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Energy and Water in the Texas and Western Interconnections

WSWC/WGA Energy-Water Workshop

Denver, CO

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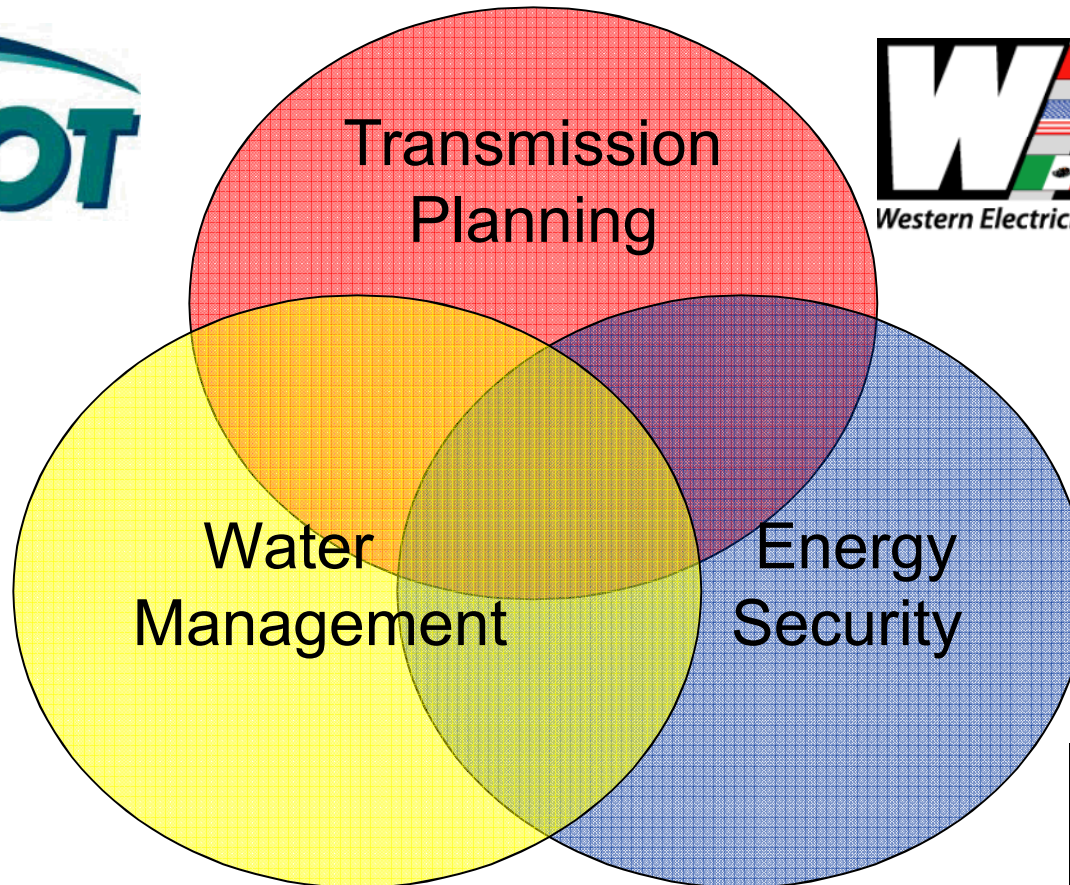
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- Ruby Leung

- University of Texas

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- Carey King



Integrated Planning



**WESTERN
GOVERNORS'
ASSOCIATION**

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



WSWC

Western States Water Council

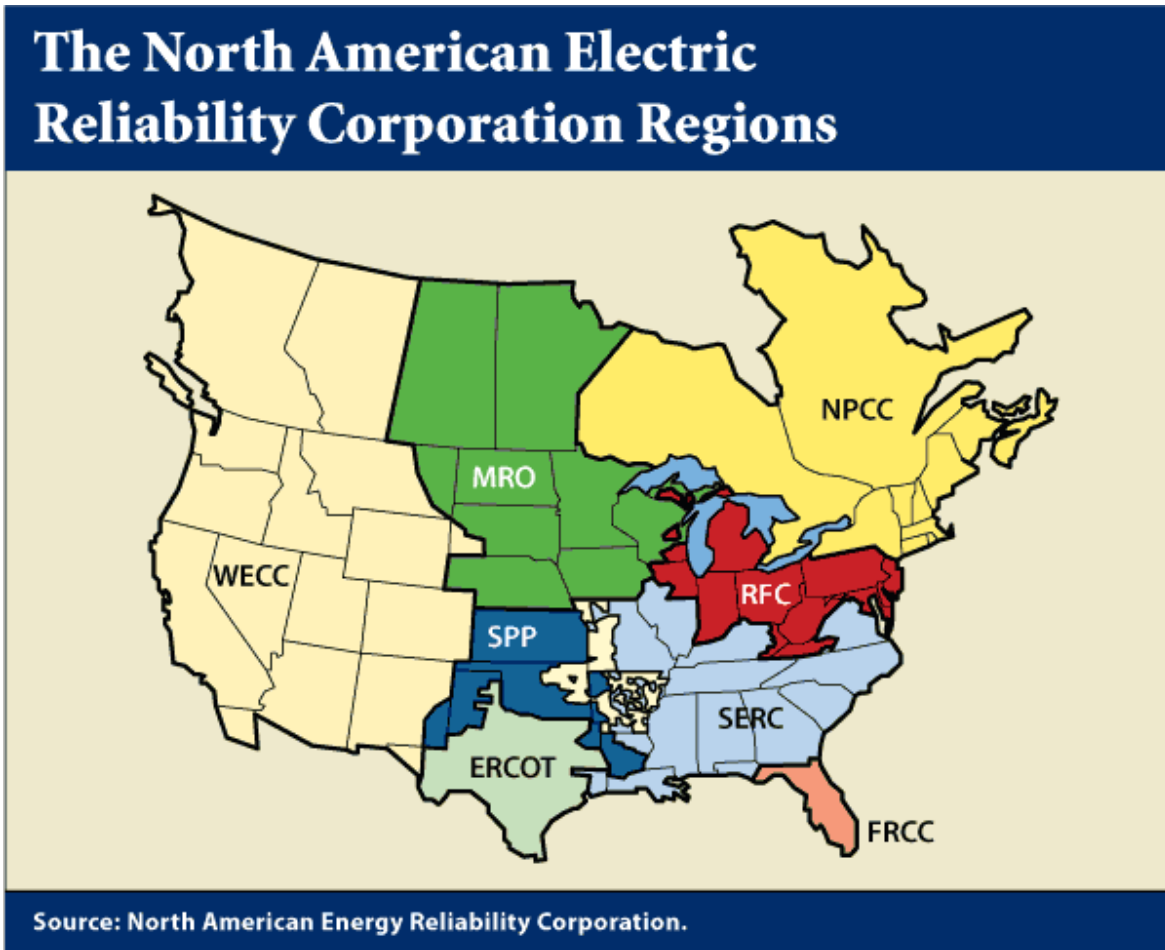


Energy and Water in the Western and Texas Interconnections

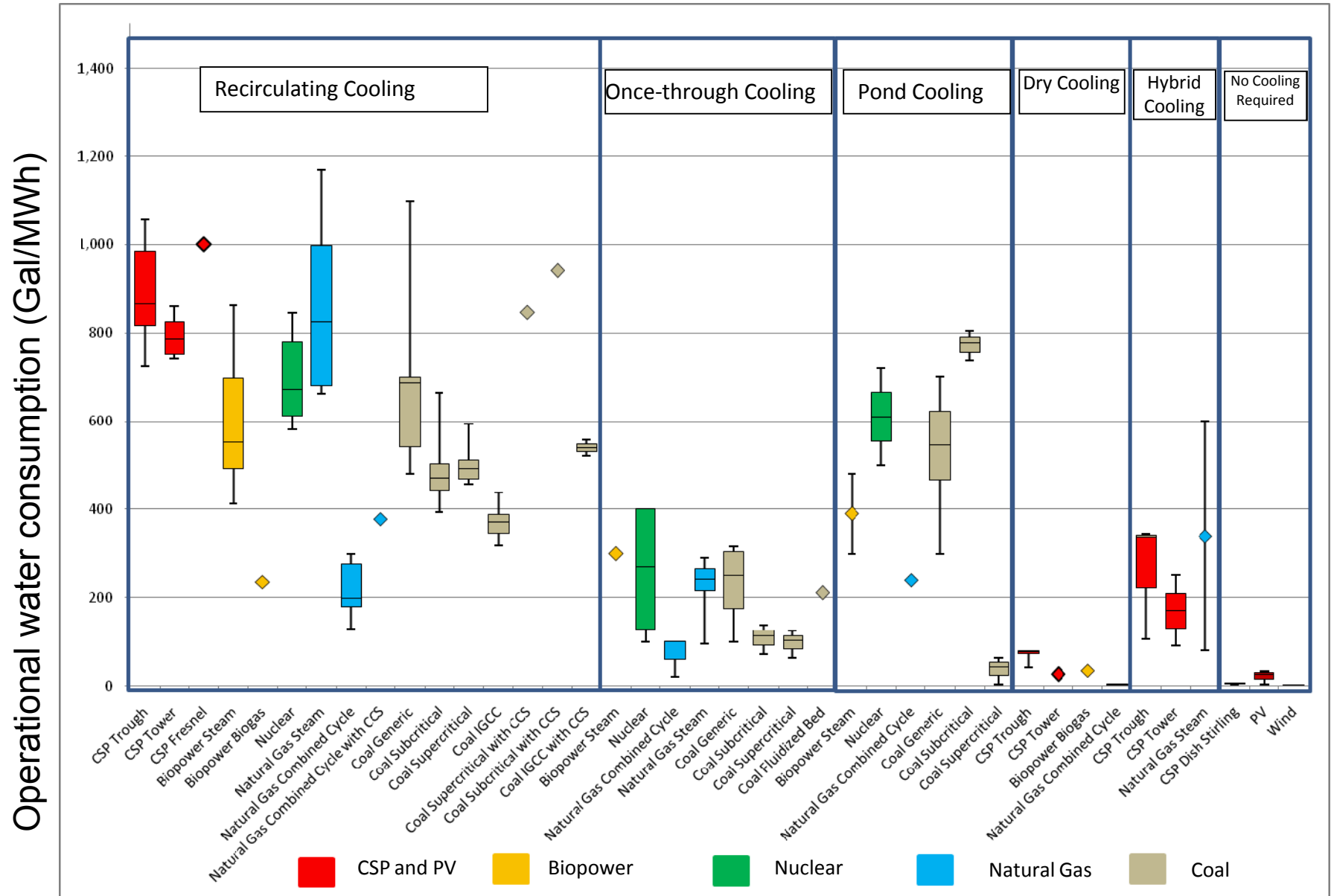
- Reduce the water footprint of electric power production in western United States:
 - Develop tools for a quantitative assessment of the energy-water nexus,
 - Engage stakeholders across the energy-water spectrum, and
 - Evaluate water implications of alternative interconnection-wide transmission expansion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

