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Sandia National Laboratories




Energy and Water in the Texas and Western Interconnections

WSWC/WGA Energy-Water Workshop

Denver, CO

April 2, 2013

U.S. DEPARTMENT OF ENERGY | NNSA Nuclear Security Administration

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- Pacific Northwest National Laboratory
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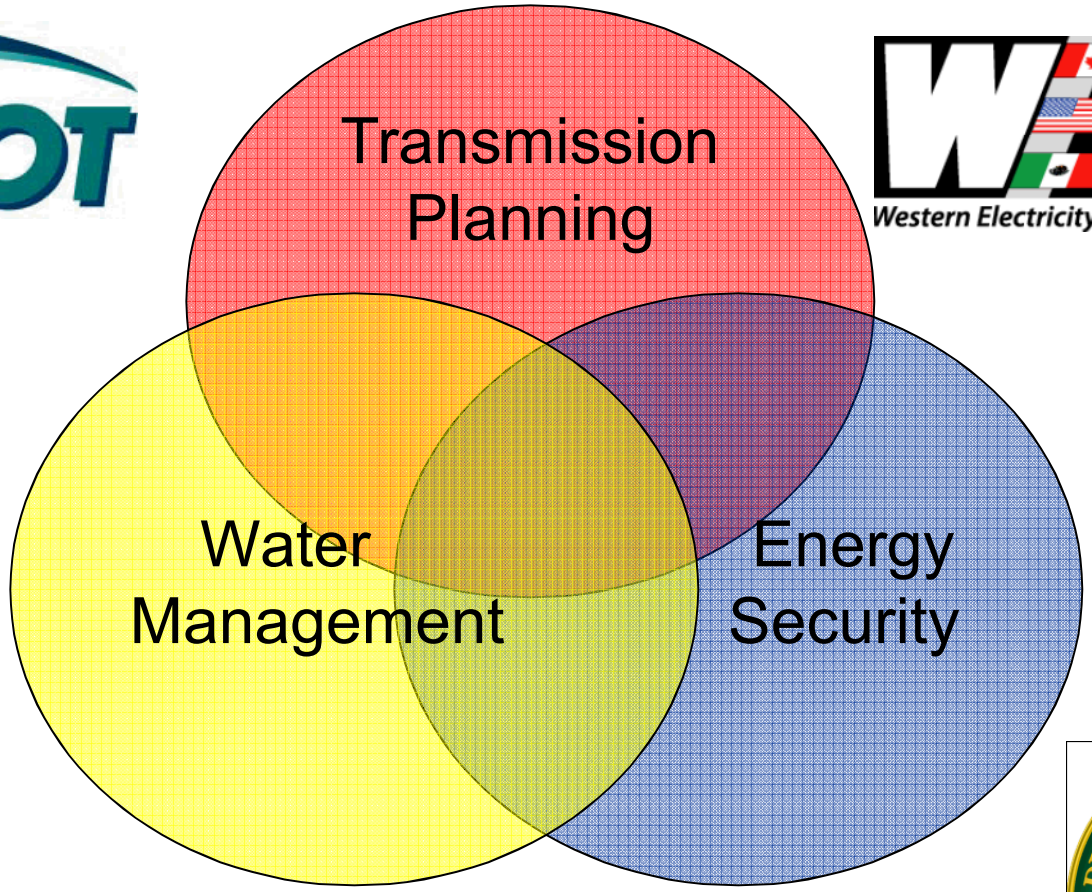
Integrated Planning



ERCOT

WECC
Western Electricity Coordinating Council

Western Governors' Association
Serving the Governors of 19 States and 3 US-Flag Pacific Islands

WSWC
Western States Water Council

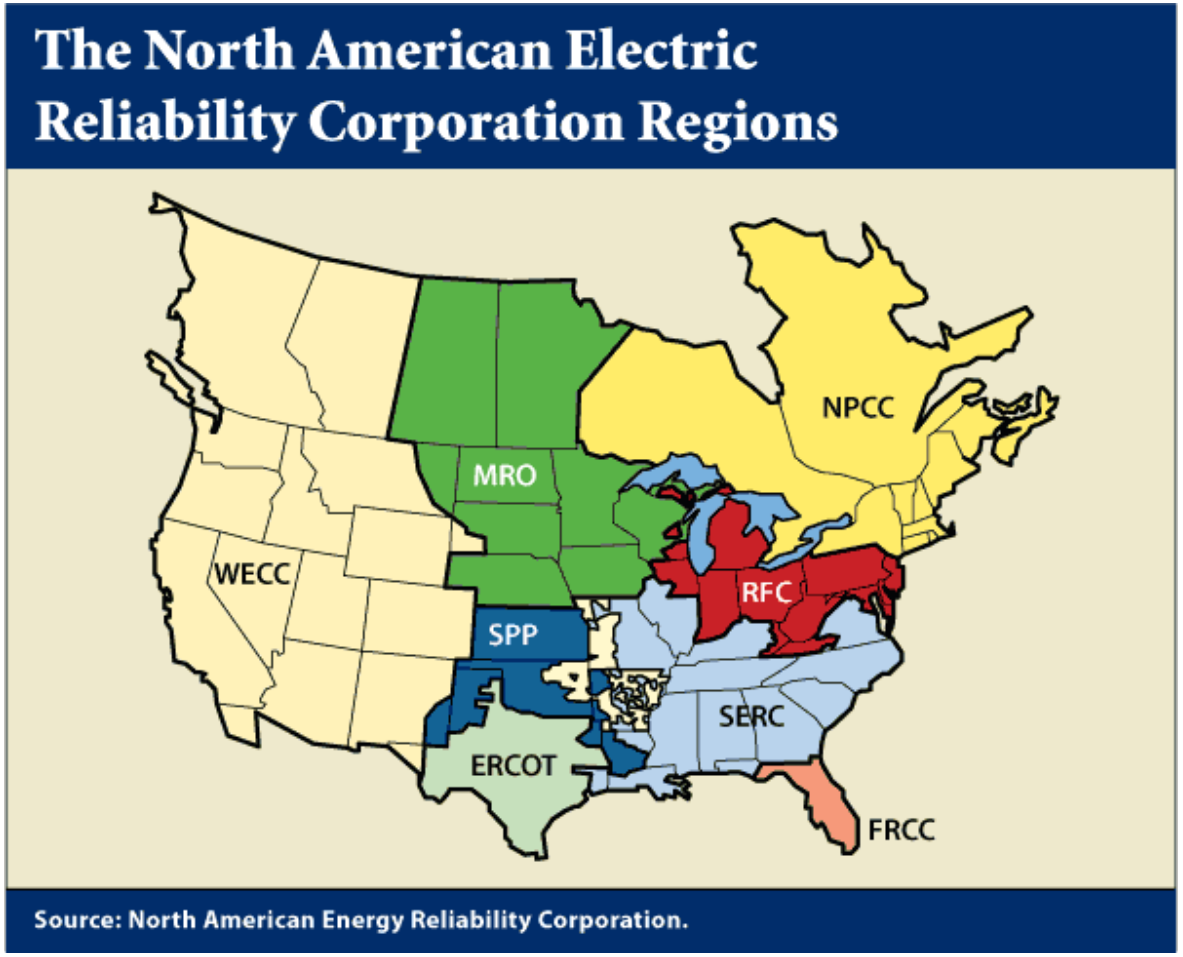
Department of Energy · United States of America

Energy and Water in the Western and Texas Interconnections

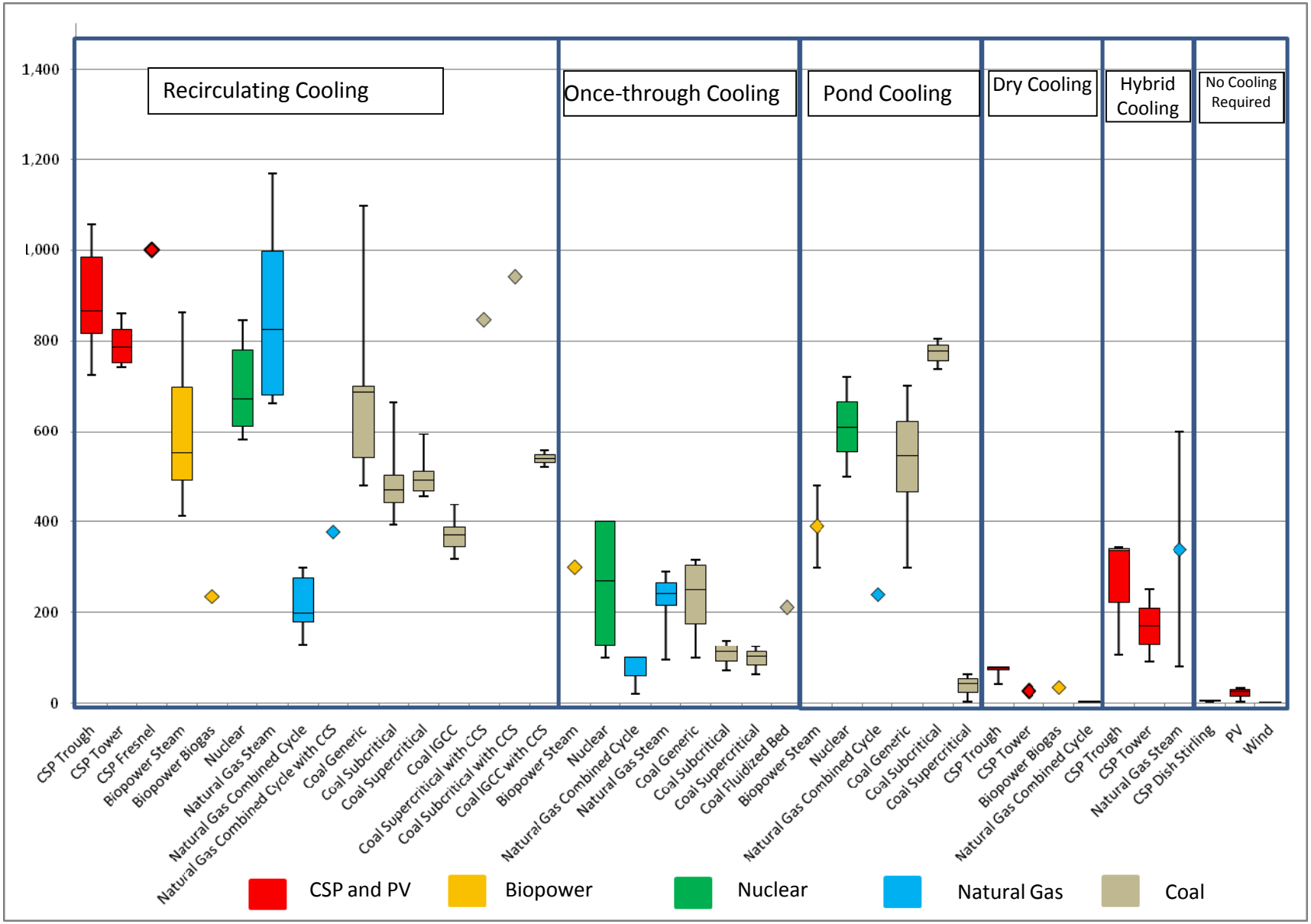
- Reduce the water footprint of electric power production in western United States:
  - Develop tools for a quantitative assessment of the energy-water nexus,
  - Engage stakeholders across the energy-water spectrum, and
  - Evaluate water implications of alternative interconnection-wide transmission expansion scenarios.

Transmission Planning

- WECC and ERCOT are conducting long-range transmission planning (20 yrs.)
  - Siting of new power plants
  - New transmission capacity

