HAWQS Future Work and Improvements

Development from
SWAT to SWAT+

Adding land use
changes within the
platform interface

Enhancing the
visualization
capabilities

Creating similar
platforms for
other regions and
countries

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)



INTERNATIONAL HAWQS PLATFORMS

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



U.S. HAWQS

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Global HAWQS

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*Questions?
Comments?*