Transmission Planning

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

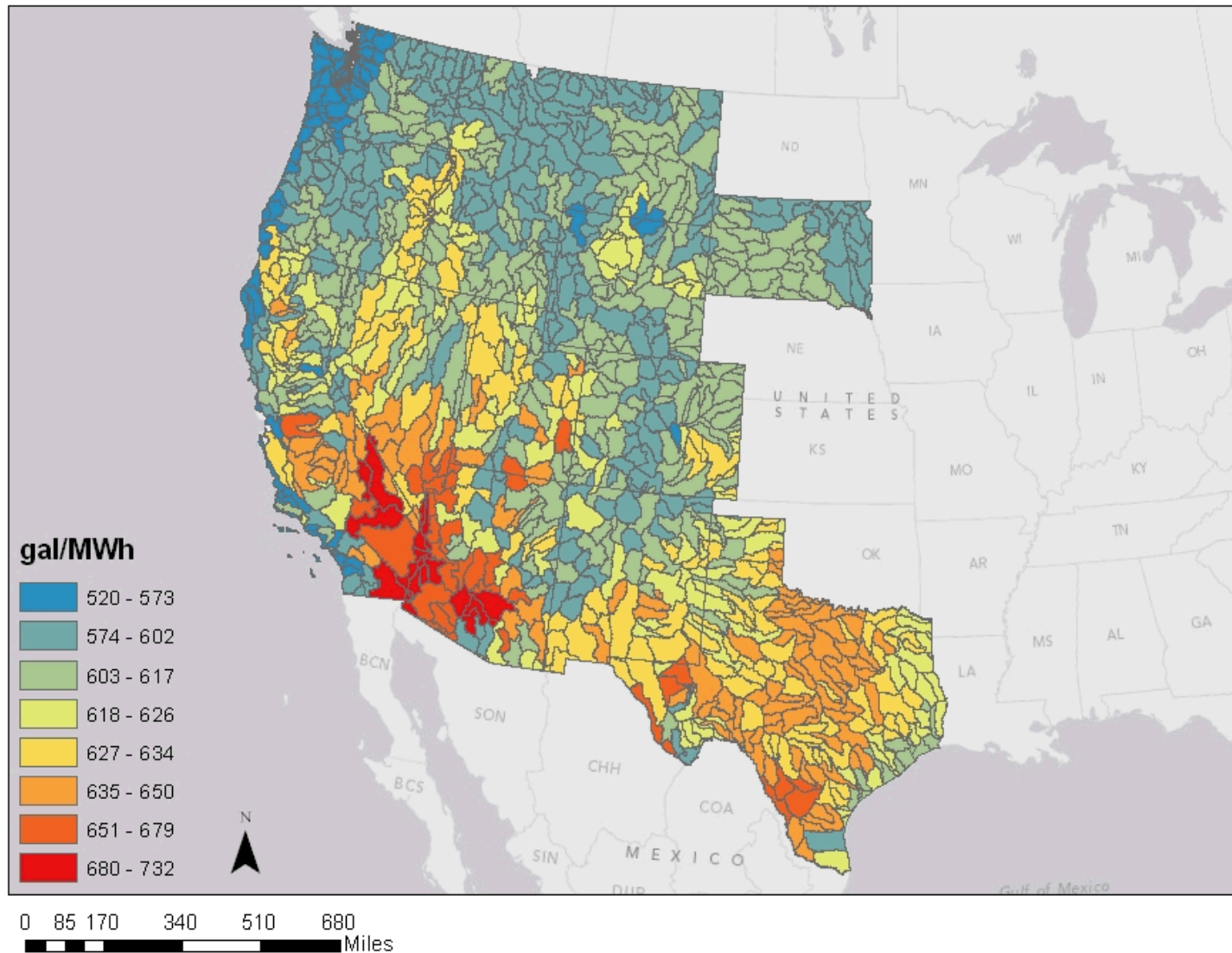


Operational water *consumption* factors for electricity generating technologies

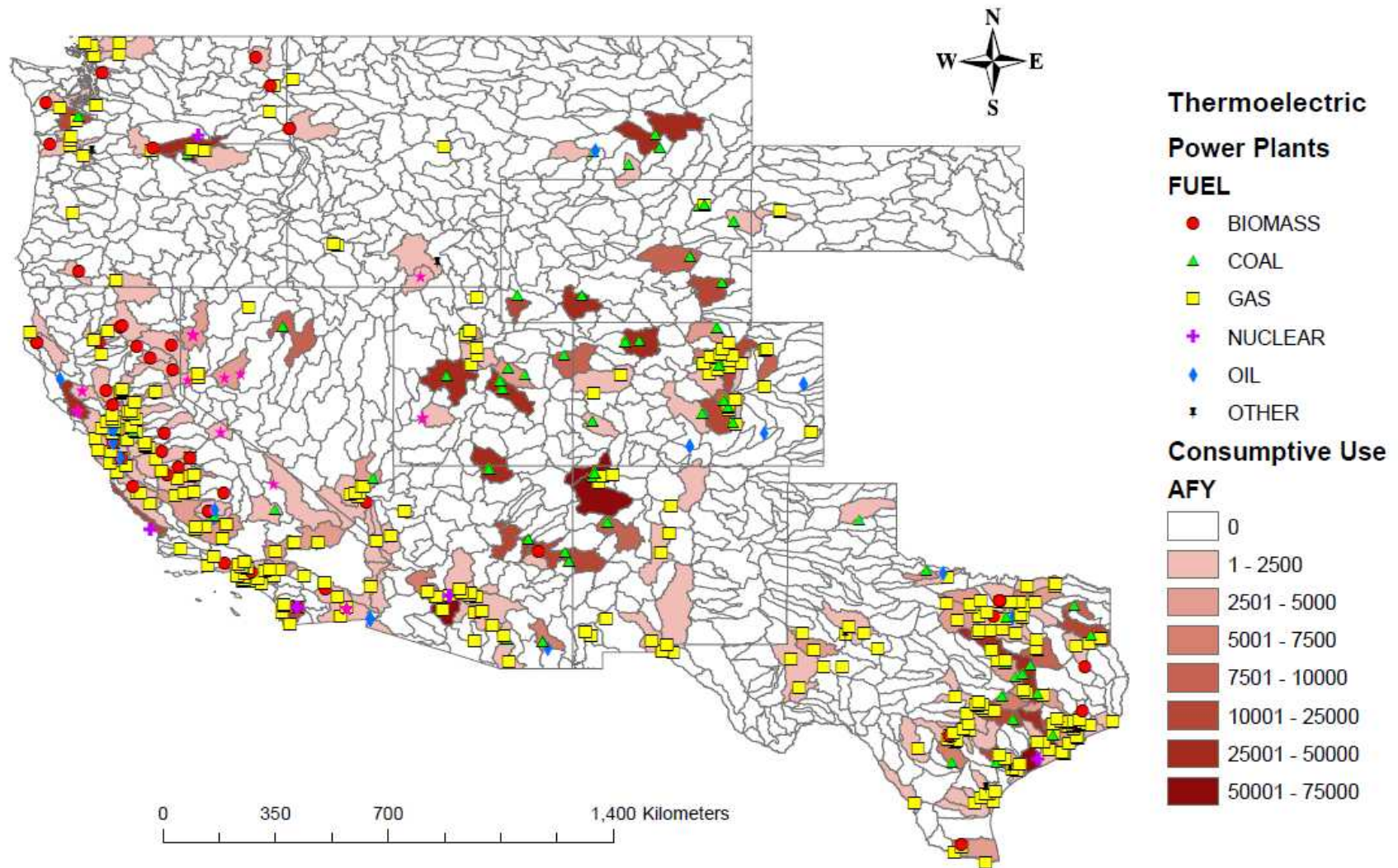


Source: Macknick *et al.* 2011

Coal Plant Water Use (gal/MWh)



Thermoelectric Consumptive Use and Power Plants (Current)