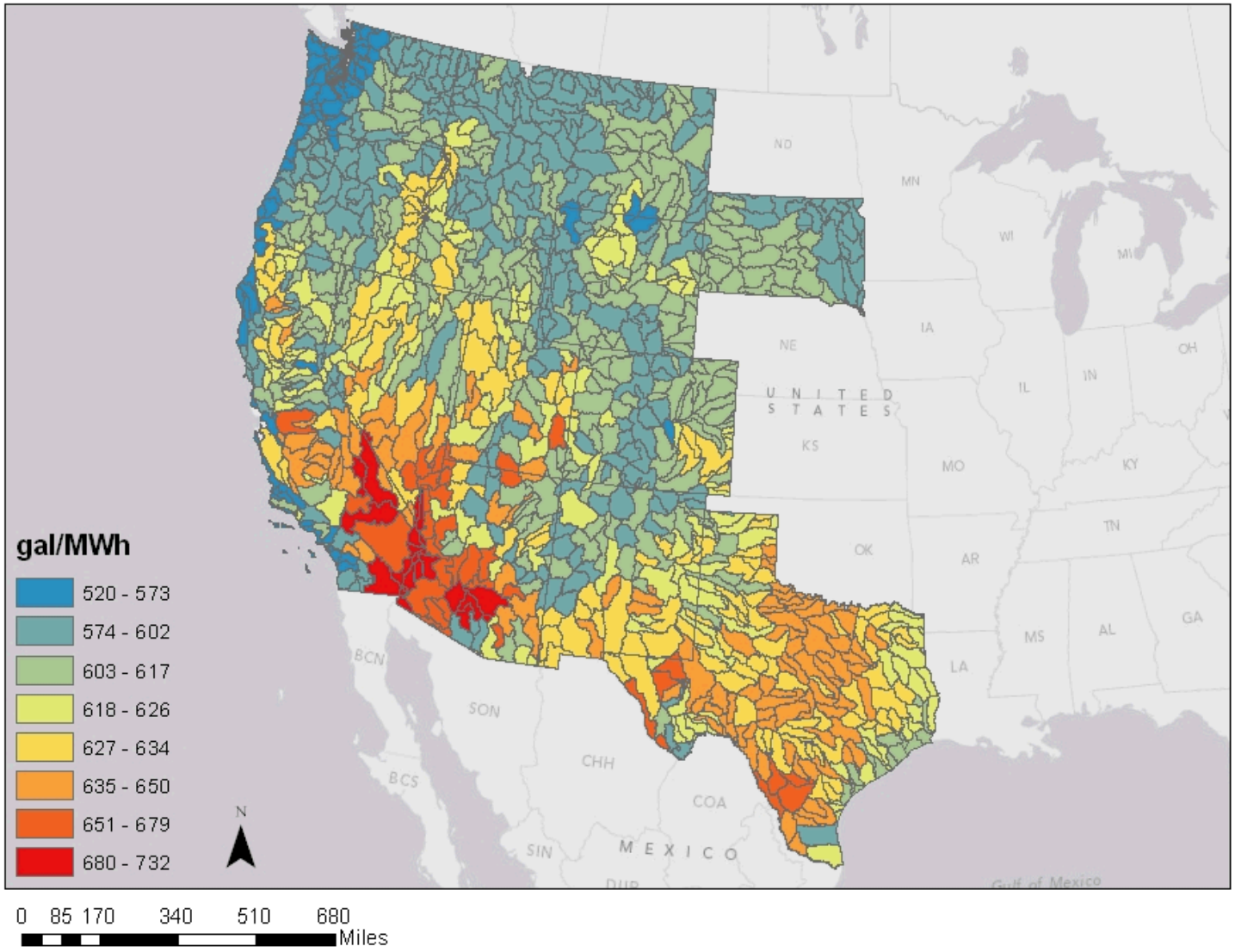


Operational water *consumption* factors for electricity generating technologies



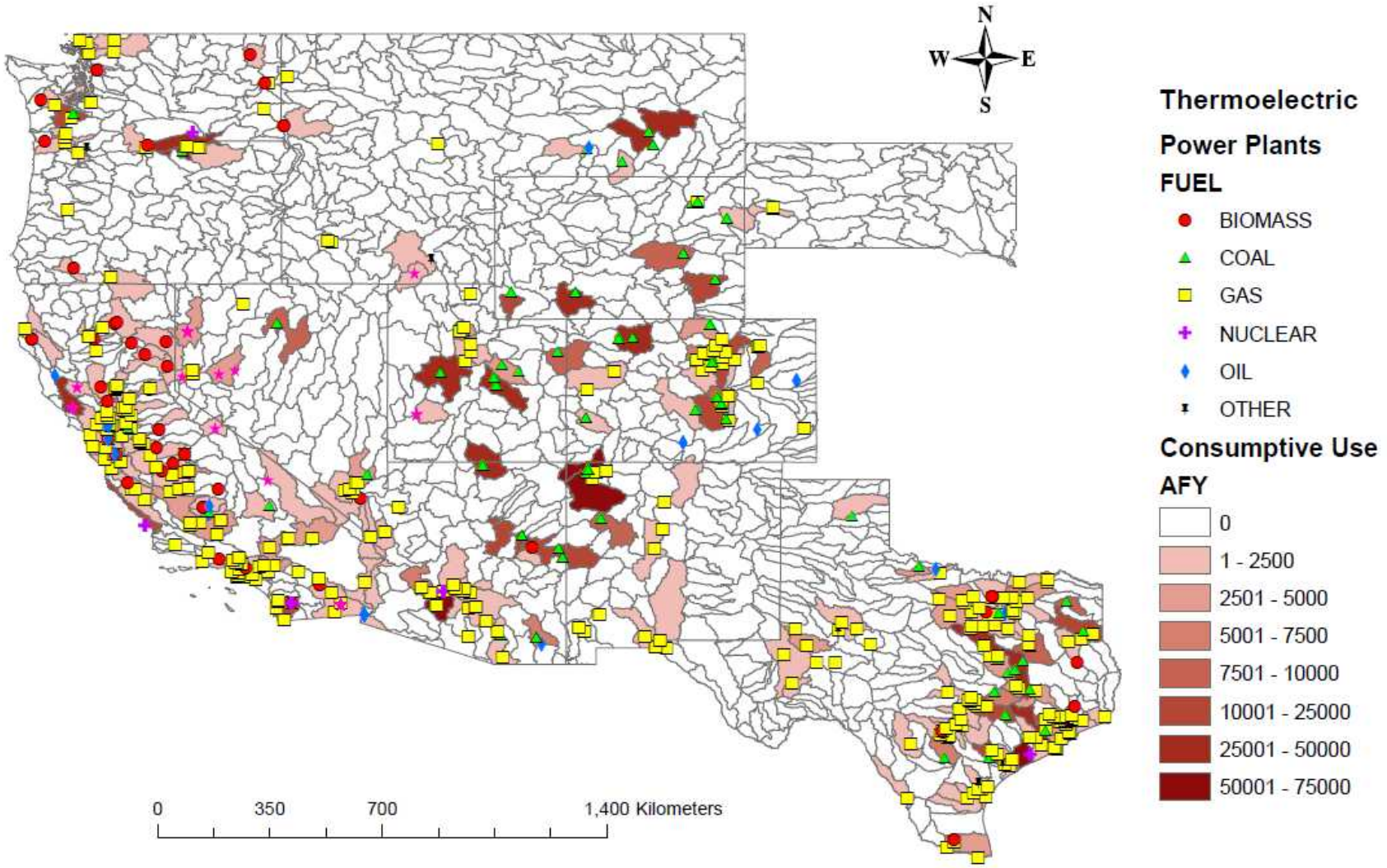
Source: Macknick *et al.* 2011

Coal Plant Water Use (gal/MWh)



NREL 2012

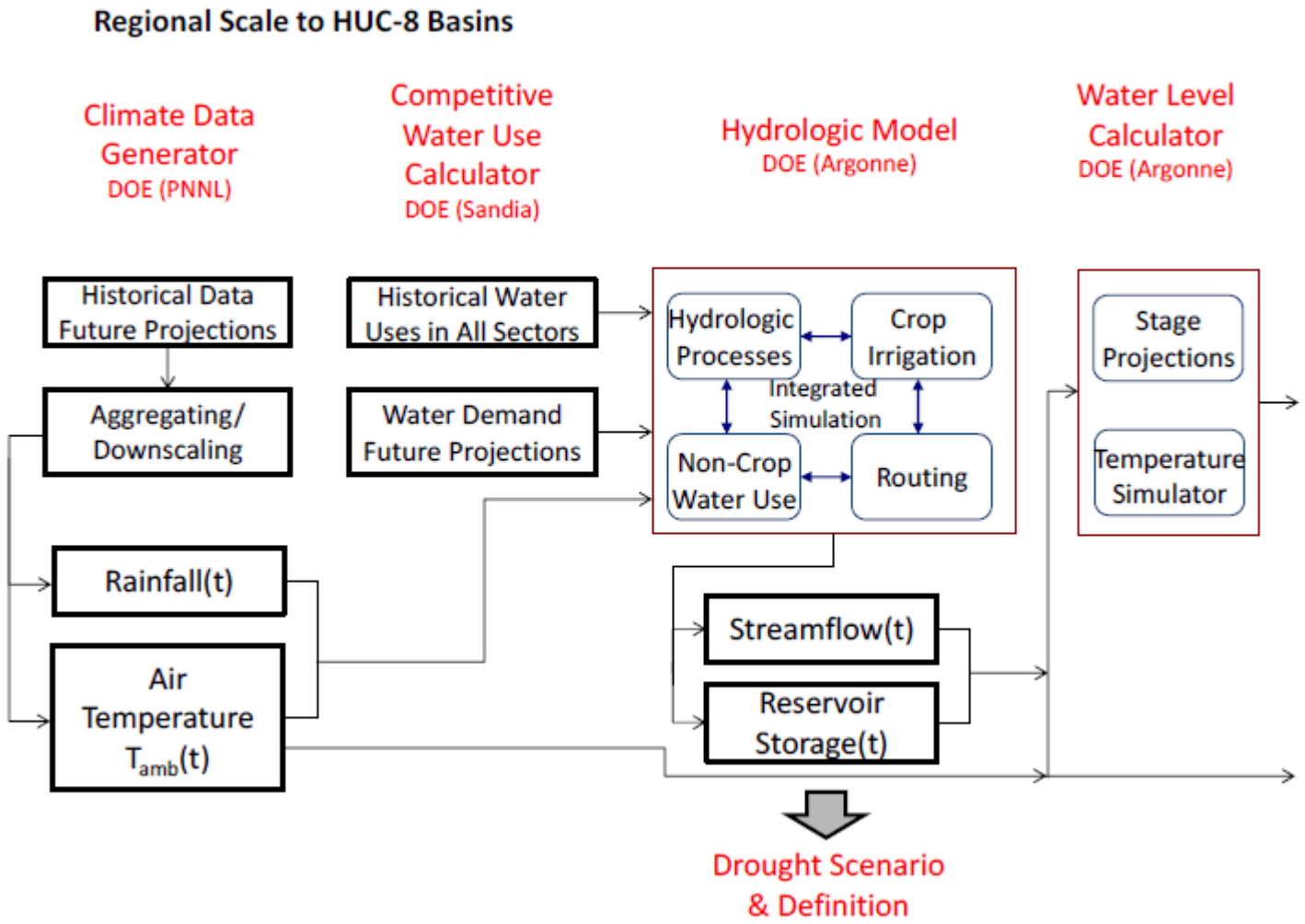
Thermoelectric Consumptive Use and Power Plants (Current)



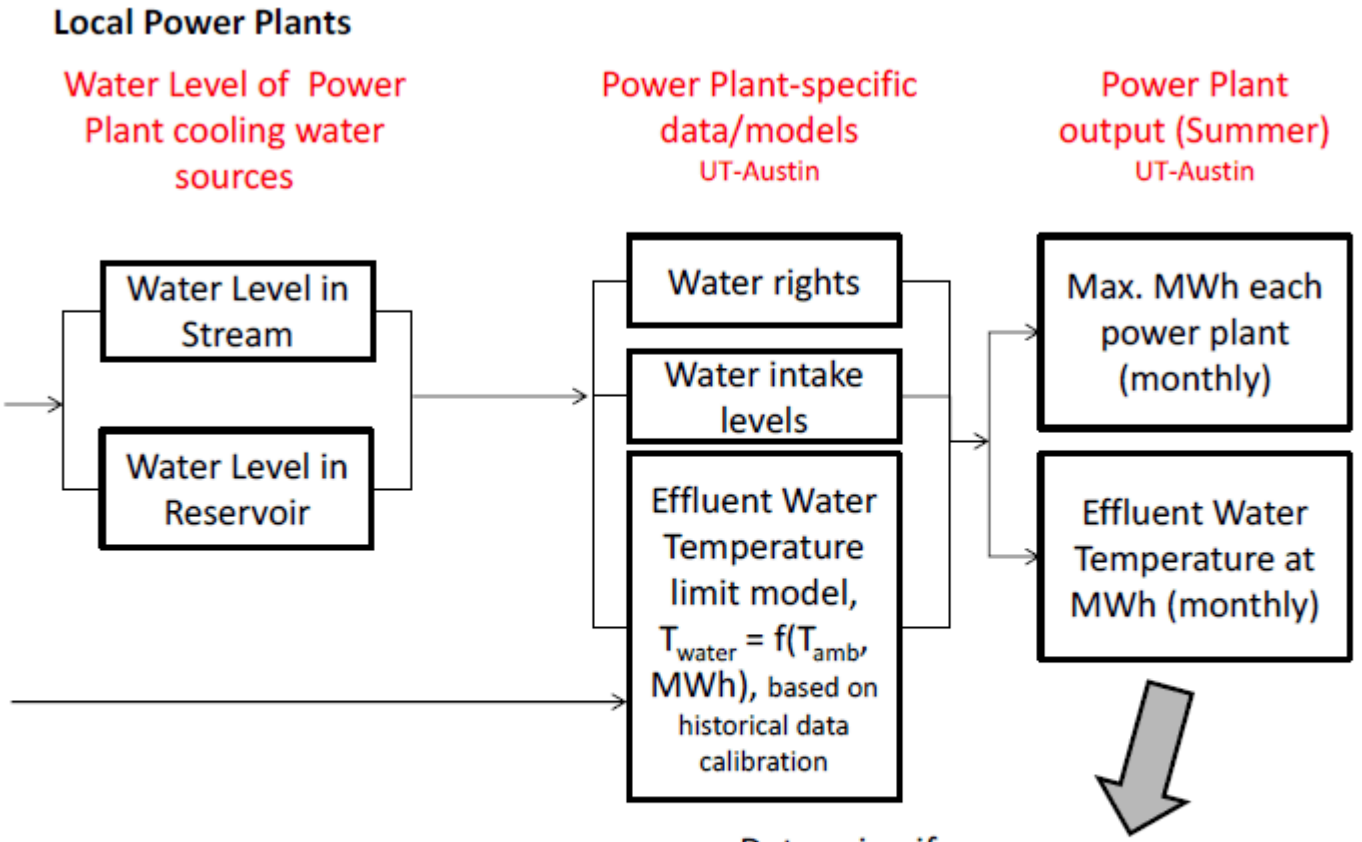
CLIMATE VARIABILITY IMPACTS ON ELECTRICITY GENERATION

- Evaluate impacts of future (2030s) climate variability, drought scenarios, and water demand
- Potential reduction or curtailment of power generation
  - Low lake levels
  - Thermal effluent limitations

Methods of Analysis (1)



Methods of Analysis (2)



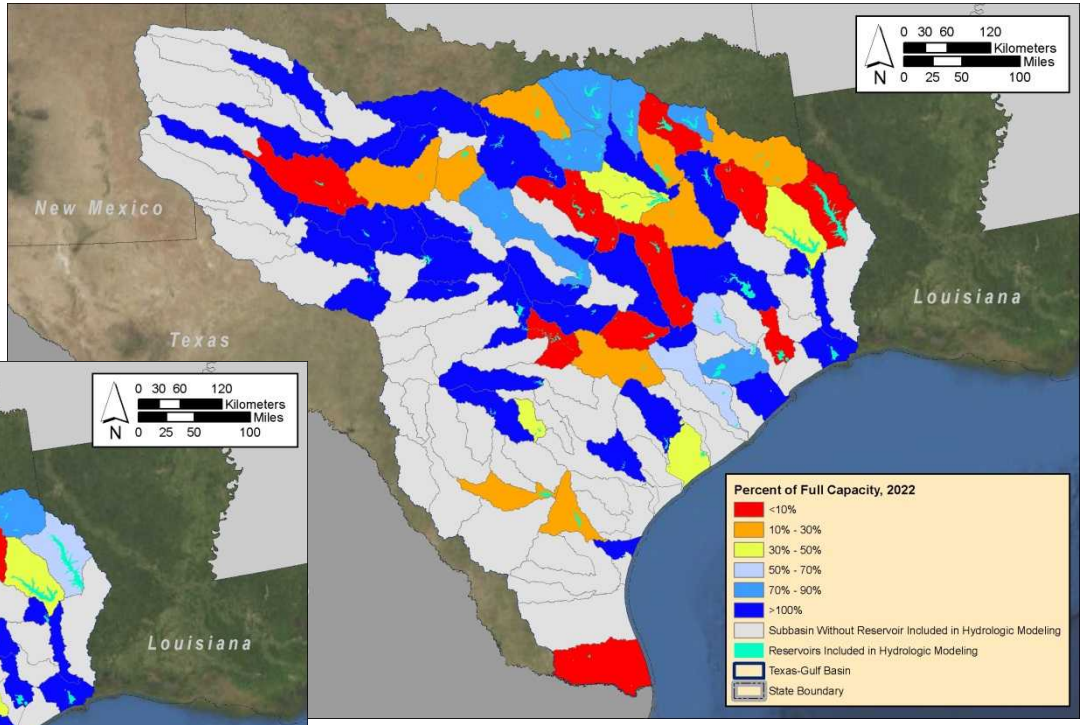
Determine if:

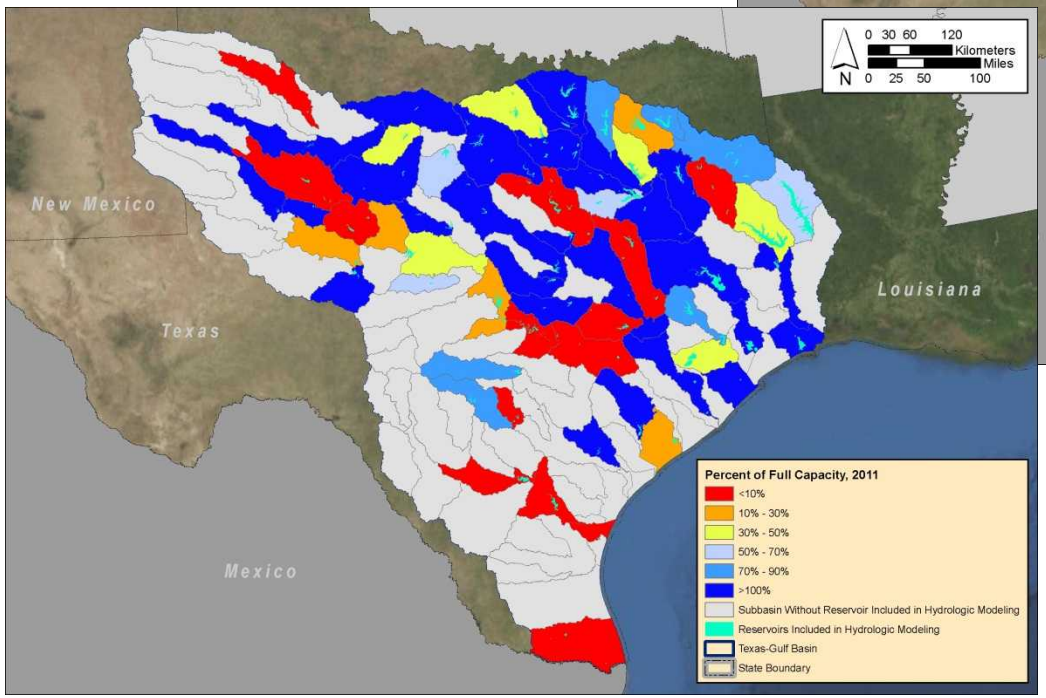
(i) water effluent temperature permit limits can reduce power generation,

(ii) intake levels constrain water intake, and therefore power generation

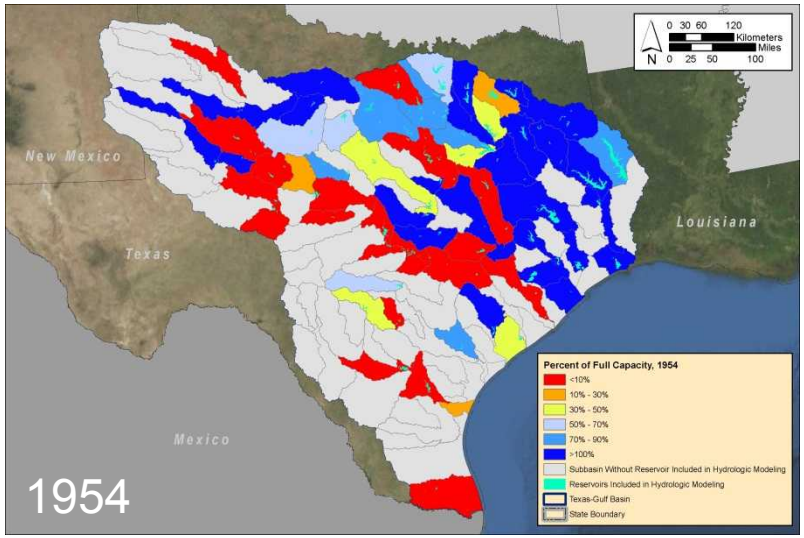
Hydrologic Modeling Results – *Single-Year Drought*

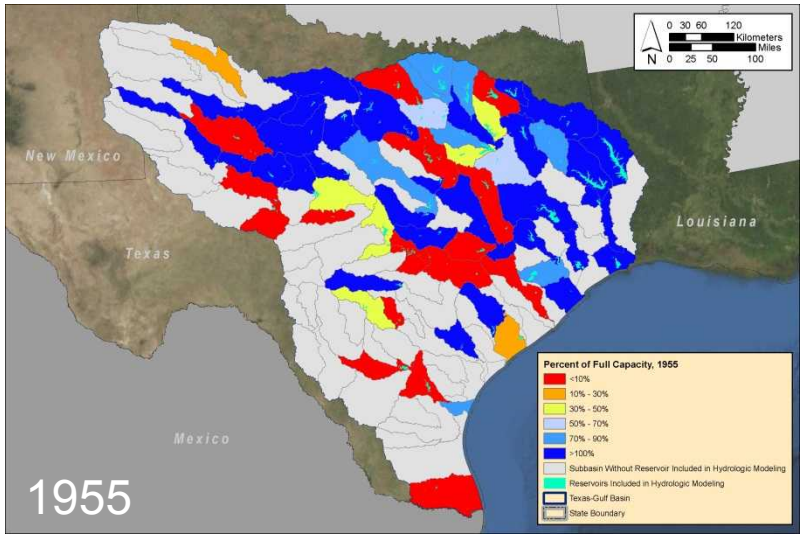
- Projected Reservoir Capacity in HUC-8 Basins



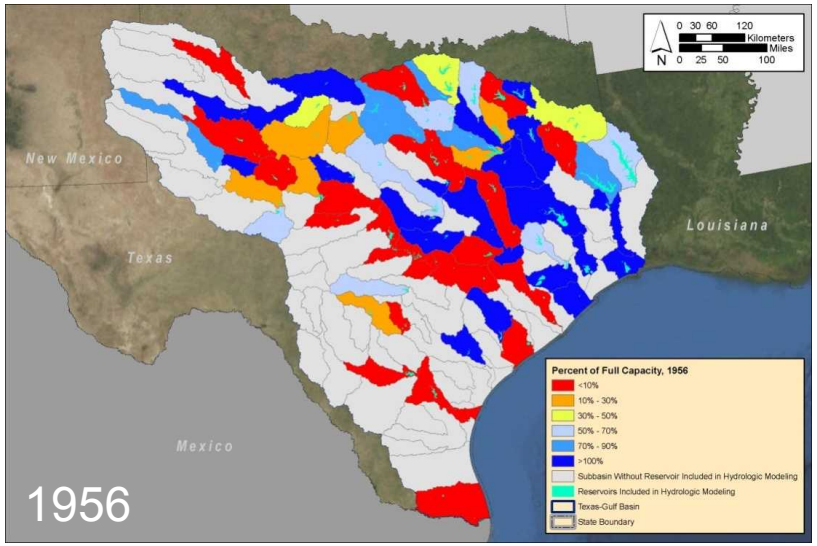


Hydrologic Modeling Results – *Multiple-Year Drought*

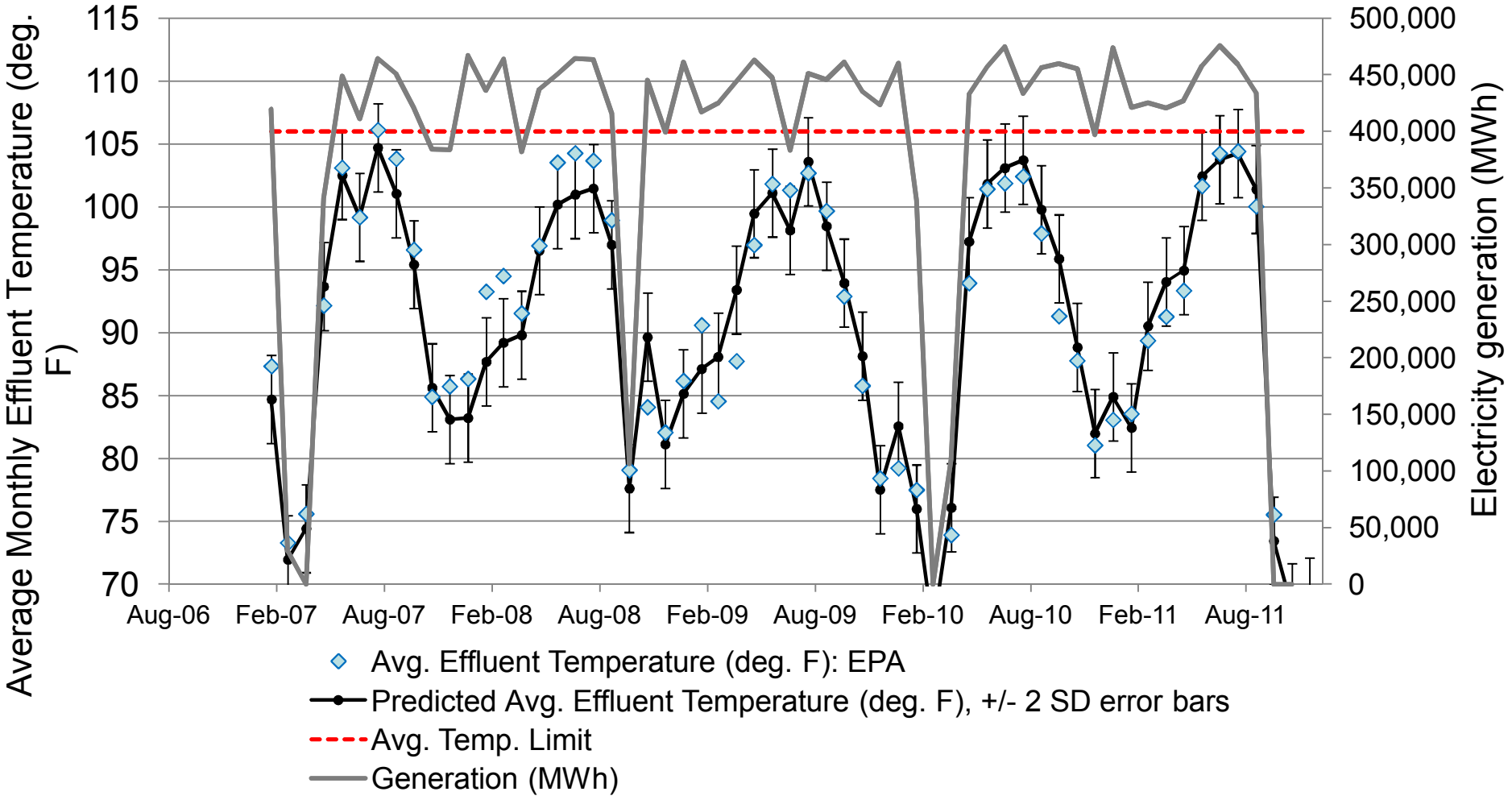




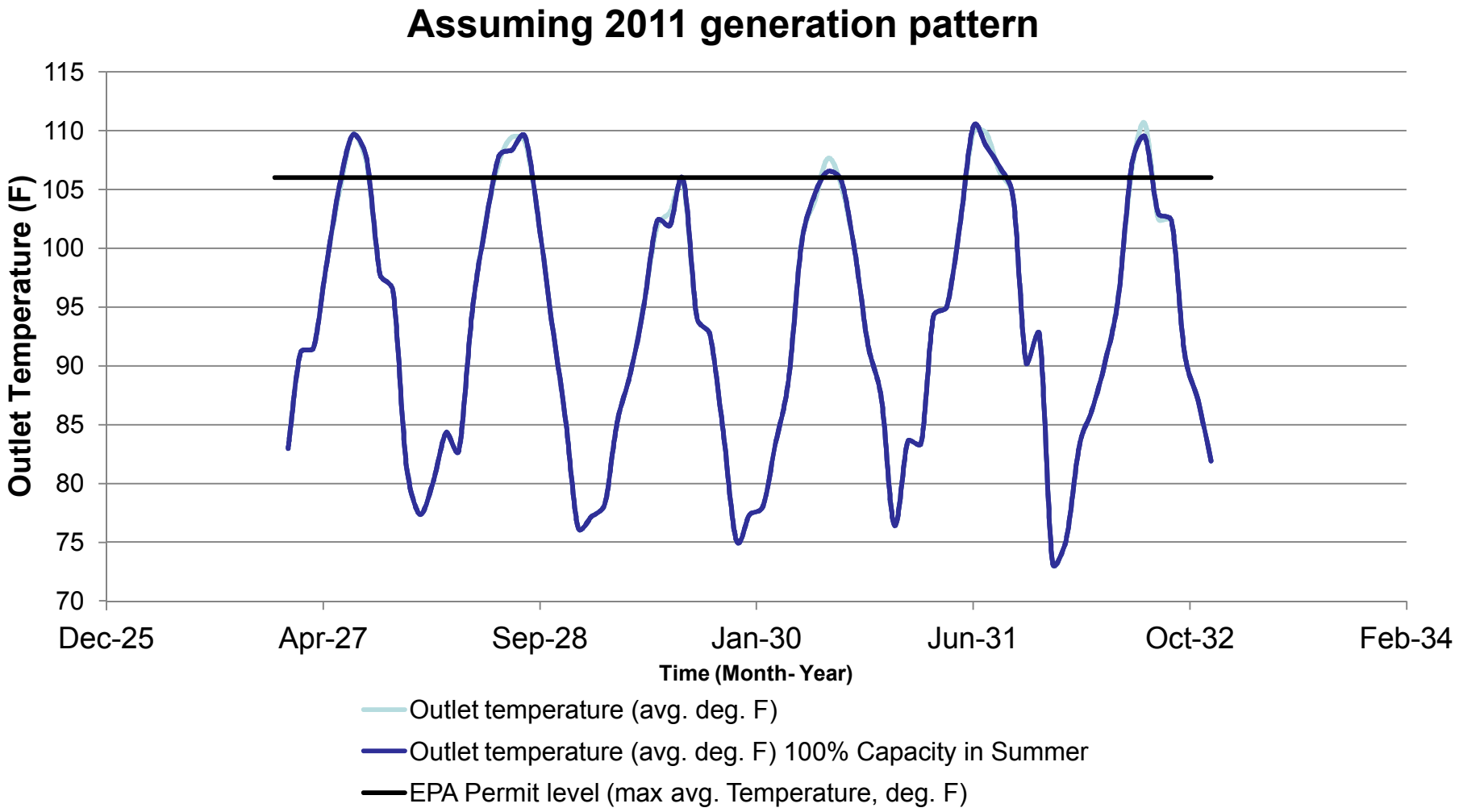
- Projected reservoir storage in HUC-8 basins under 1950-1957 drought scenario



Operations near thermal limit



Operations near thermal limit in future summers



Power Plant Siting Decisions

- West-wide objectives
  - Minimize cost
  - Maximize reliability
  - Maximize transmission capacity utilization
  - Limit exposure to policy change
  - ***Minimize stress over water***
- Power plant siting criteria
  - Fuel type
  - Cooling type
  - Capacity
  - Location
  - Water source