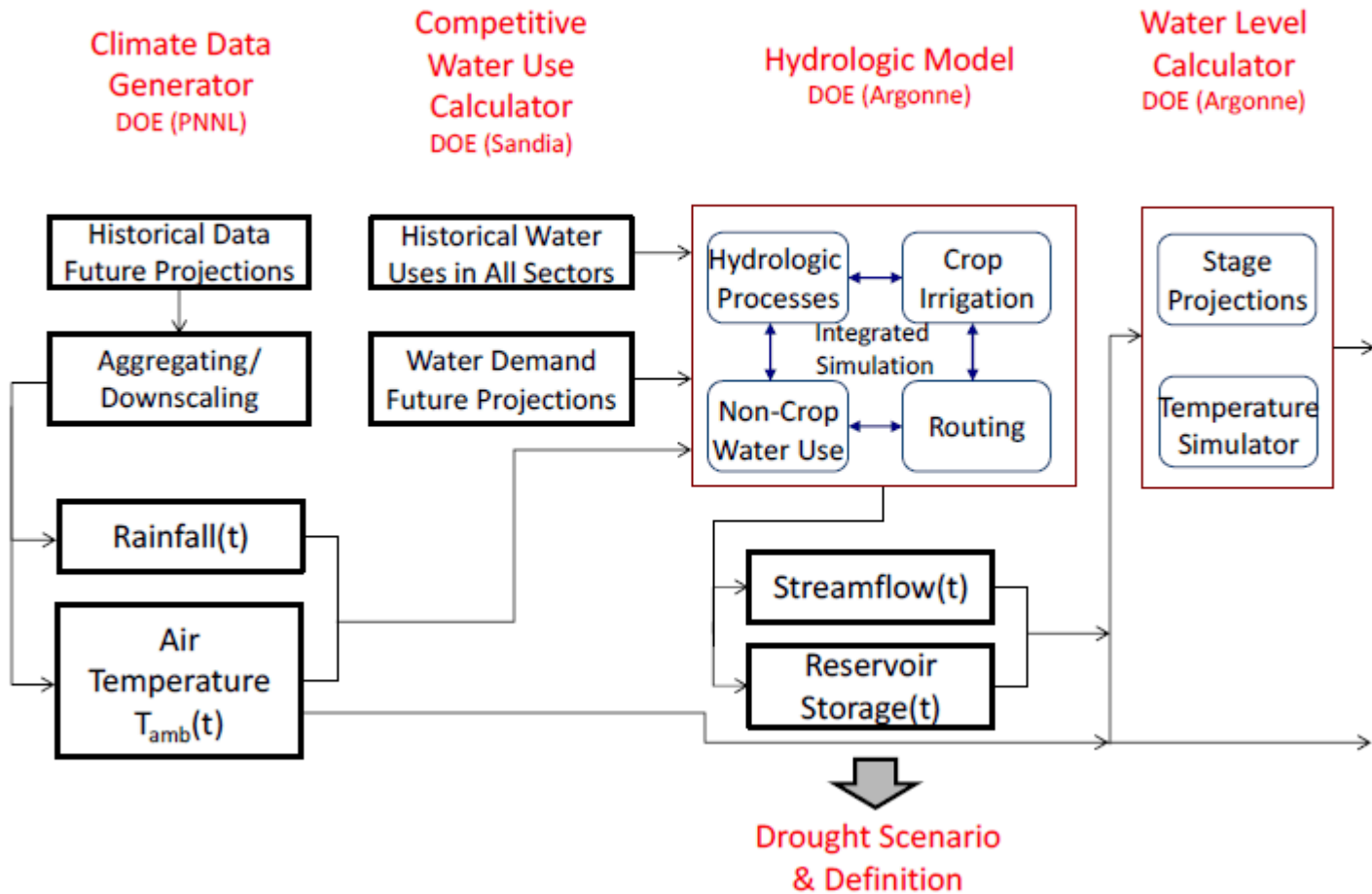


CLIMATE VARIABILITY IMPACTS ON ELECTRICITY GENERATION

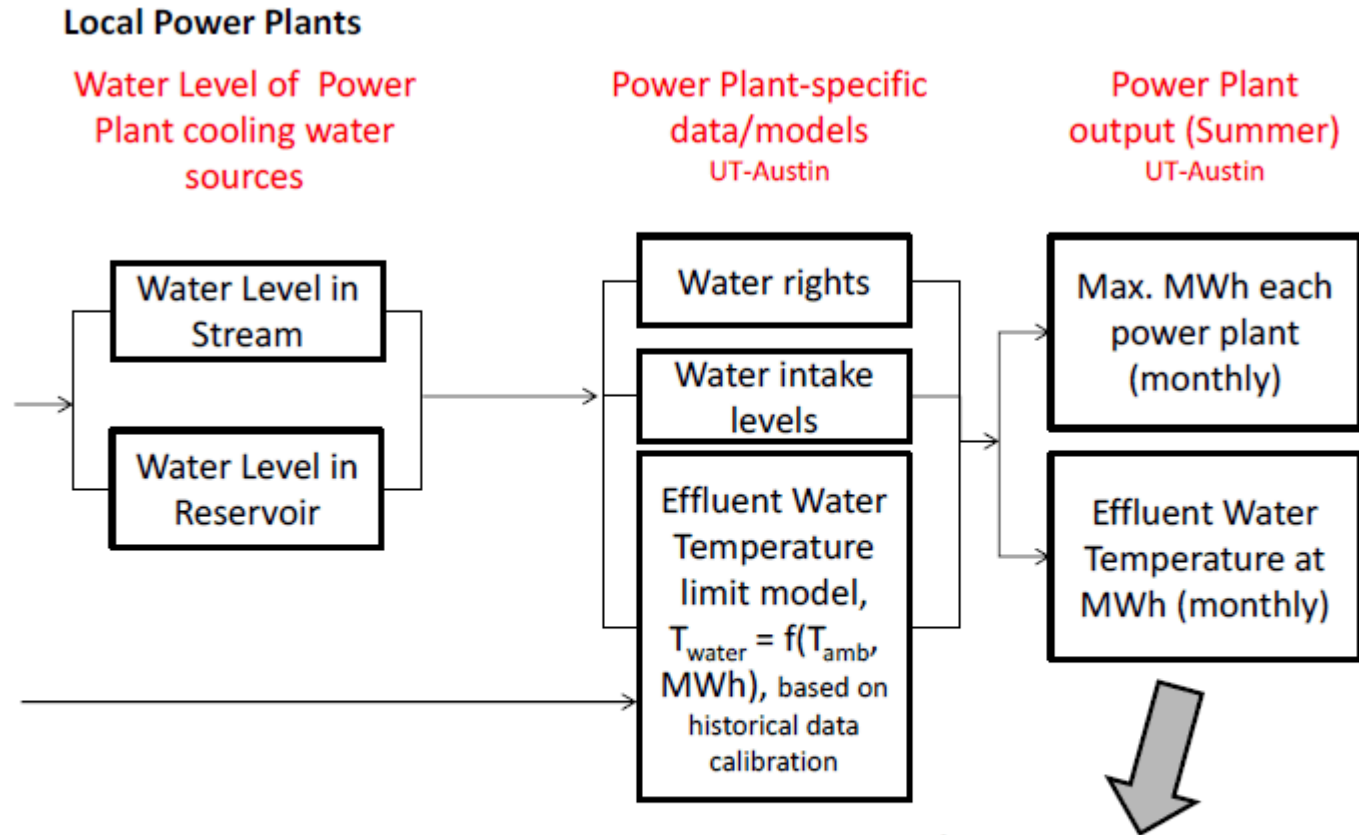
- Evaluate impacts of future (2030s) climate variability, drought scenarios, and water demand
- Potential reduction or curtailment of power generation
 - Low lake levels
 - Thermal effluent limitations

Methods of Analysis (1)

Regional Scale to HUC-8 Basins



Methods of Analysis (2)

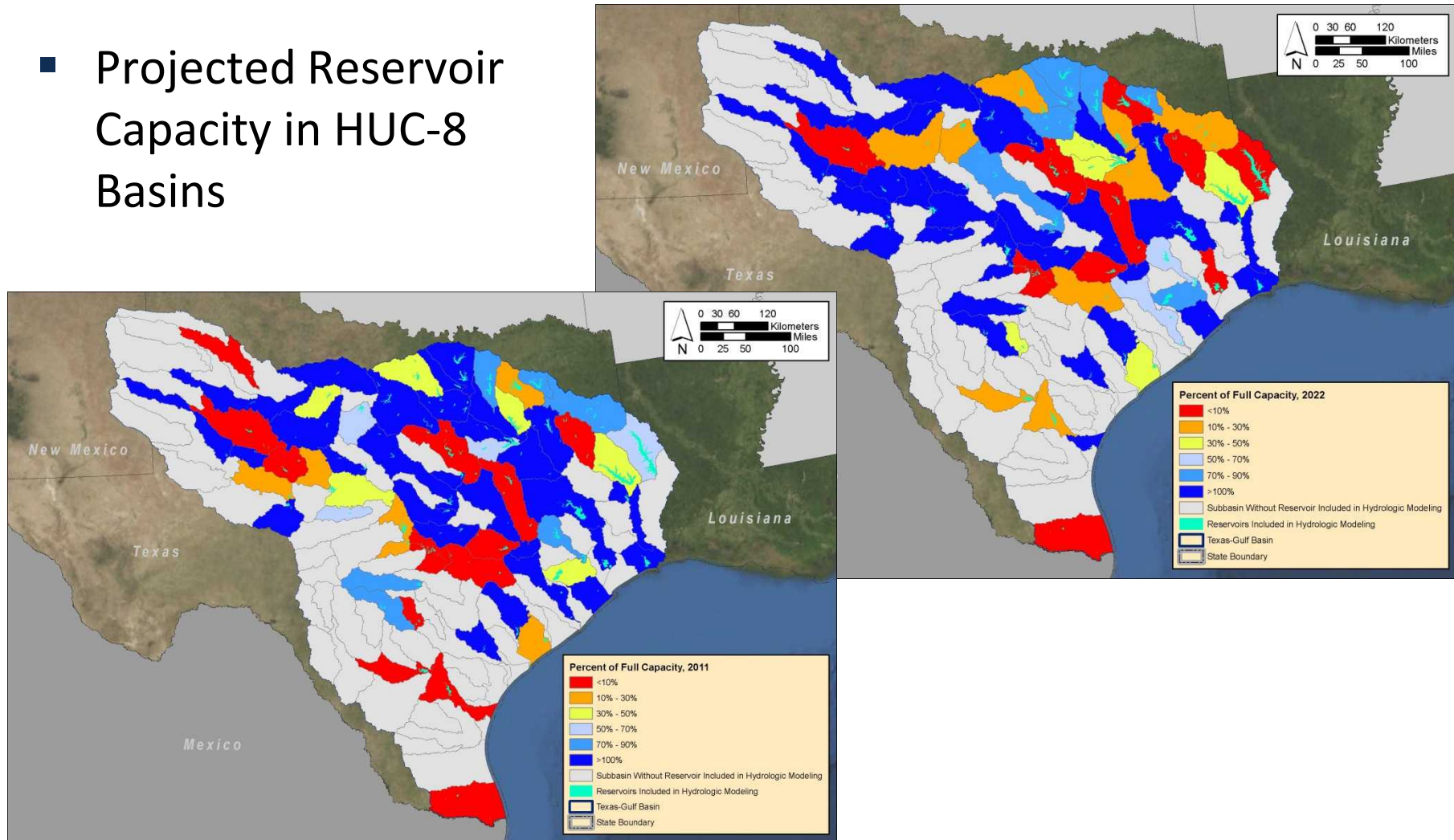


Determine if:

- (i) water effluent temperature permit limits can reduce power generation,
- (ii) intake levels constrain water intake, and therefore power generation

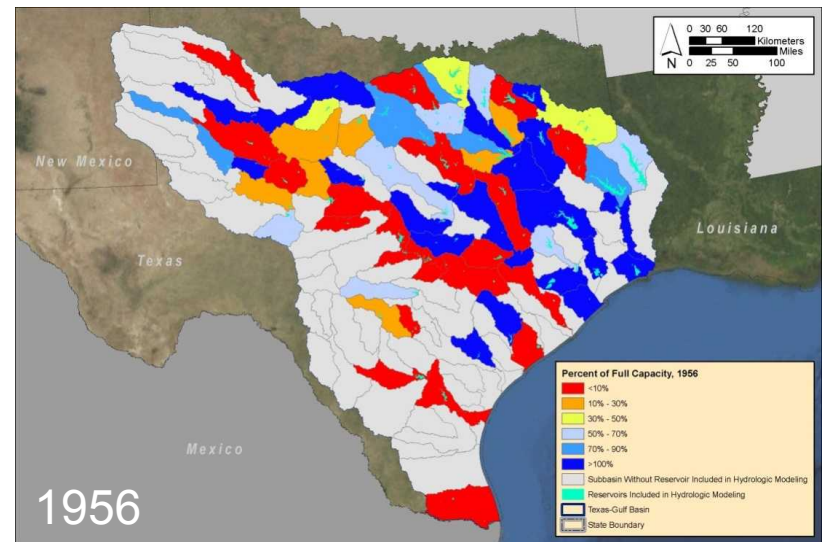
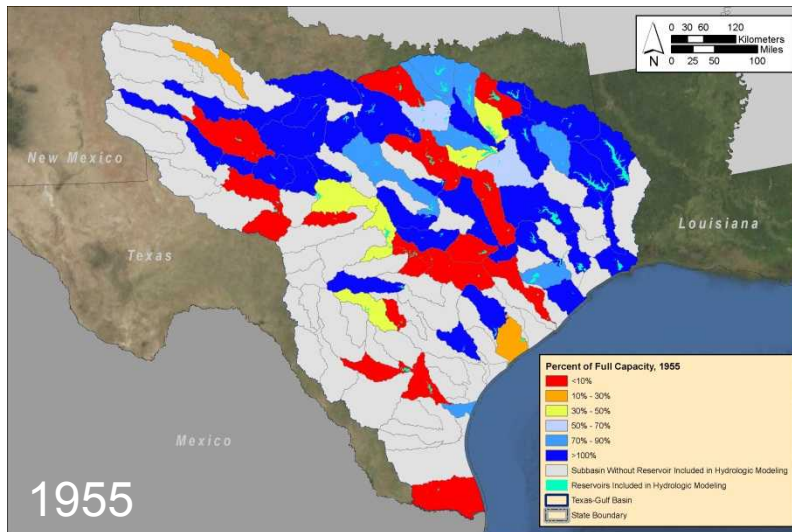
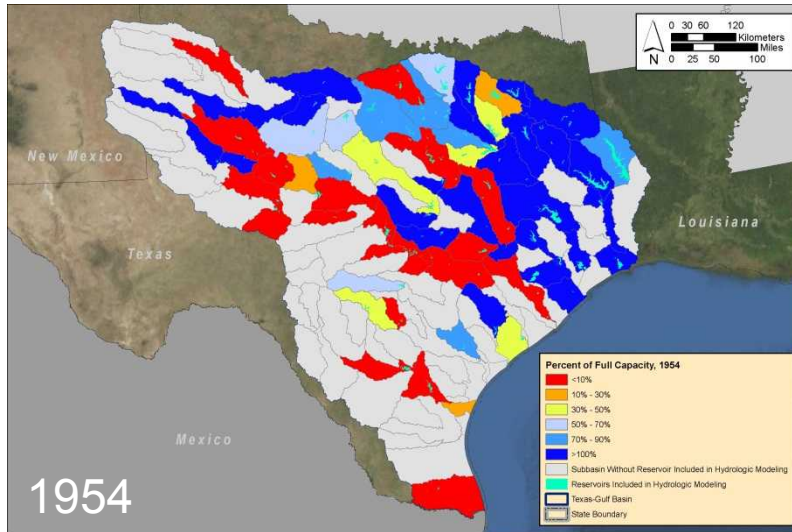
Hydrologic Modeling Results – *Single-Year Drought*

- Projected Reservoir Capacity in HUC-8 Basins

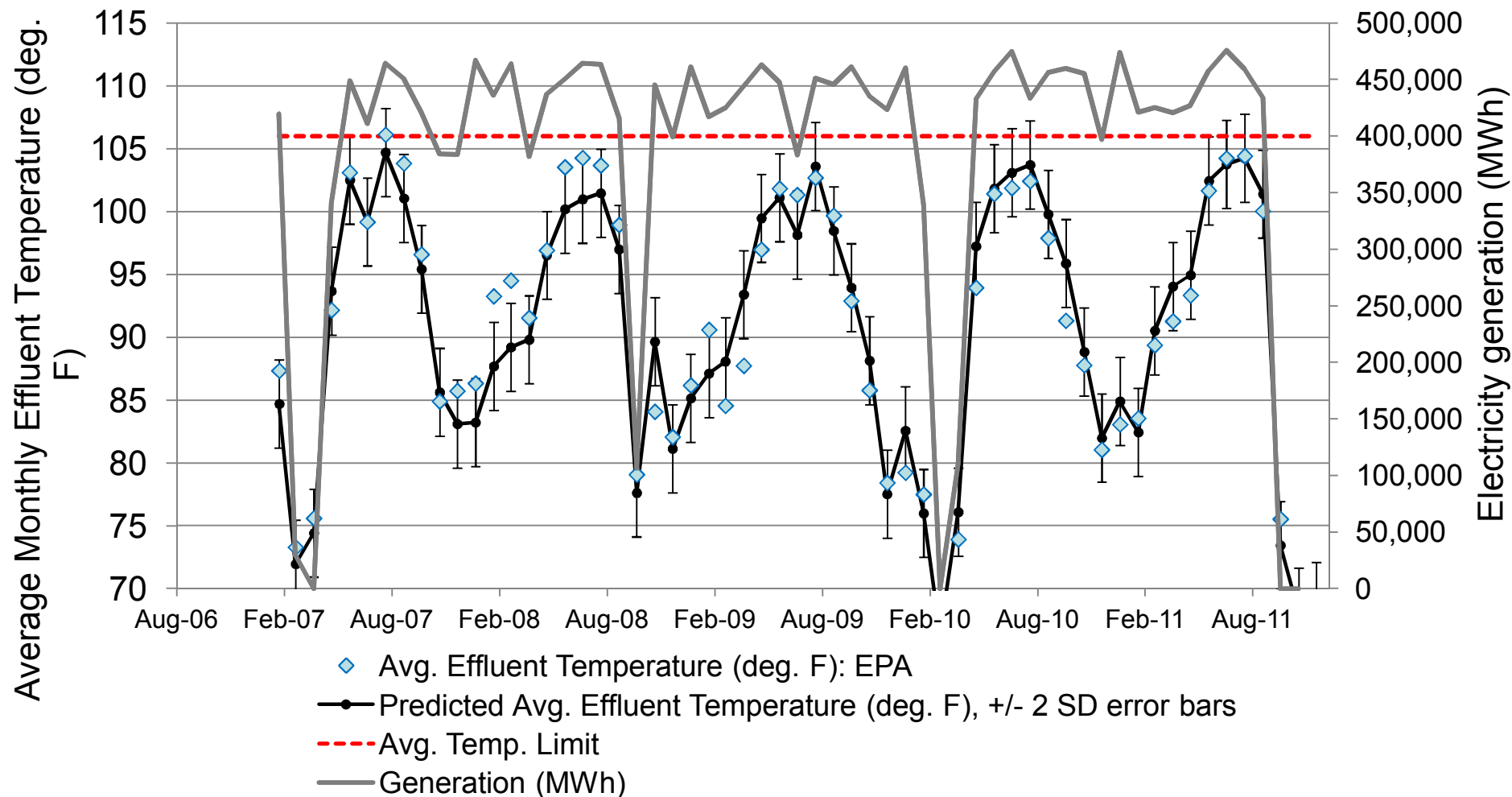


Hydrologic Modeling Results – *Multiple-Year Drought*

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

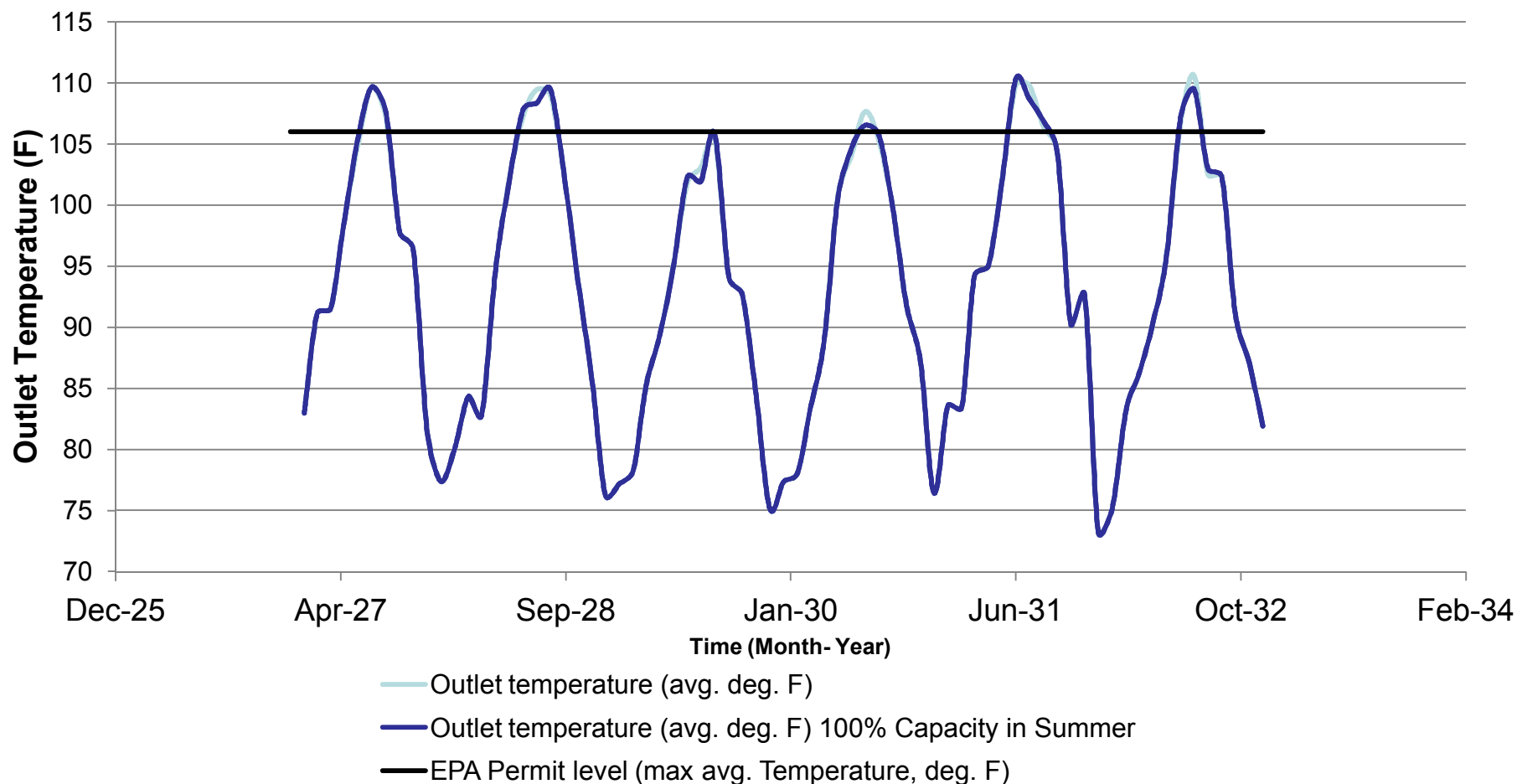


Operations near thermal limit



Operations near thermal limit in future summers

Assuming 2011 generation pattern



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

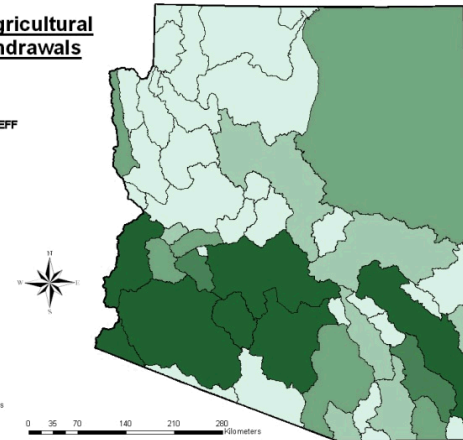
- ***Focus on withdrawals***
- ***Estimate consumption from withdrawals***
- ***Disaggregate by:***
 - ***8-digit watershed***
 - ***Sector***
 - ❖ ***M&I***
 - ❖ ***Agriculture***
 - ❖ ***Evaporative***
 - ❖ ***Instream***
 - ***Water source***