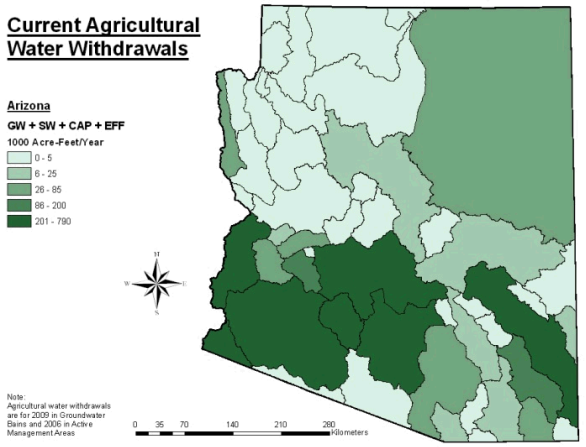
Key Water Sources

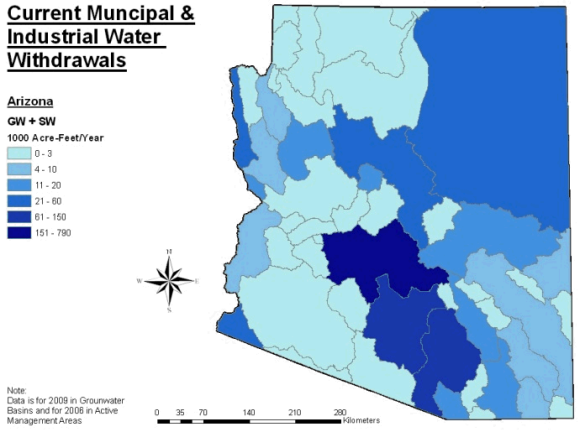
- **Potable Water**
  - **Unappropriated surface water**
  - **Unappropriated groundwater**
  - **Appropriated water (rights transfers)**
- **Non-Potable Water**
  - **Municipal/Industrial wastewater**
  - **Shallow brackish water**

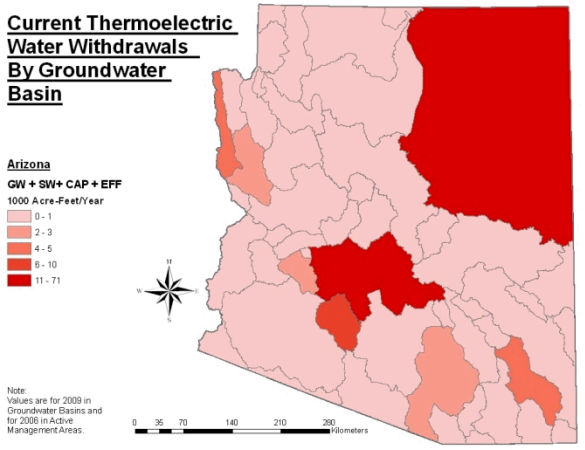
Relative Availability and Cost

Water Availability Indicators: Demand

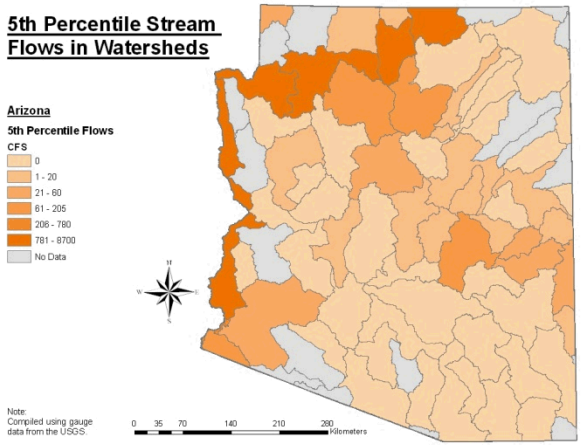
- ***Focus on withdrawals***
- ***Estimate consumption from withdrawals***
- ***Disaggregate by:***
  - ***8-digit watershed***
  - ***Sector***
    - ***M&I***
    - ***Agriculture***
    - ***Evaporative***
    - ***Instream***
  - ***Water source***



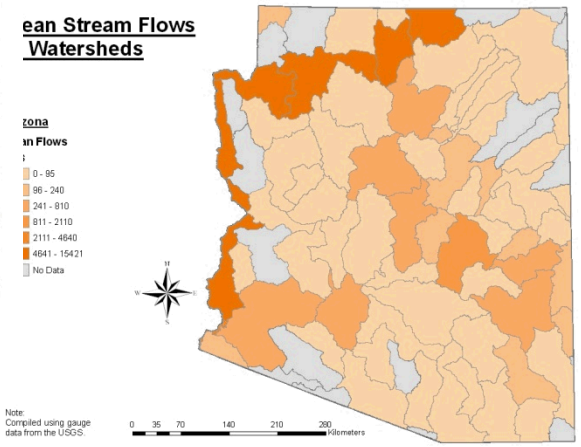




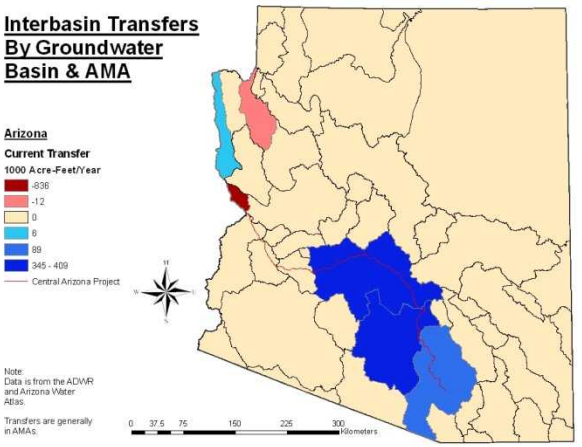
Water Availability Indicators: Supply



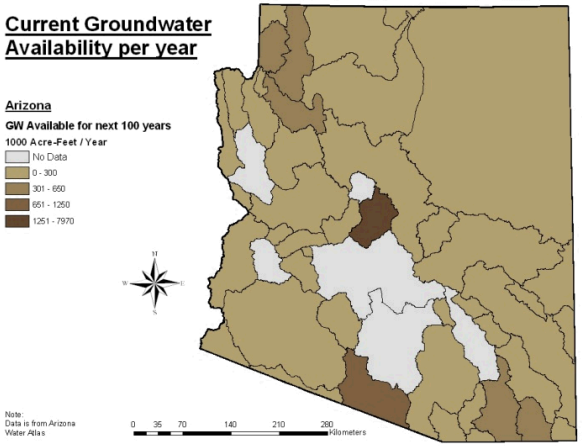
Mean Gauged Streamflow



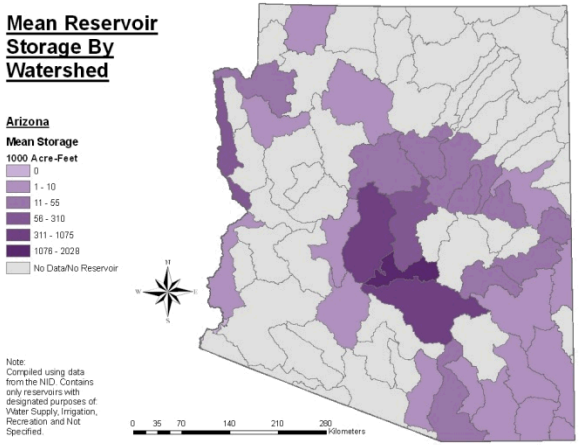
Annual Low Flow



Interbasin Transfers

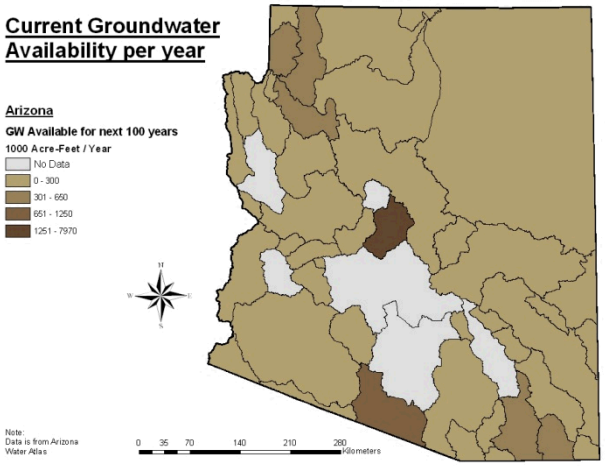


Groundwater Depletion

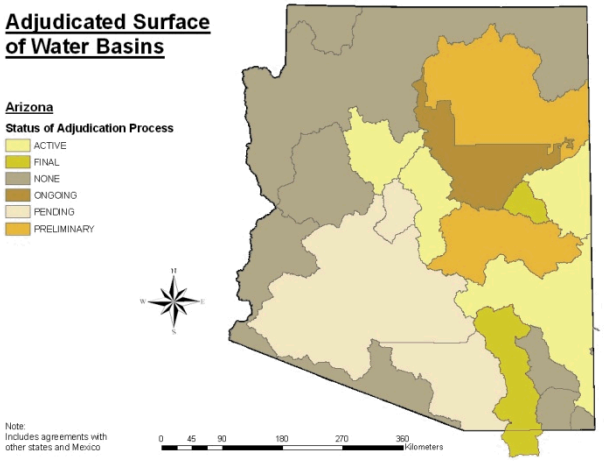


Reservoir Storage

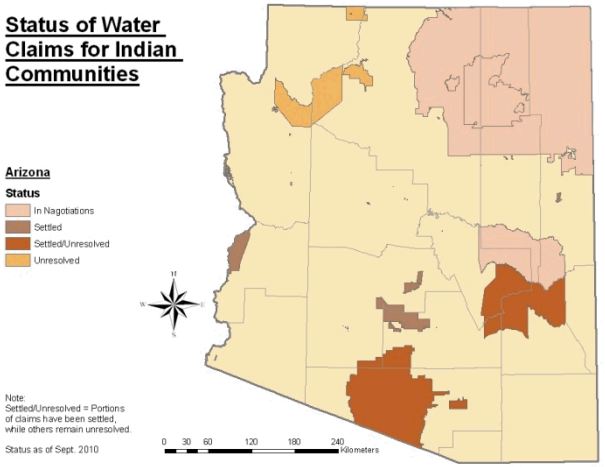
Water Availability Indicators: Institutional Factors