Current Agricultural Water Withdrawals

Arizona

GW + SW + CAP + EFF
1000 Acre-Feet/year

0 - 5
6 - 25
26 - 65
66 - 200
201 - 790



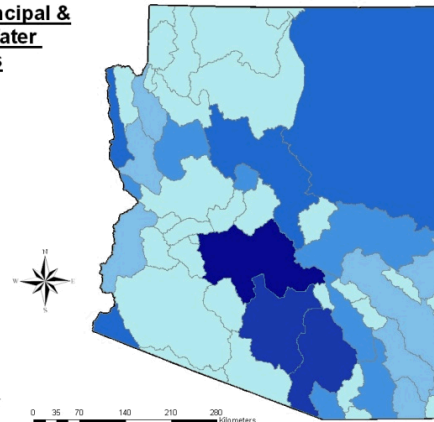
Note:
Agricultural water withdrawals
are for 2009 in Groundwater
Basins and 2006 in Active
Management Areas

Current Municipal & Industrial Water Withdrawals

Arizona

GW + SW
1000 Acre-Feet/year

0 - 3
4 - 10
11 - 20
21 - 60
61 - 150
151 - 790



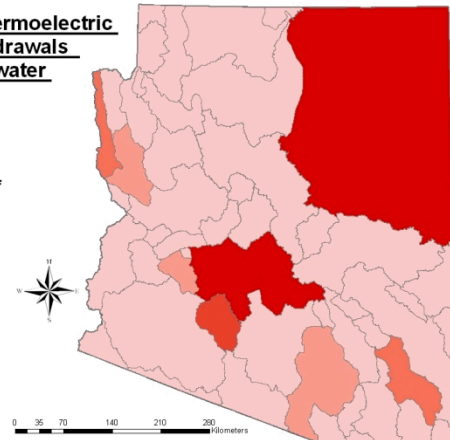
Note:
Data is for 2009 in Groundwater
Basins and for 2006 in Active
Management Areas

Current Thermoelectric Water Withdrawals By Groundwater Basin

Arizona

GW + SW + CAP + EFF
1000 Acre-Feet/year

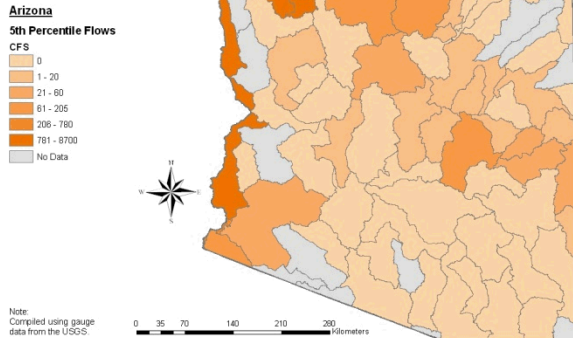
0 - 1
2 - 3
4 - 5
6 - 10
11 - 71



Note:
Values are for 2009 in
Groundwater Basins and
for 2006 in Active
Management Areas

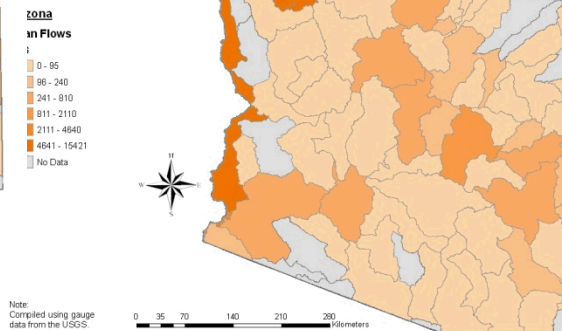
Water Availability Indicators: Supply

5th Percentile Stream Flows in Watersheds



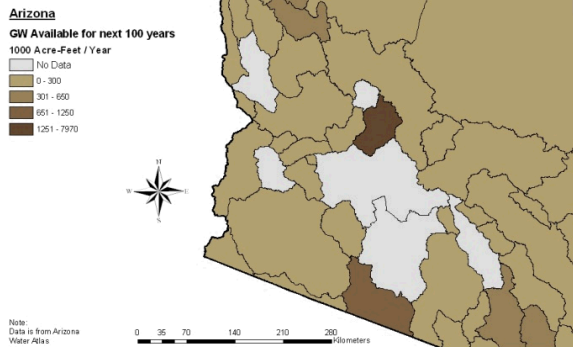
Mean Gauged Streamflow

Mean Stream Flows in Watersheds



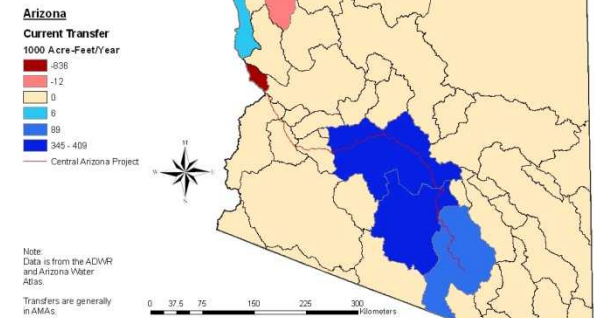
Annual Low Flow

Current Groundwater Availability per year



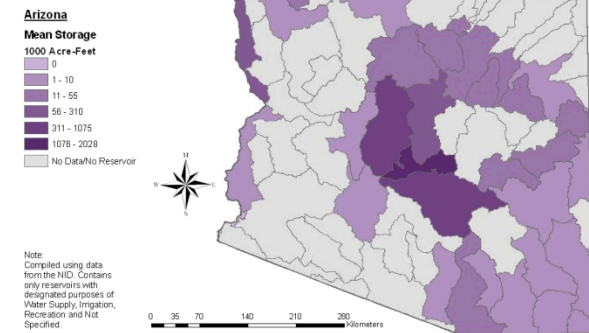
Groundwater Depletion

Interbasin Transfers By Groundwater Basin & AMA



Interbasin Transfers

Mean Reservoir Storage By Watershed



Reservoir Storage

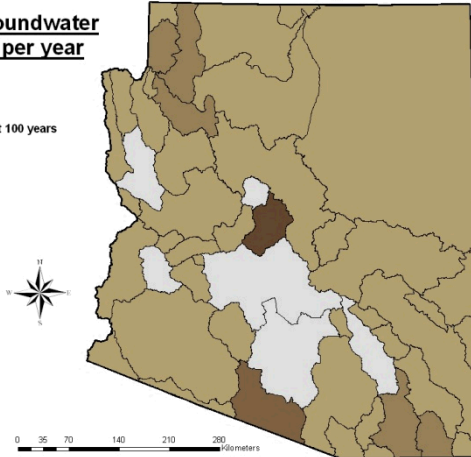
Water Availability Indicators: Institutional Factors

Current Groundwater Availability per year

Arizona
GW Available for next 100 years
1000 Acre-Feet / Year

- No Data
- 0 - 300
- 301 - 650
- 651 - 1250
- 1251 - 7970

Note:
Data is from Arizona
Water Atlas



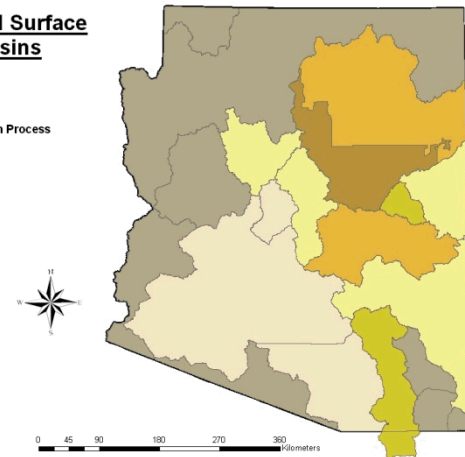
Unappropriated Water

Adjudicated Surface of Water Basins

Arizona
Status of Adjudication Process

- ACTIVE
- FINAL
- NONE
- ONGOING
- PENDING
- PRELIMINARY

Note:
Includes agreements with
other states and Mexico



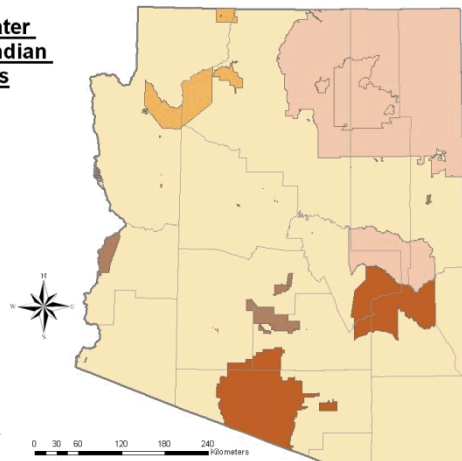
Adjudication Status

Status of Water Claims for Indian Communities

Arizona
Status

- In Negotiations
- Settled
- Settled/Unresolved
- Unresolved

Note:
Settled/Unresolved = Portions
of claims have been settled,
while others remain unresolved.
Status as of Sept. 2010



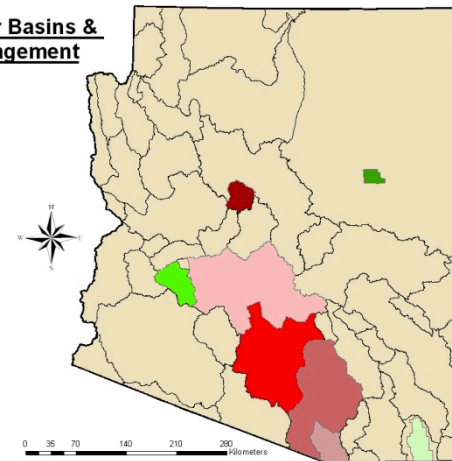
Indian Water

Groundwater Basins & Special Management Areas

Arizona
Type

- Groundwater Basin
- Douglas INA
- Harquahala INA
- Joseph City INA
- Phoenix AMA
- Pinal AMA
- Prescott AMA
- Santa Cruz AMA
- Tucson AMA