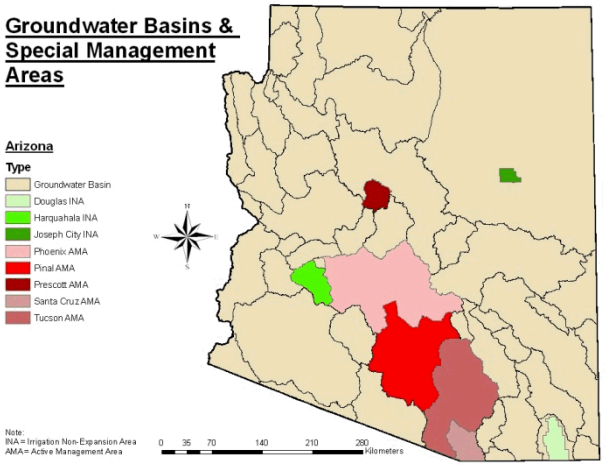
Unappropriated Water



Adjudication Status



Indian Water

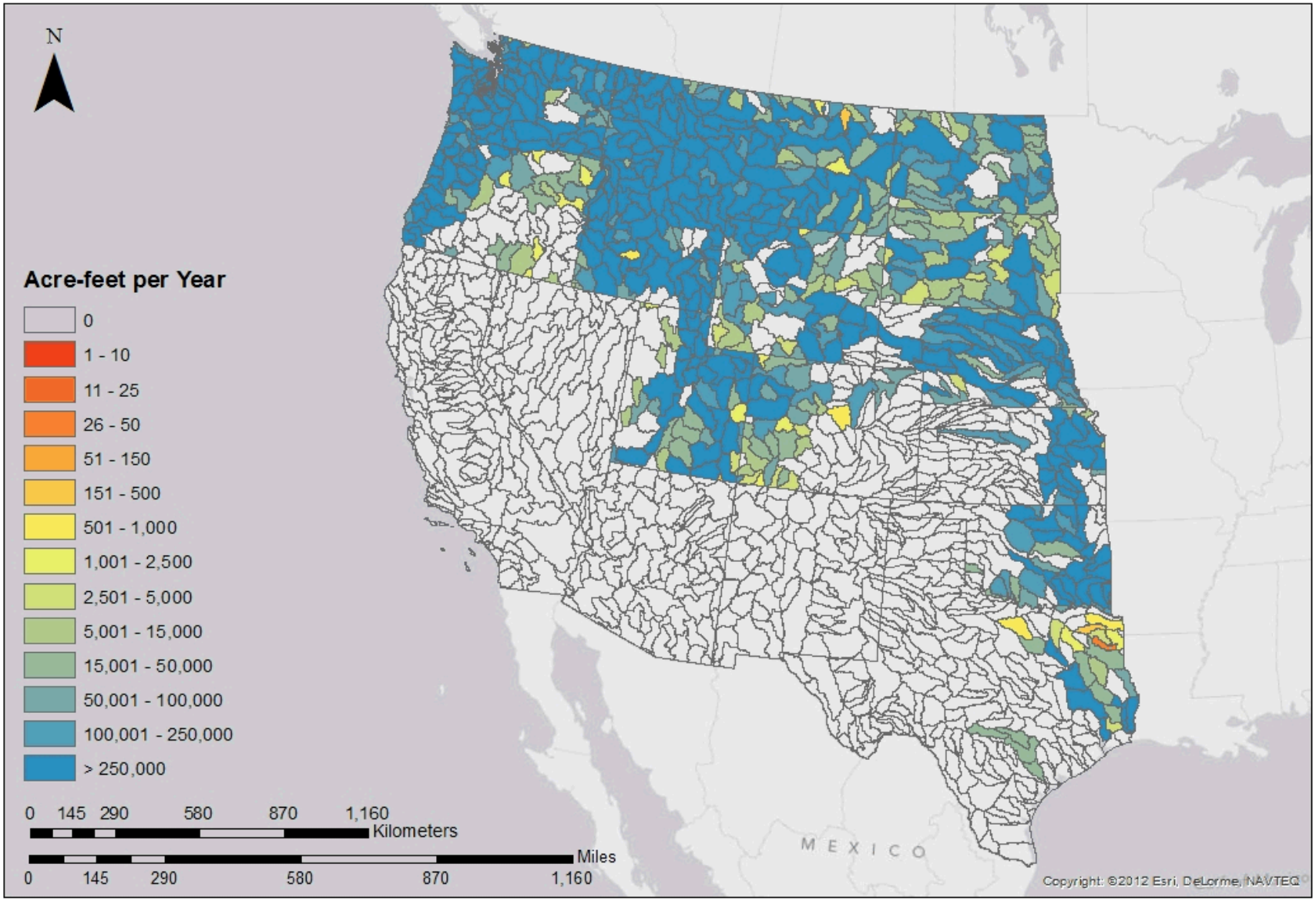


Administrative Control Areas

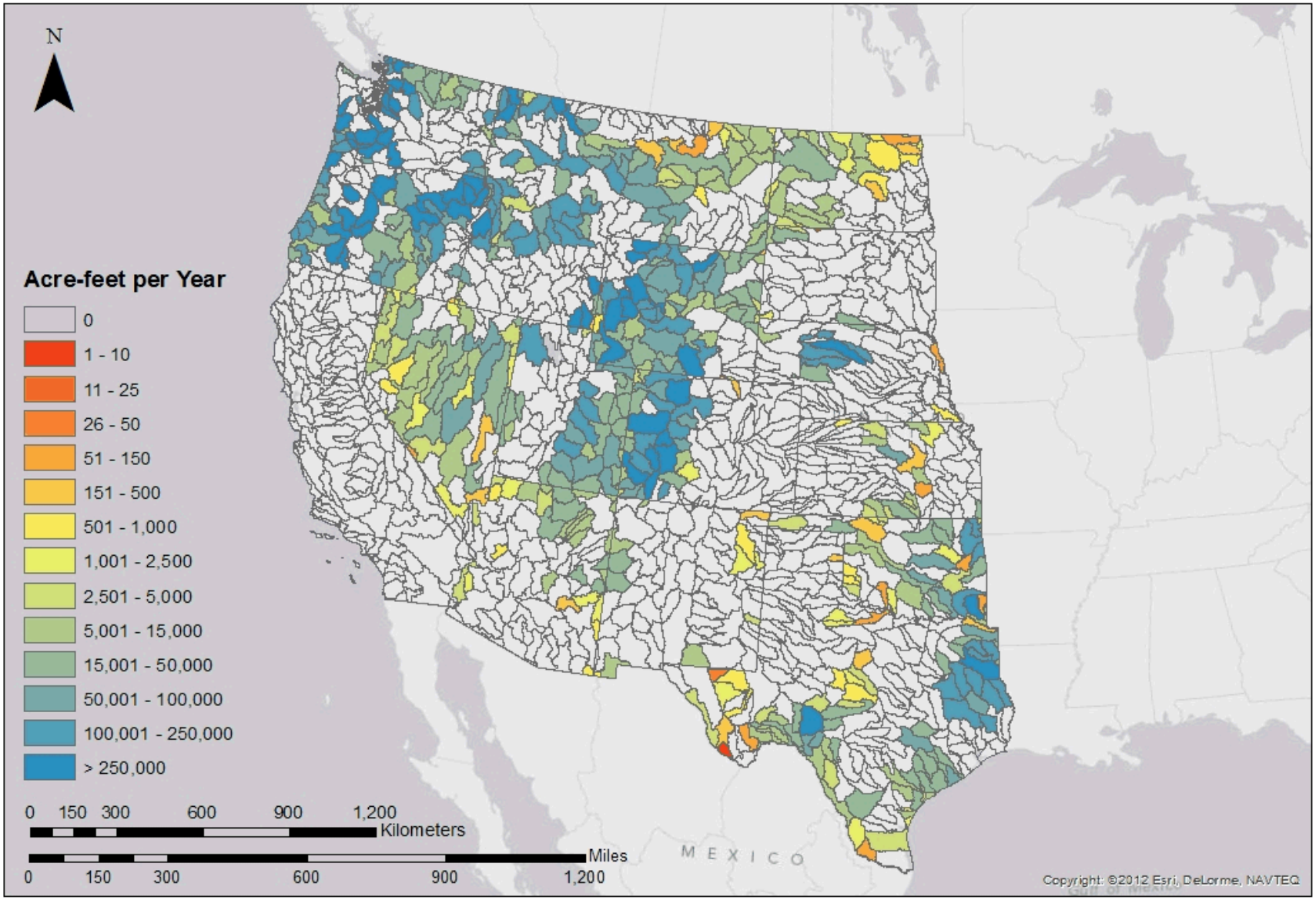
Metric Development

- **Data on “available water” are rare**
- **As such, metrics were estimated from available information**
- **Assisted by volunteer team from WSWC**
  - **Bret Bruce (USGS)**
  - **Dan Hardin (TX)**
  - **Sara Larsen (WSWC)**
  - **Dave Mitamura (TX)**
  - **Andy Moore (CO)**
  - **Ken Stahr (OR)**
  - **Todd Stonely (UT)**
  - **Steve Wolff (WY)**
  - **Dwane Young (WSWC)**

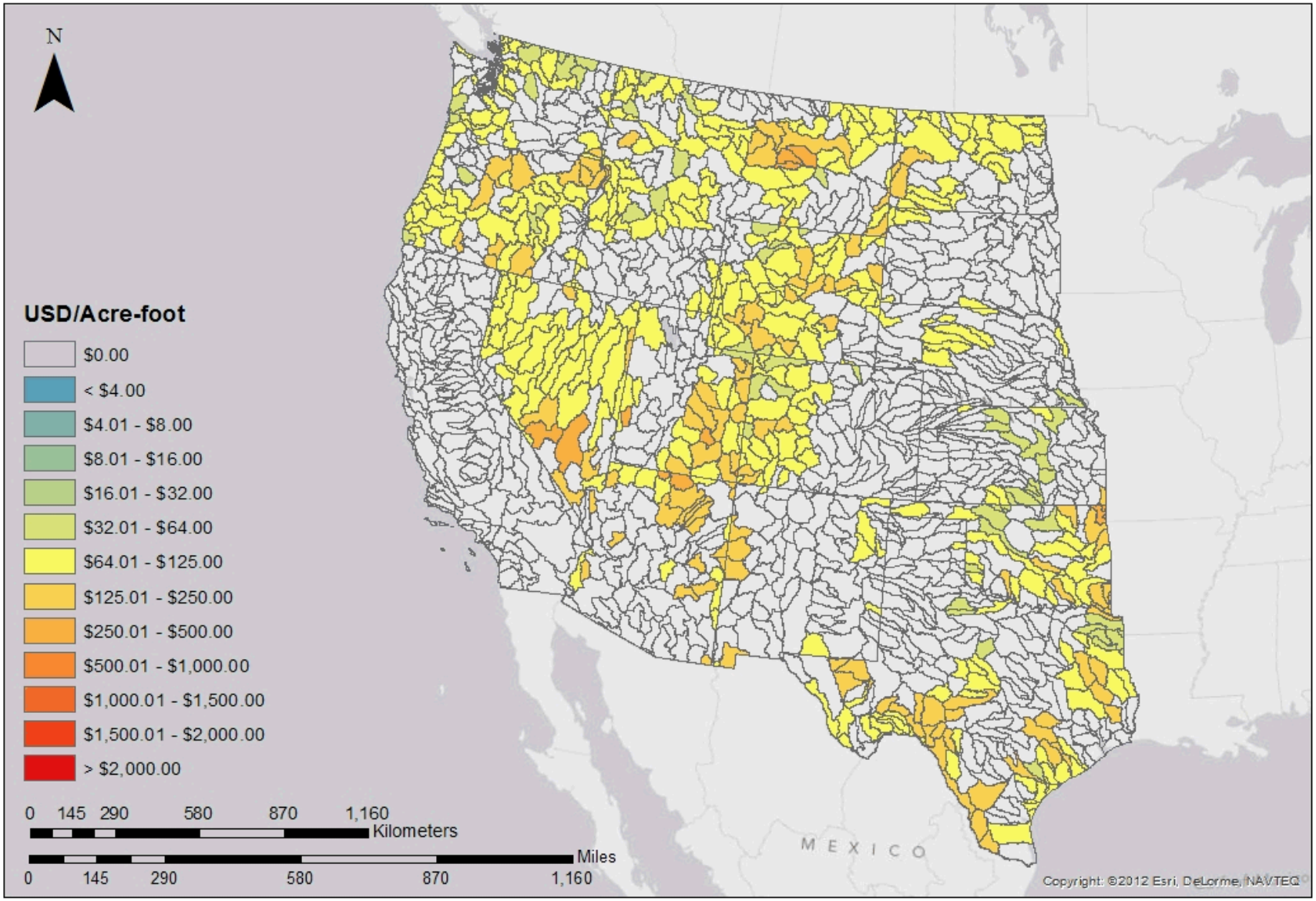
Unappropriated Surface Water Availability



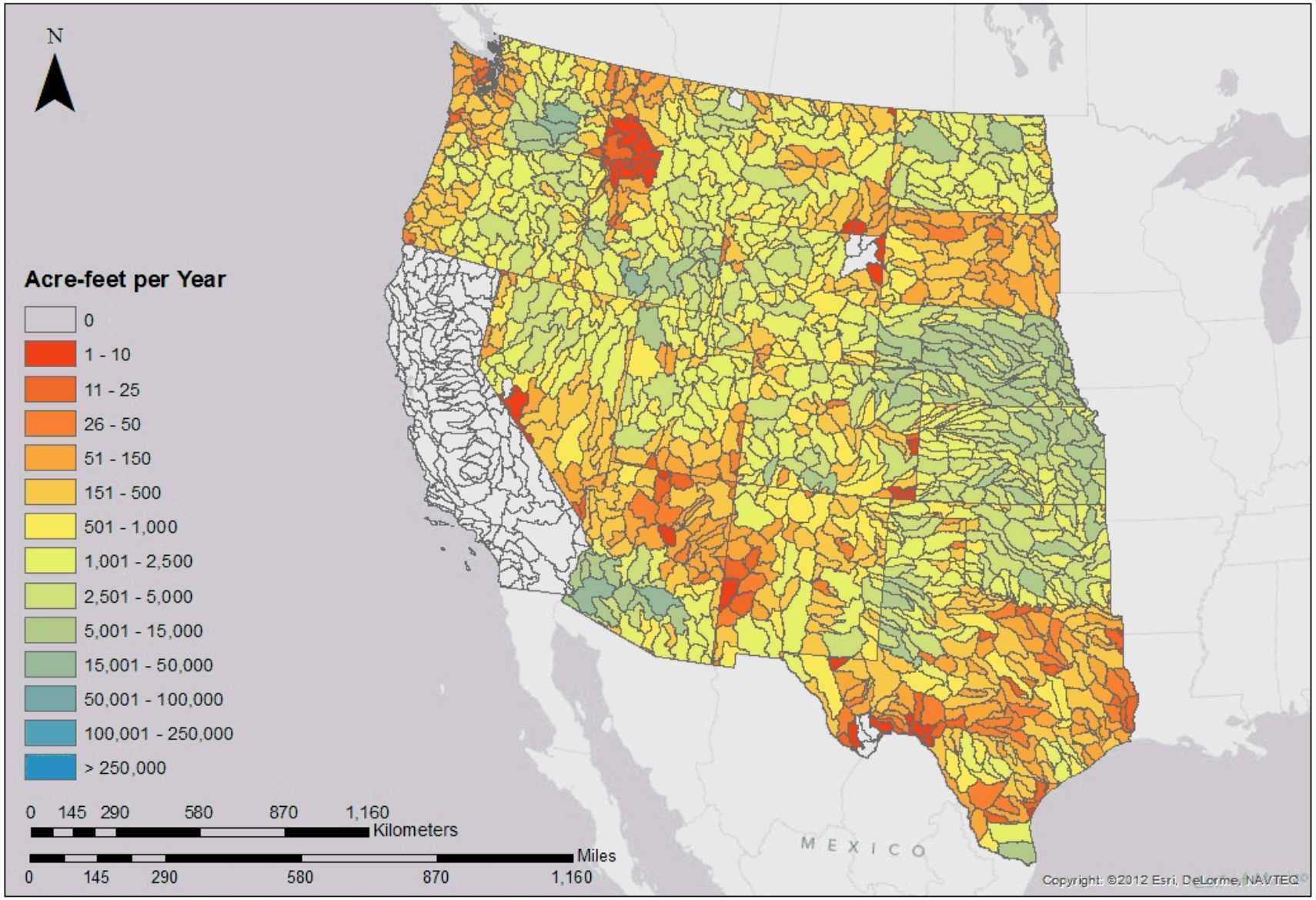
Potable Groundwater Availability



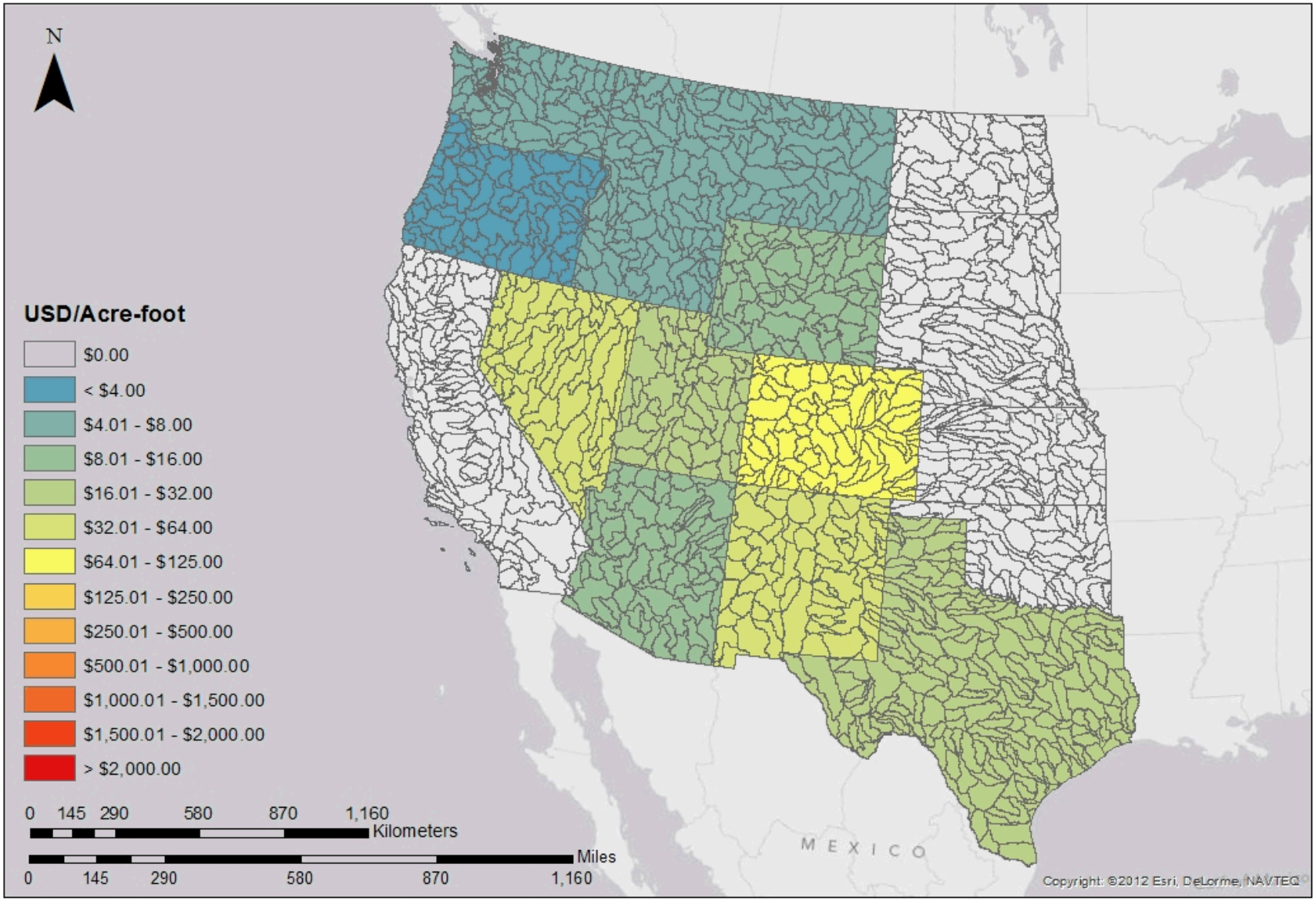
Potable Groundwater Cost



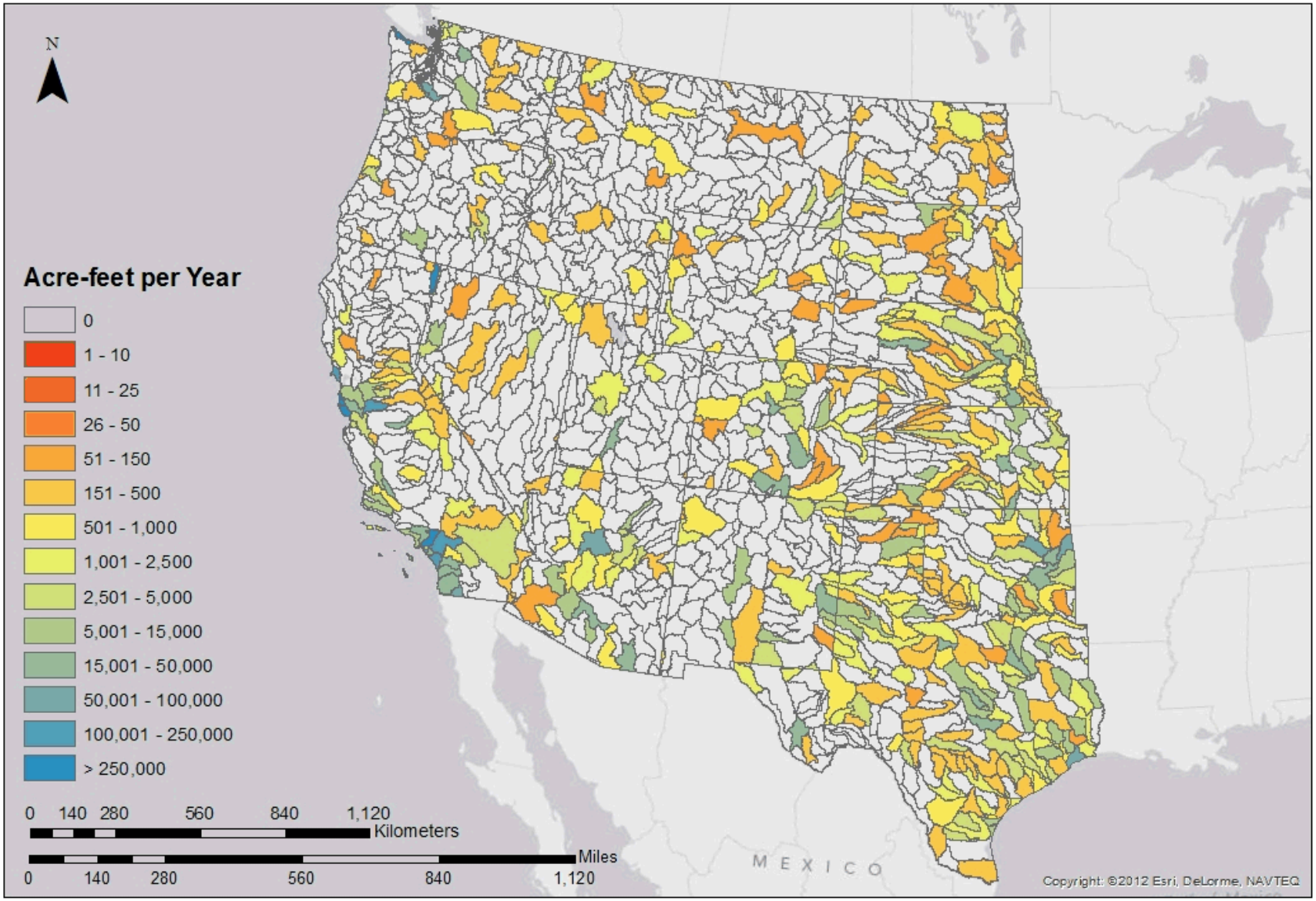
Appropriated Water Availability



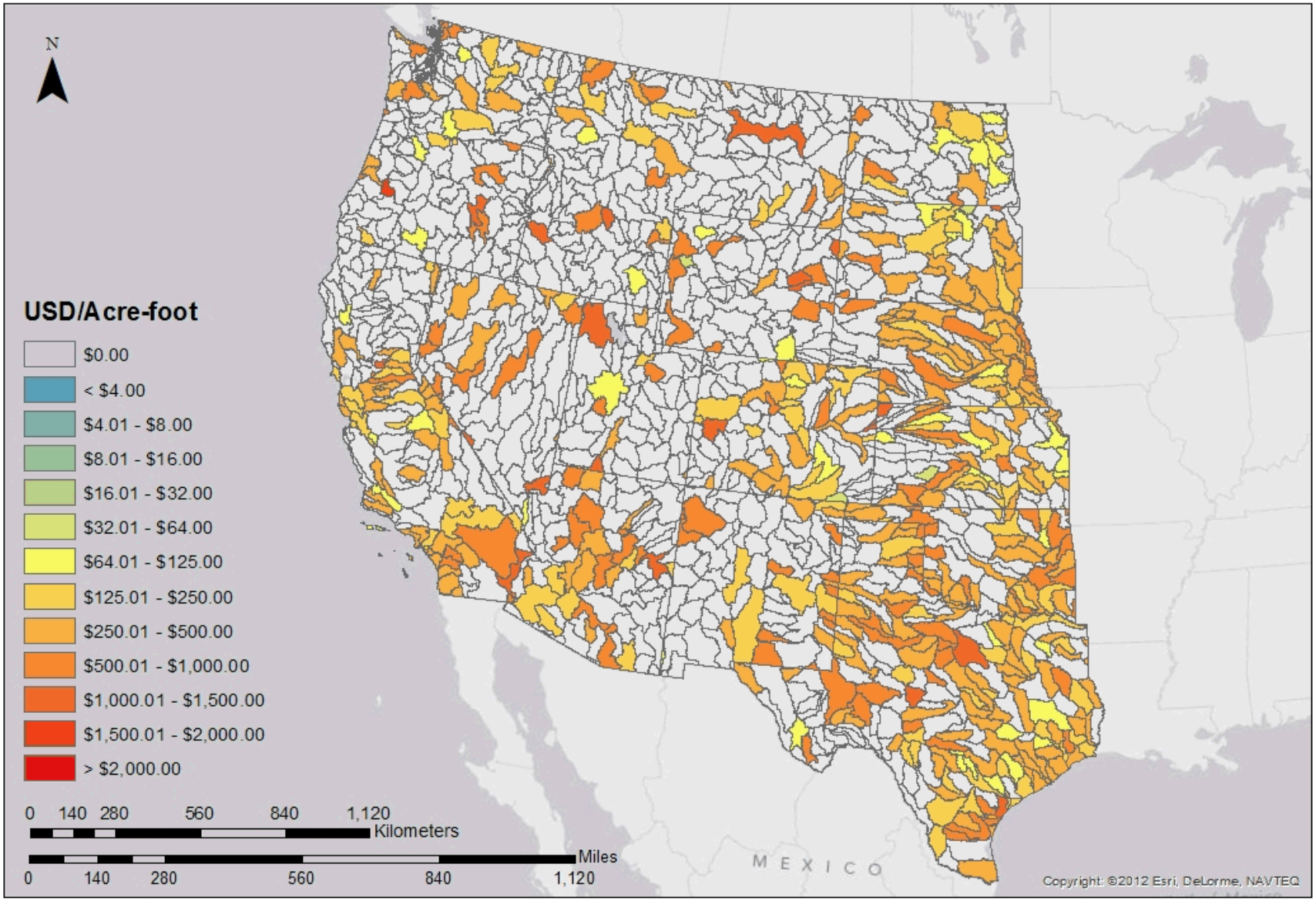
Appropriated Water Cost



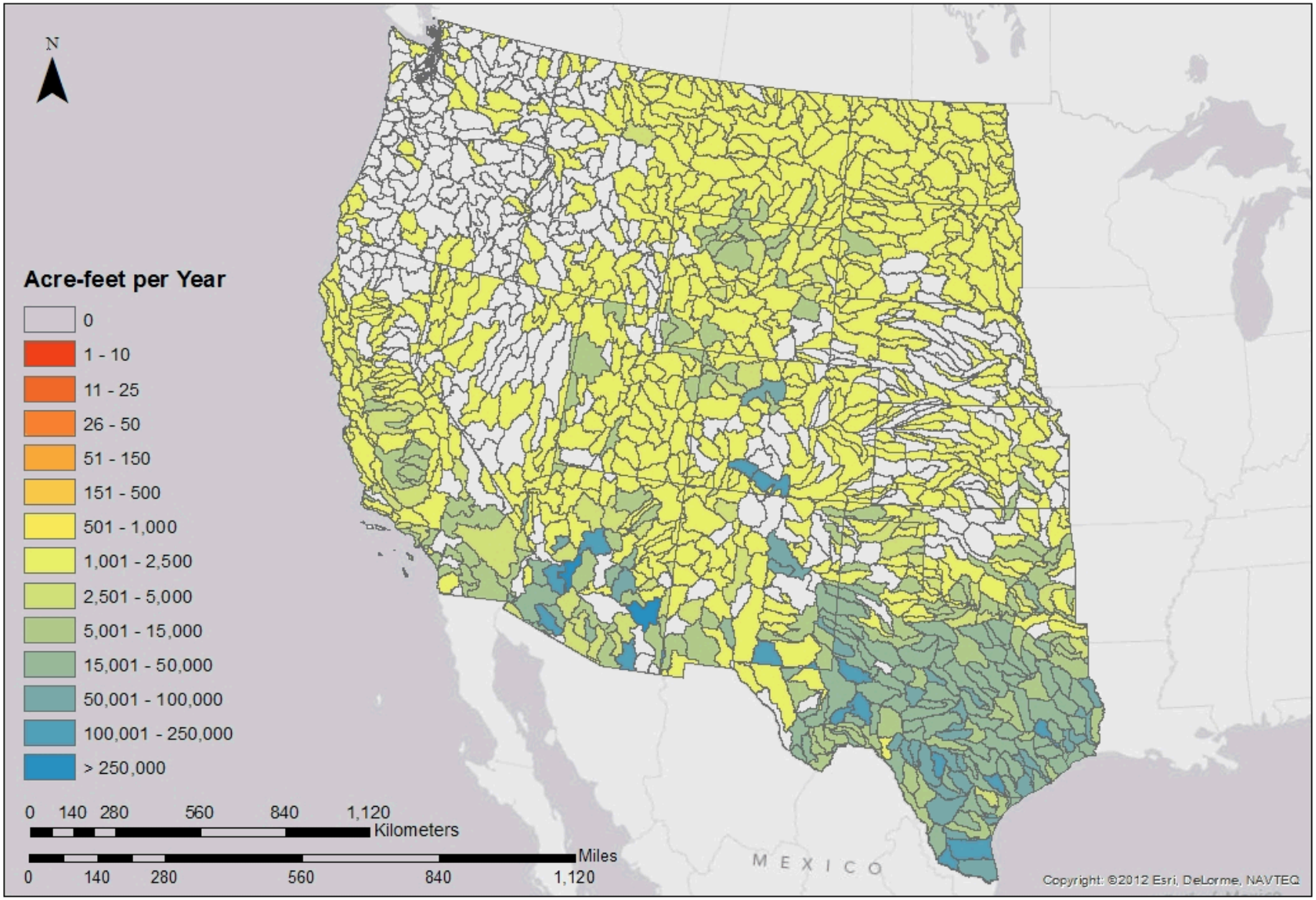
Wastewater Availability



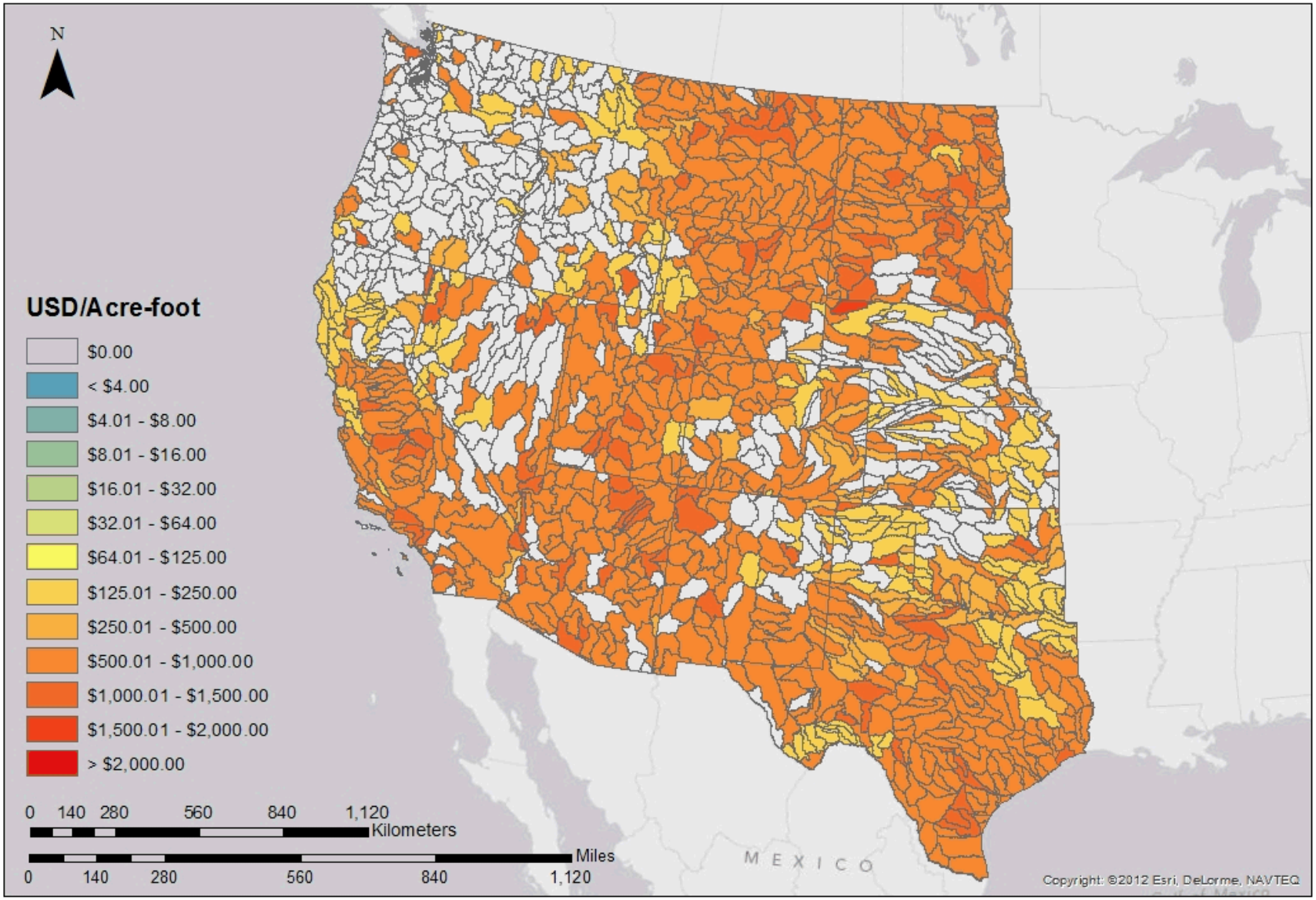
Wastewater Cost