Note:
INA = Irrigation Non-Expansion Area
AMA = Active Management Area

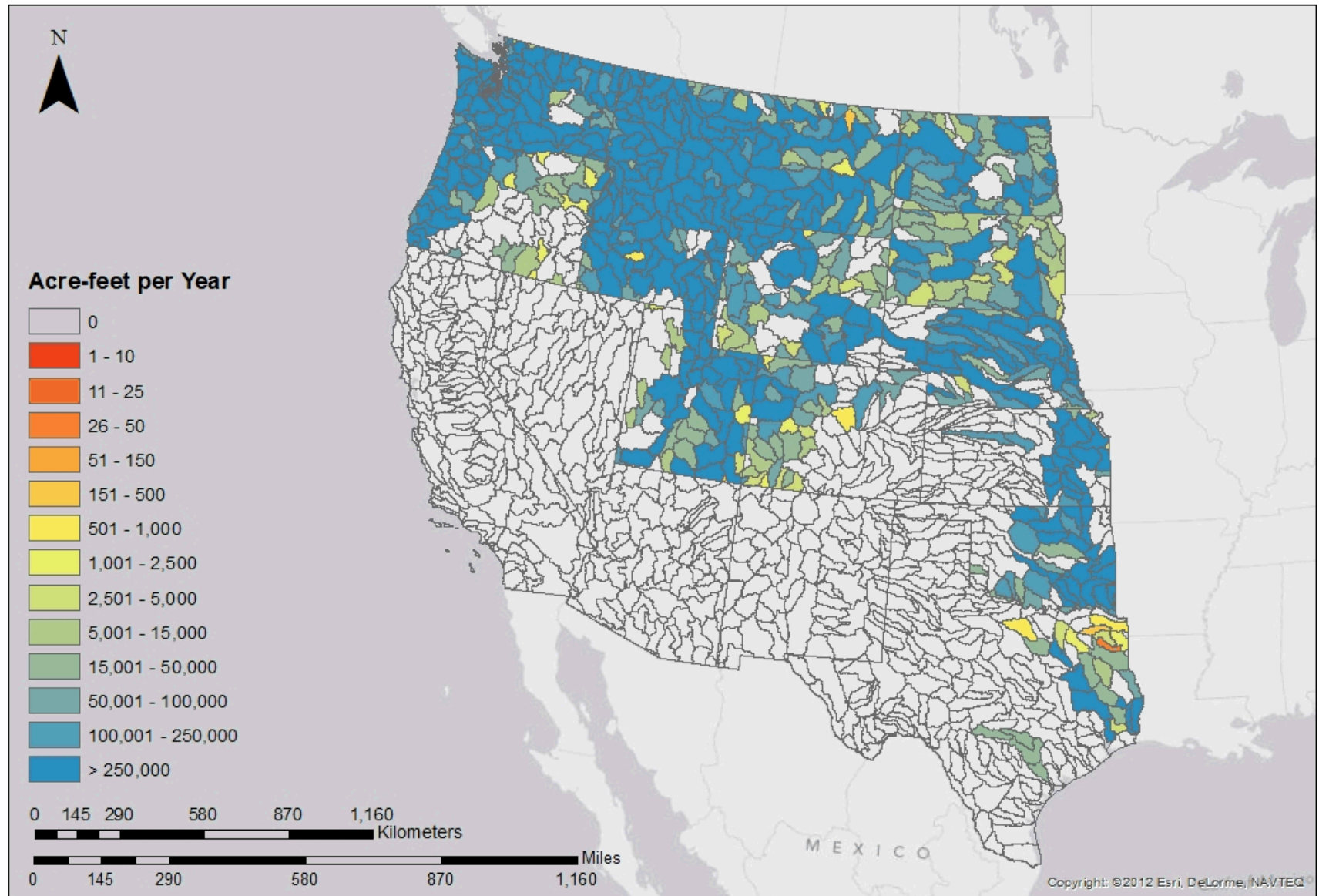


Administrative Control Areas

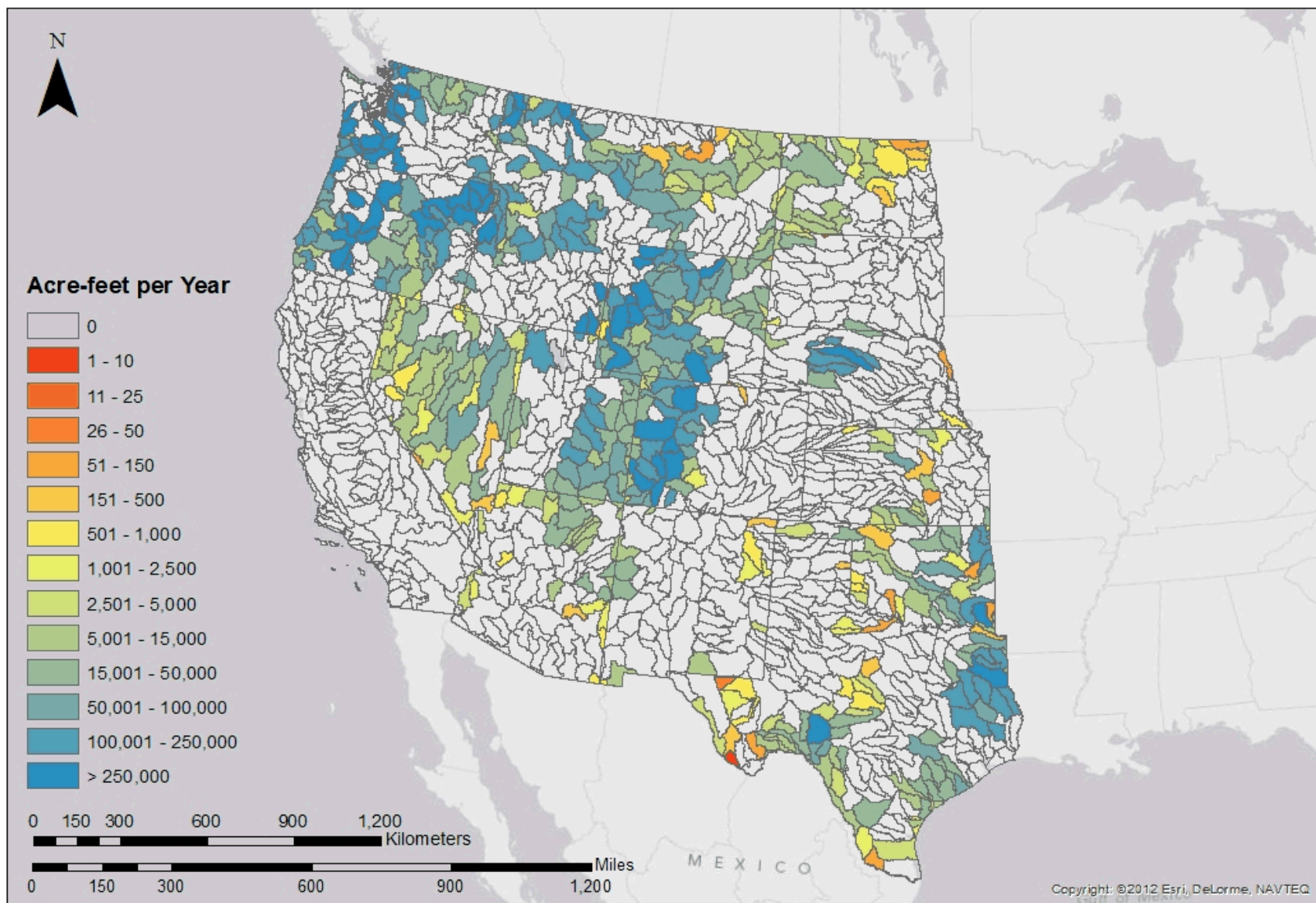
Metric Development

- **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)**

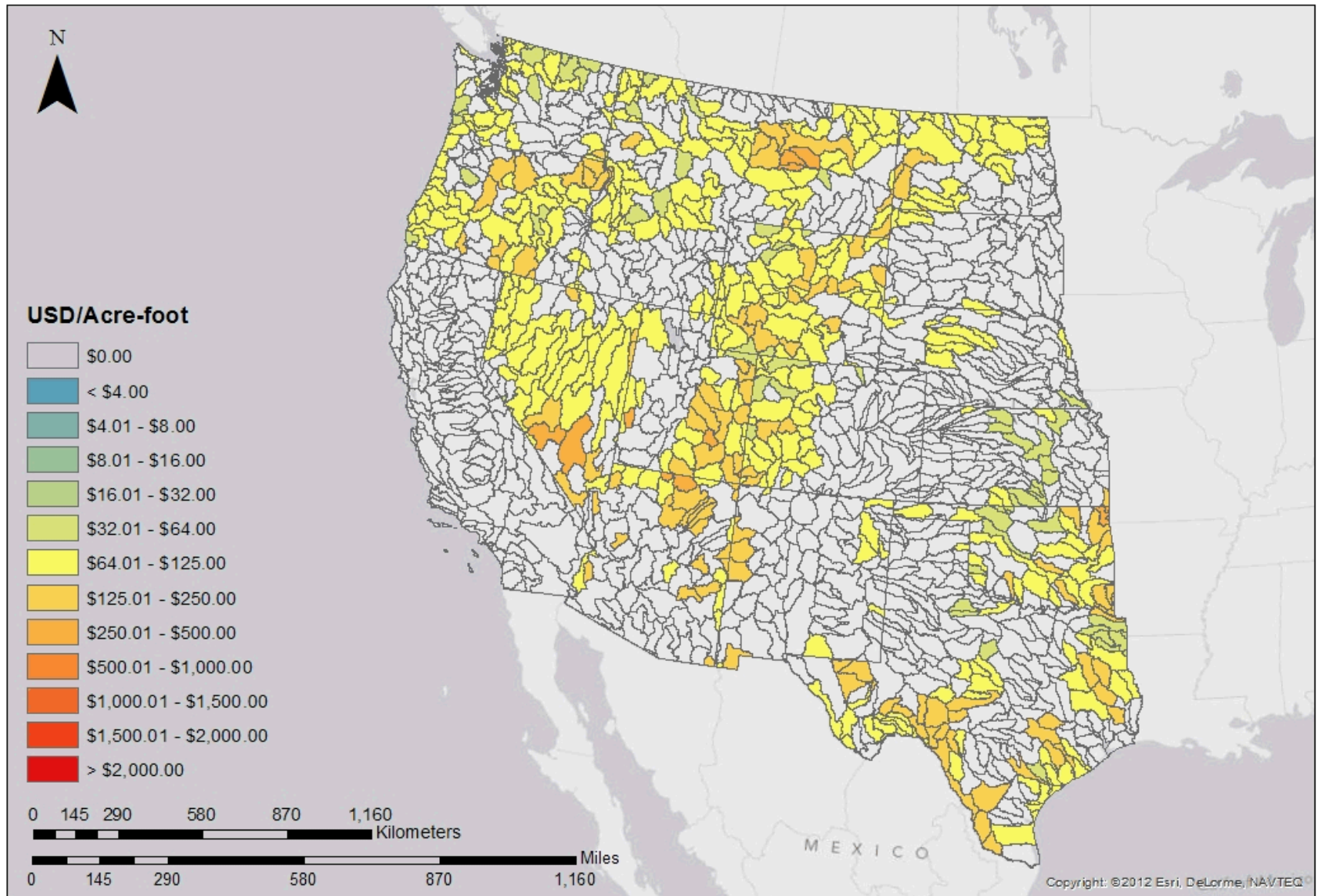
Unappropriated Surface Water Availability



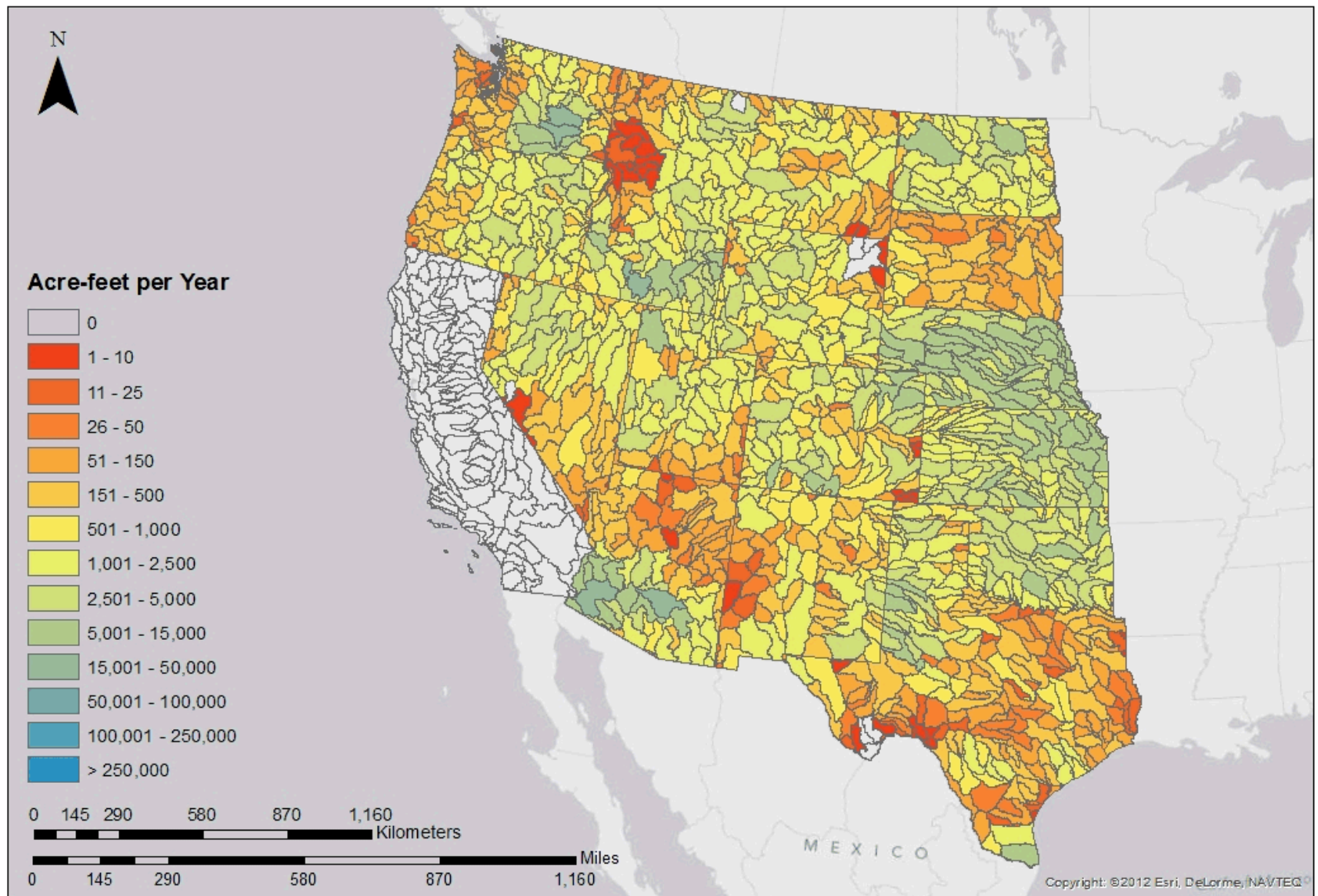
Potable Groundwater Availability



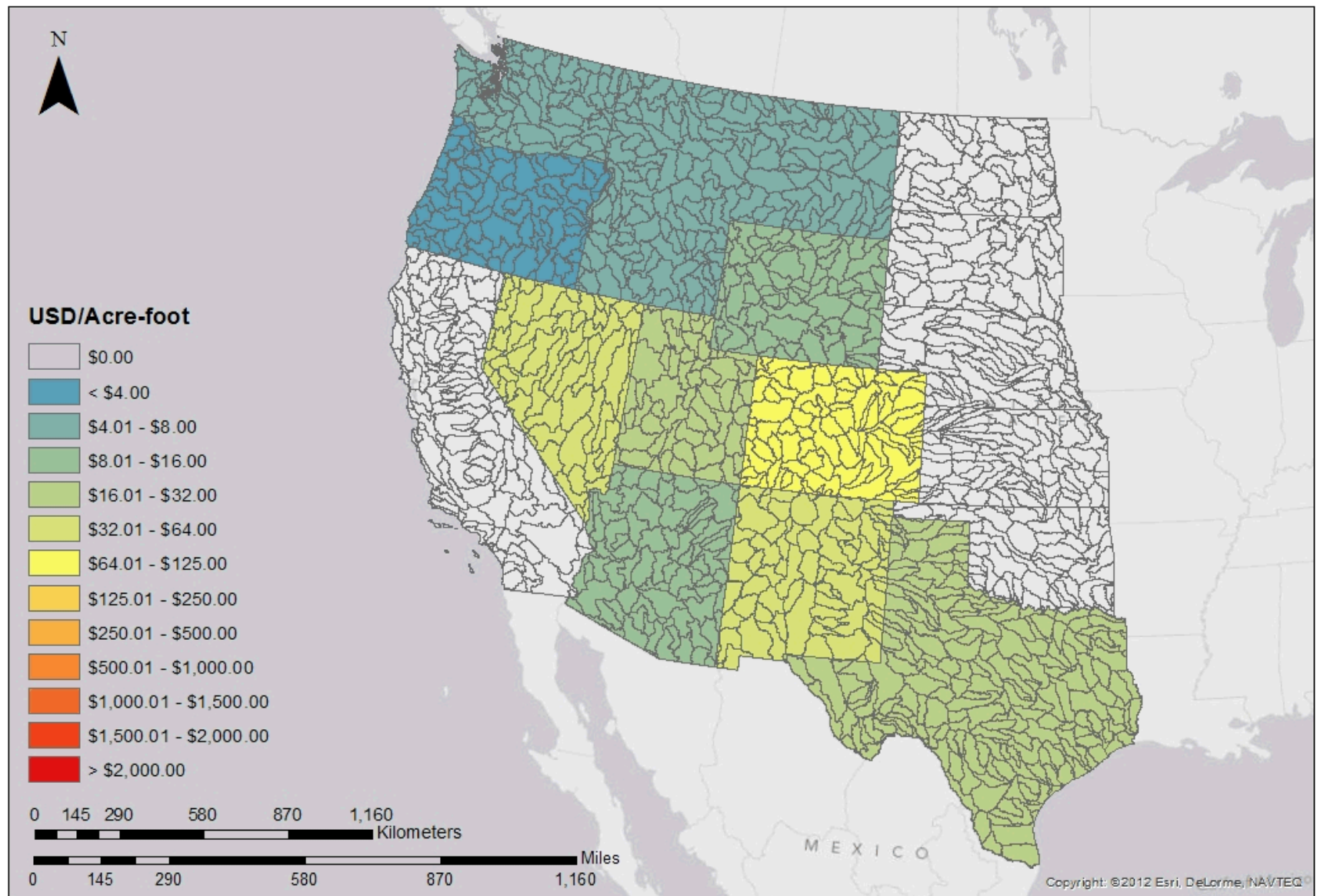
Potable Groundwater Cost



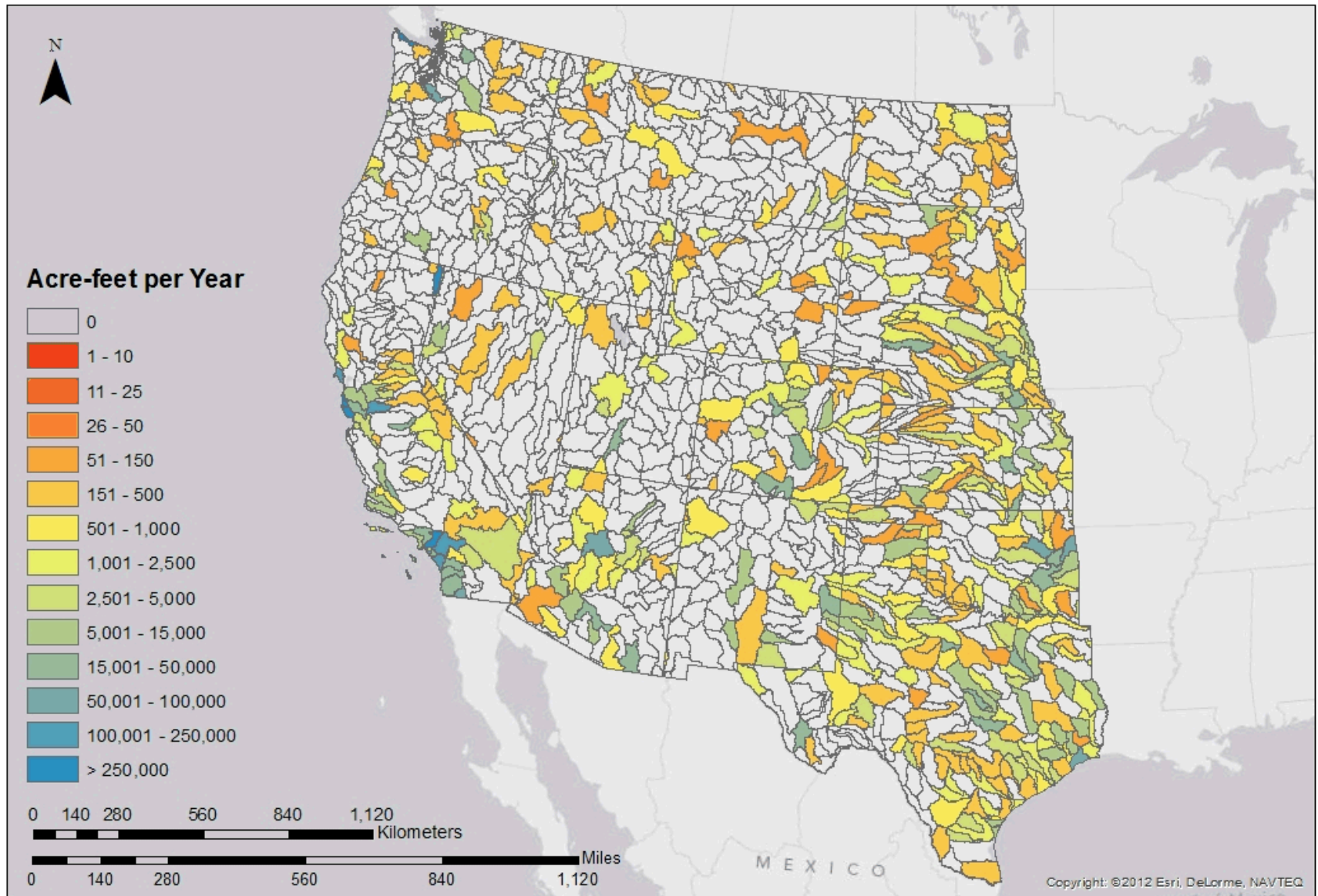
Appropriated Water Availability