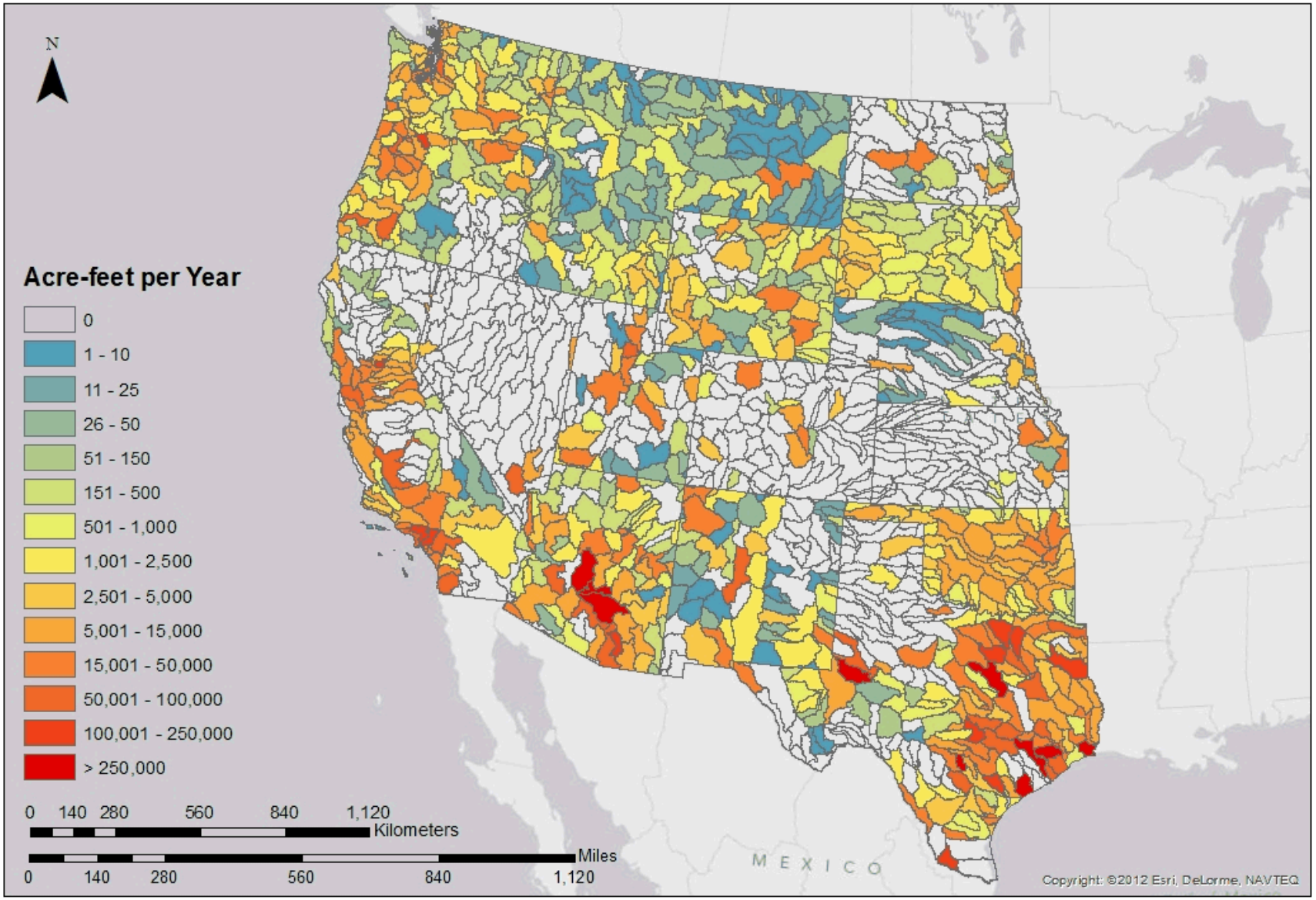
Brackish Groundwater Availability



Brackish Groundwater Cost

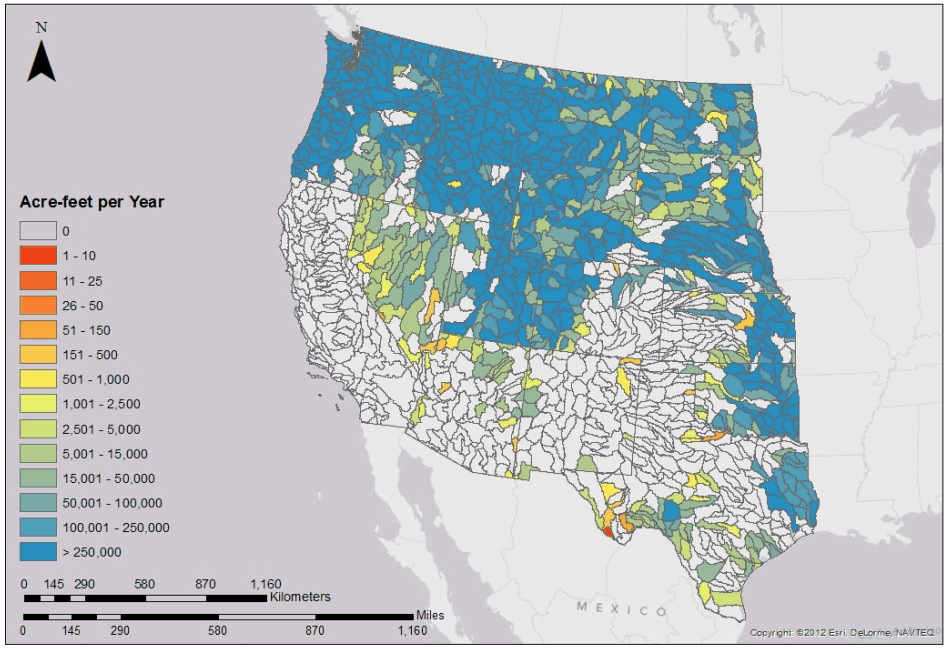


Change in Demand through 2030

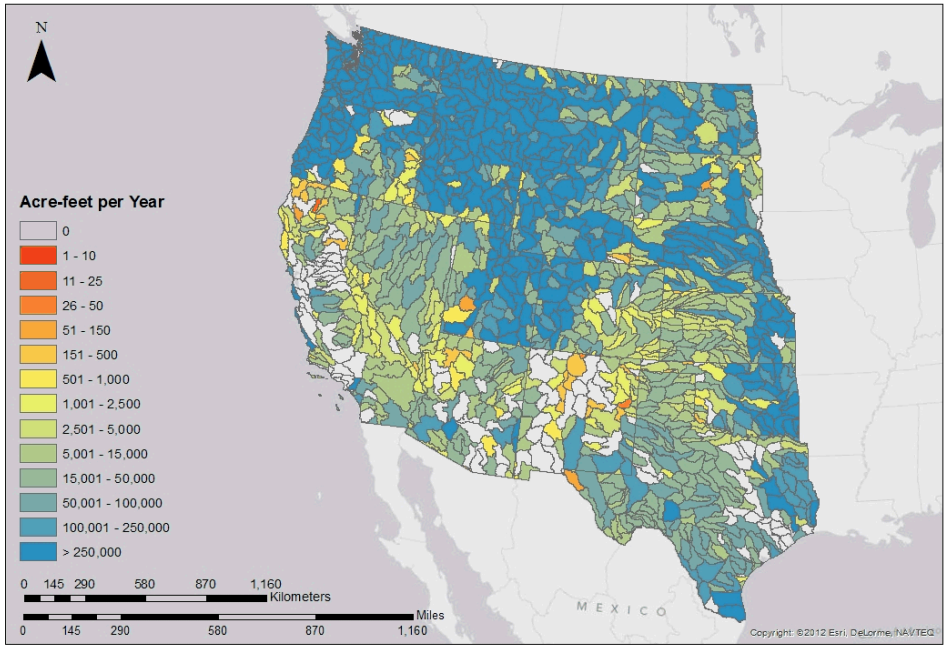


Water for Development

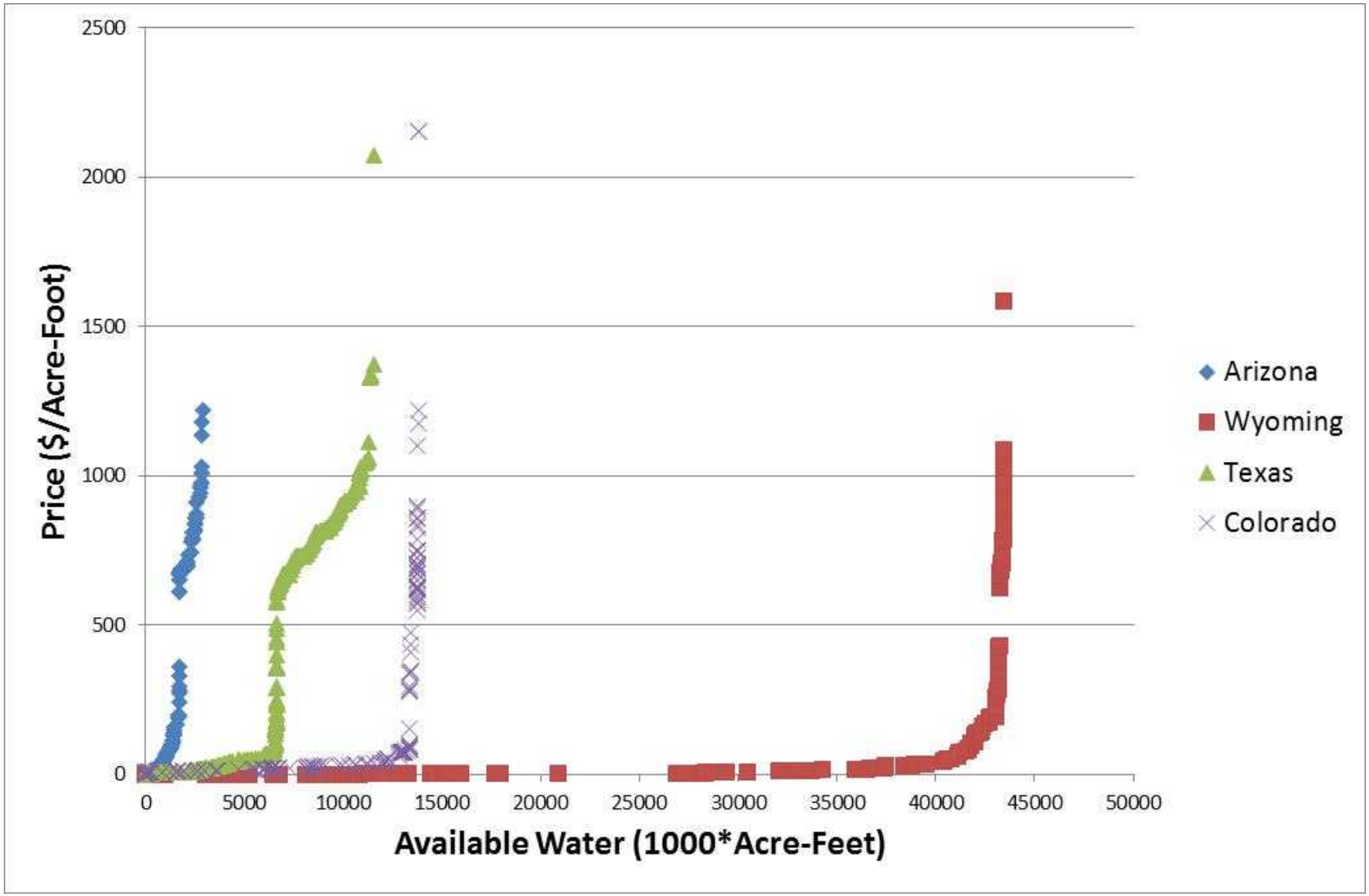
Unappropriated Water Sources - Change in Demand, 2030



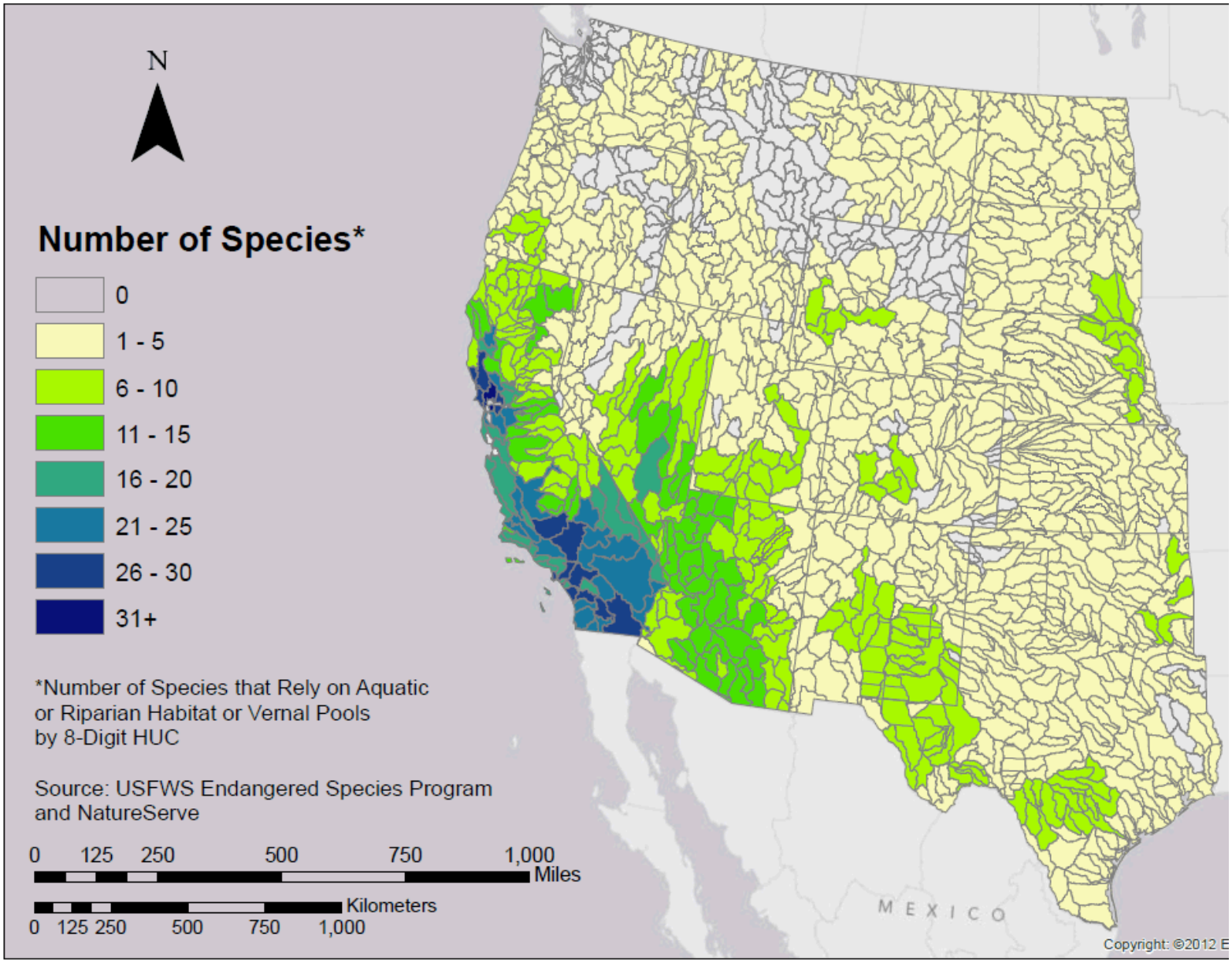
All Water Sources - Change in Demand, 2030



State-Level Supply Curves

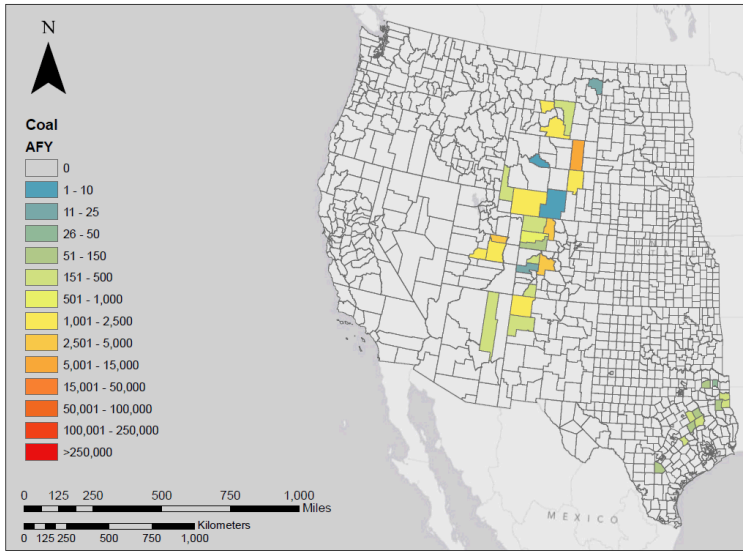


Endangered Species by 8-Digit HUC

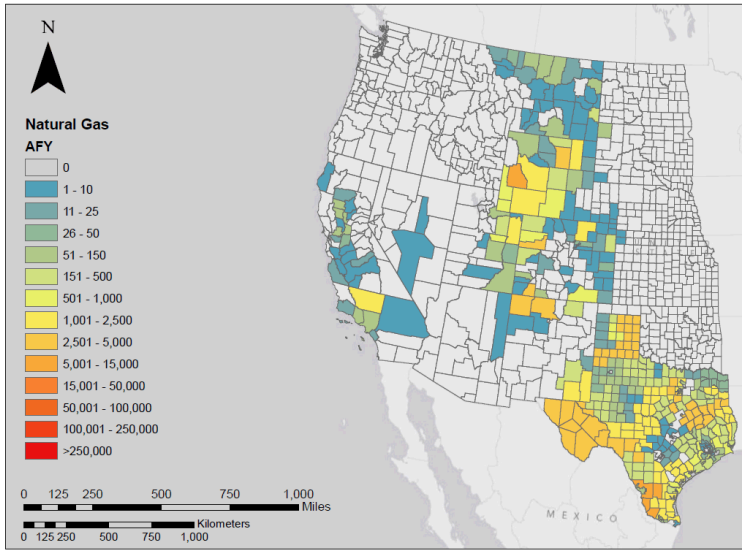


Water for Fuel Extraction

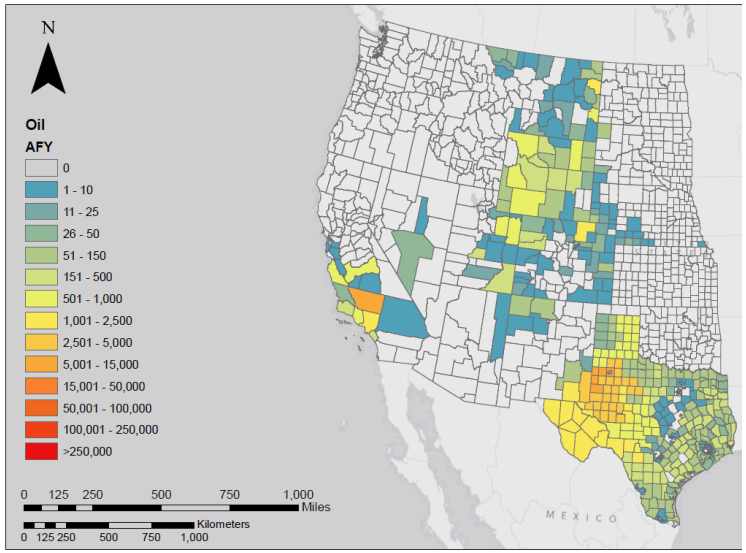
Water Use COAL



Water Use NATURAL GAS

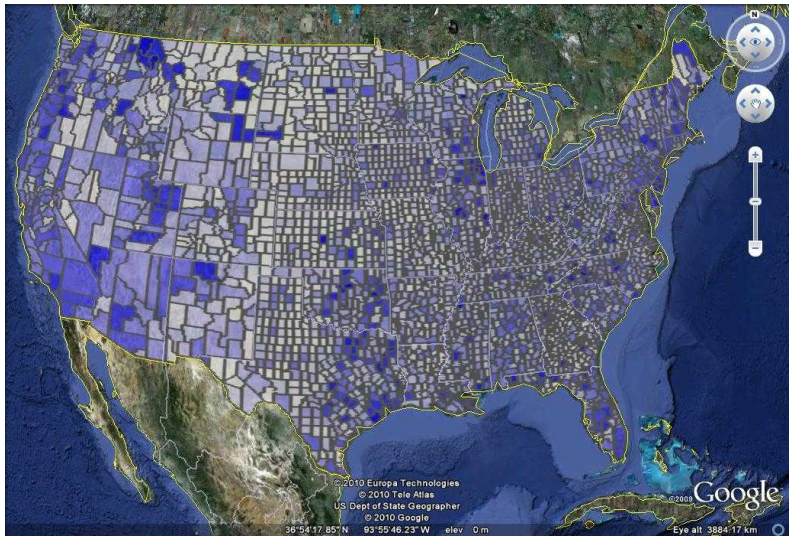


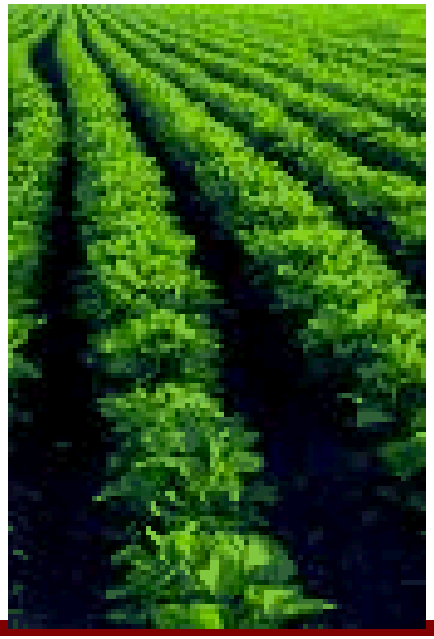
Water Use OIL



Energy for Water Calculator

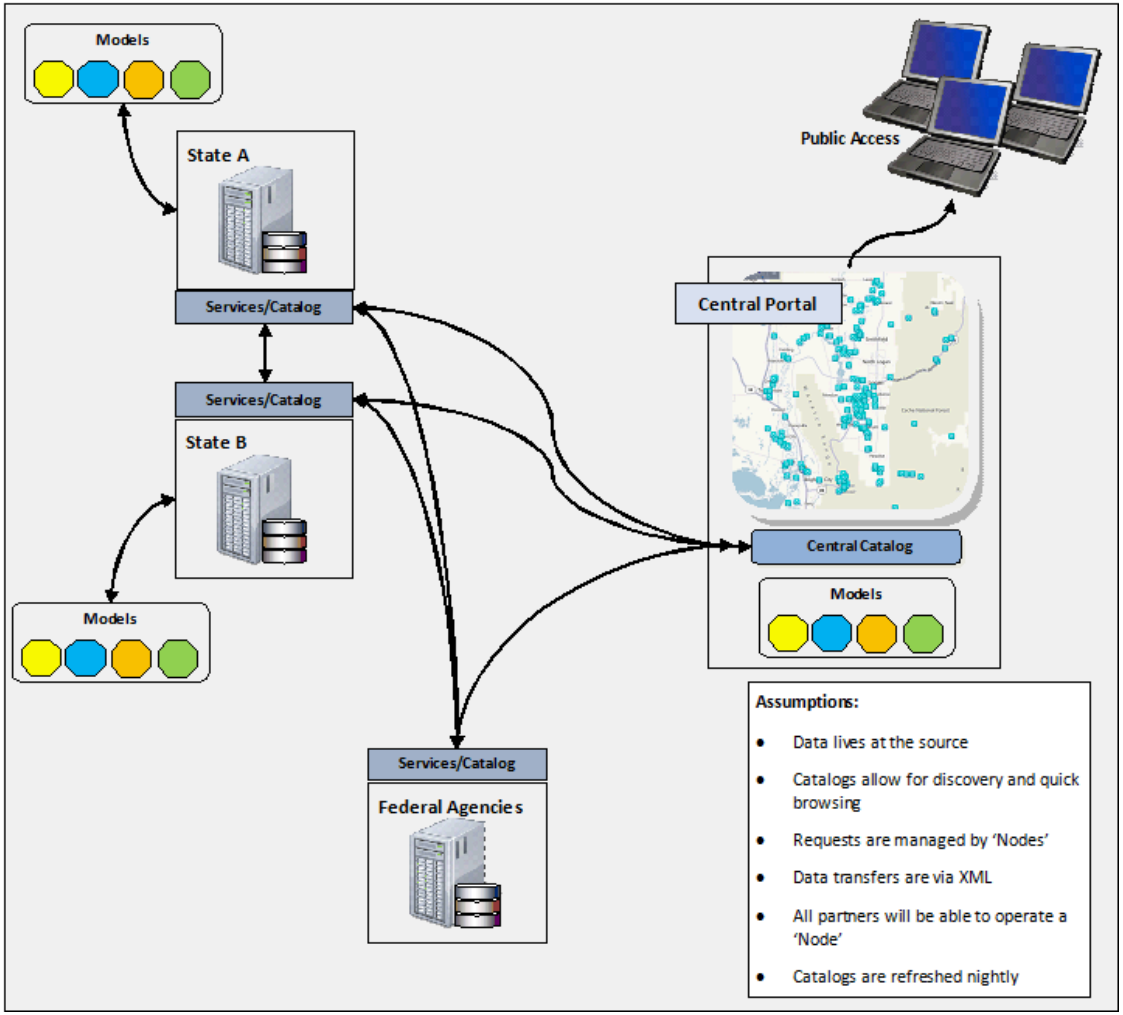
- ***Update Energy for Water Model***
- ***Energy for Large Projects***
- ***Energy for Agriculture***

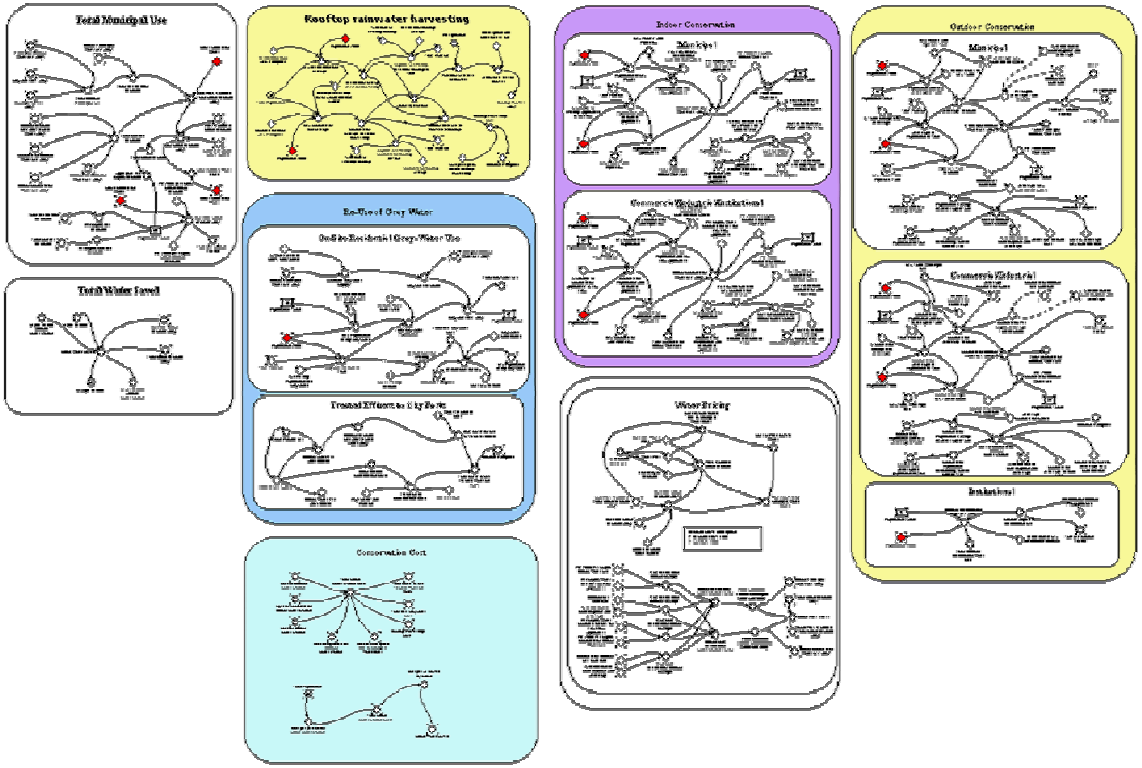


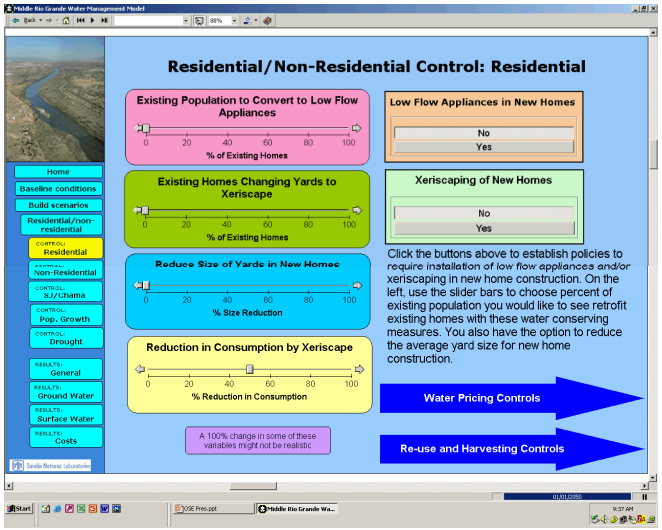


Water Use Data Exchange (WaDE)

- Use Web Services to transfer data
- Data Stay at the Source (i.e. the states)
- Provide transparent link between state data and integrated water metrics
  - Link to metadata
  - Changes in state data are automatically reflected in metrics







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