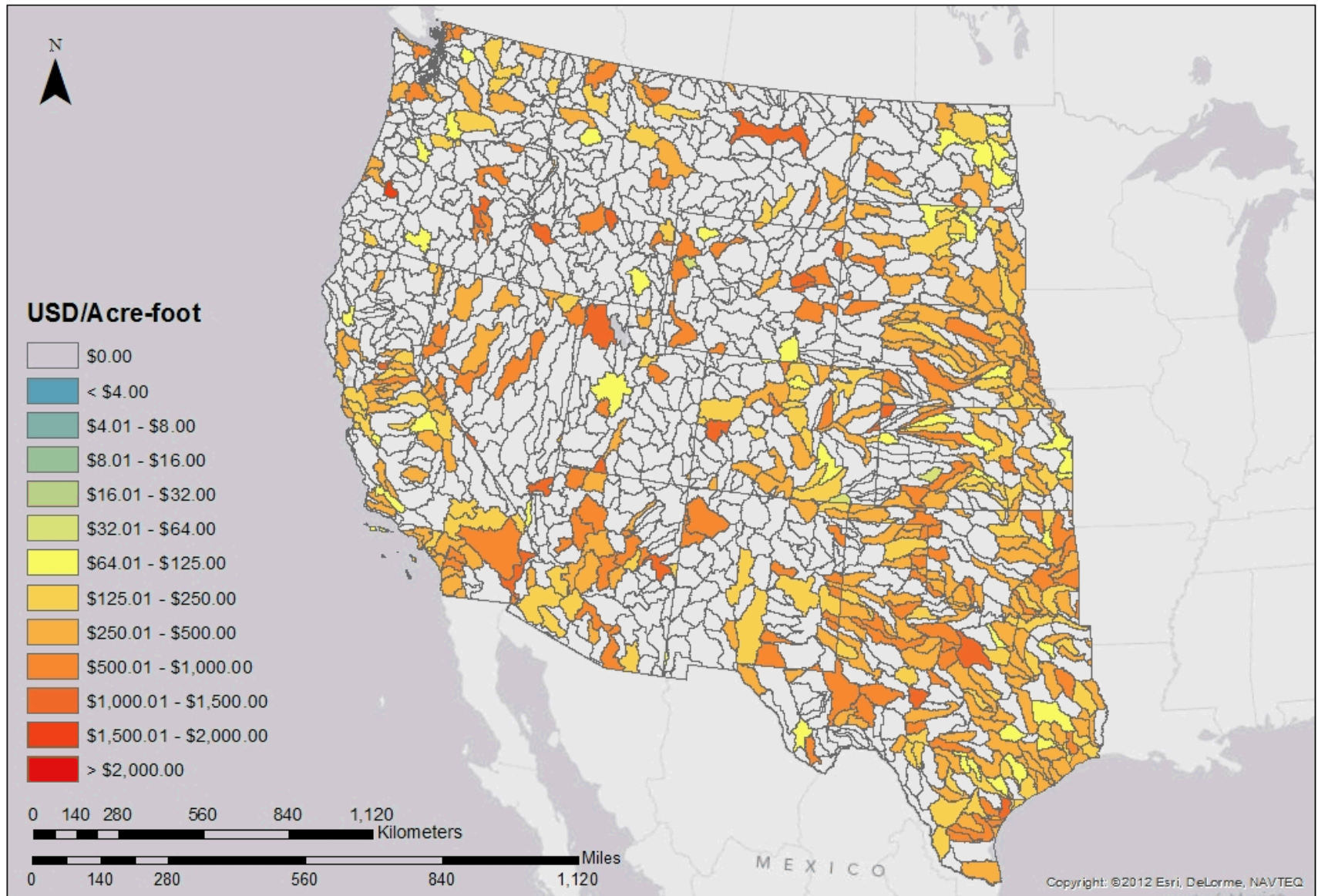
Appropriated Water Cost



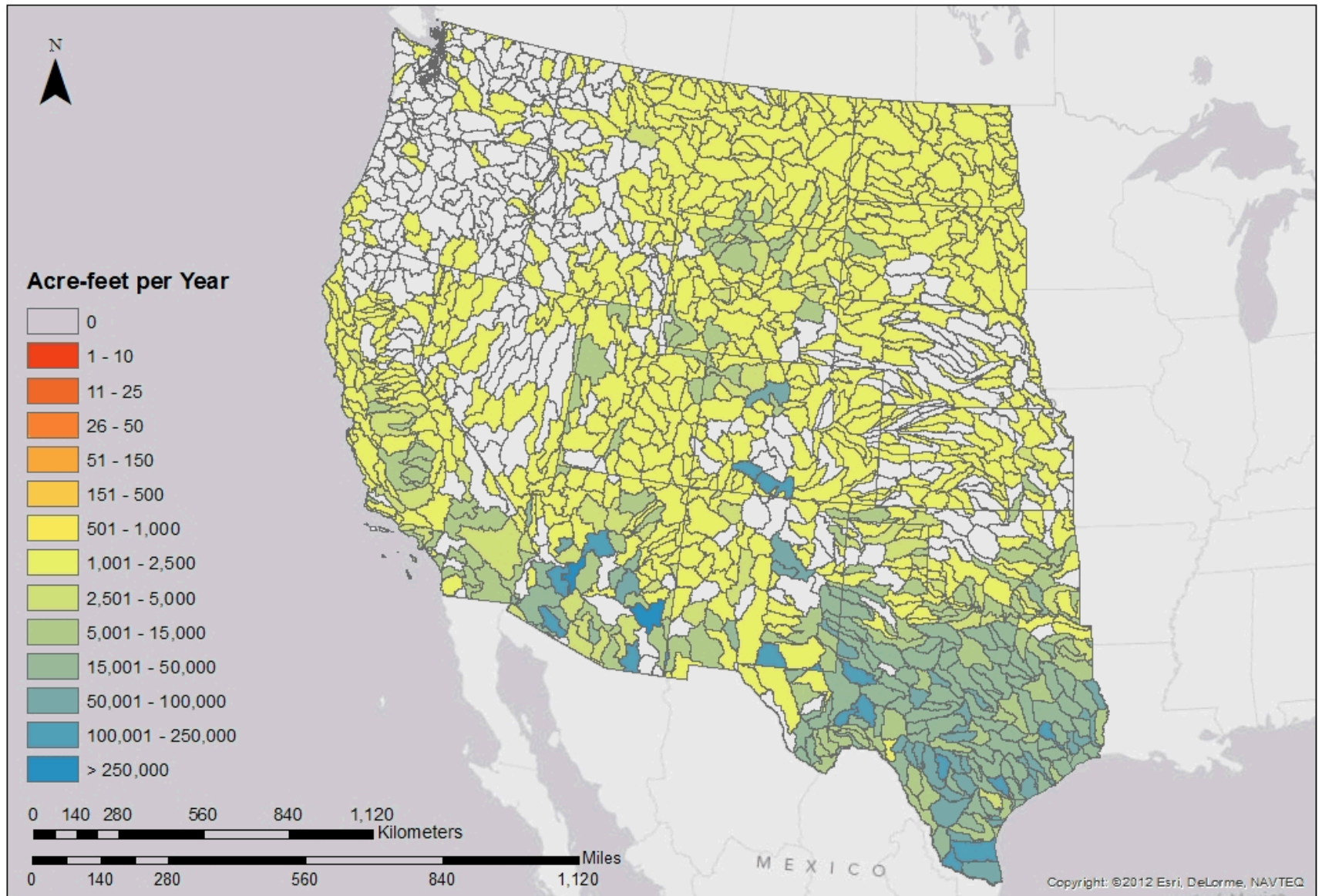
Wastewater Availability



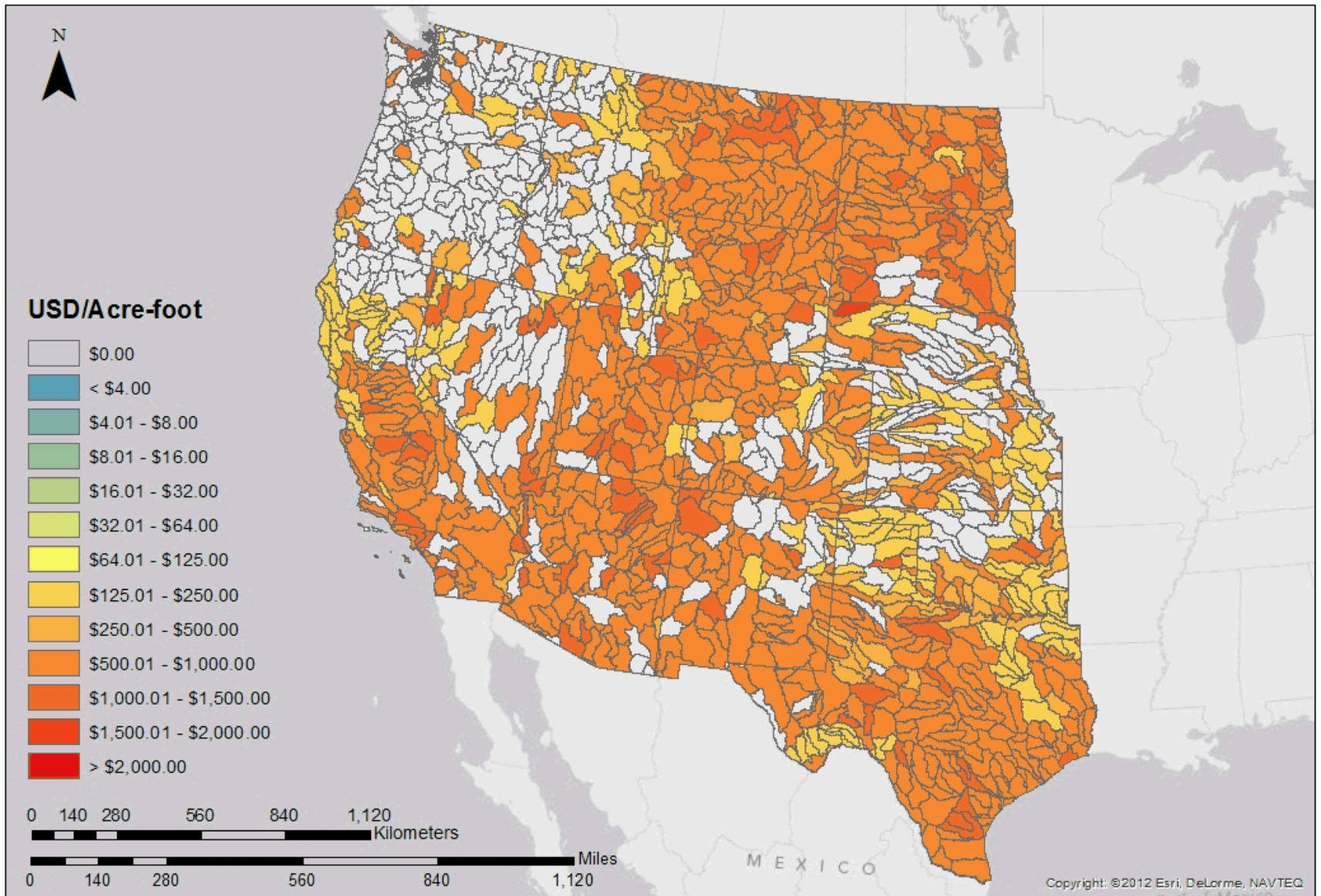
Wastewater Cost



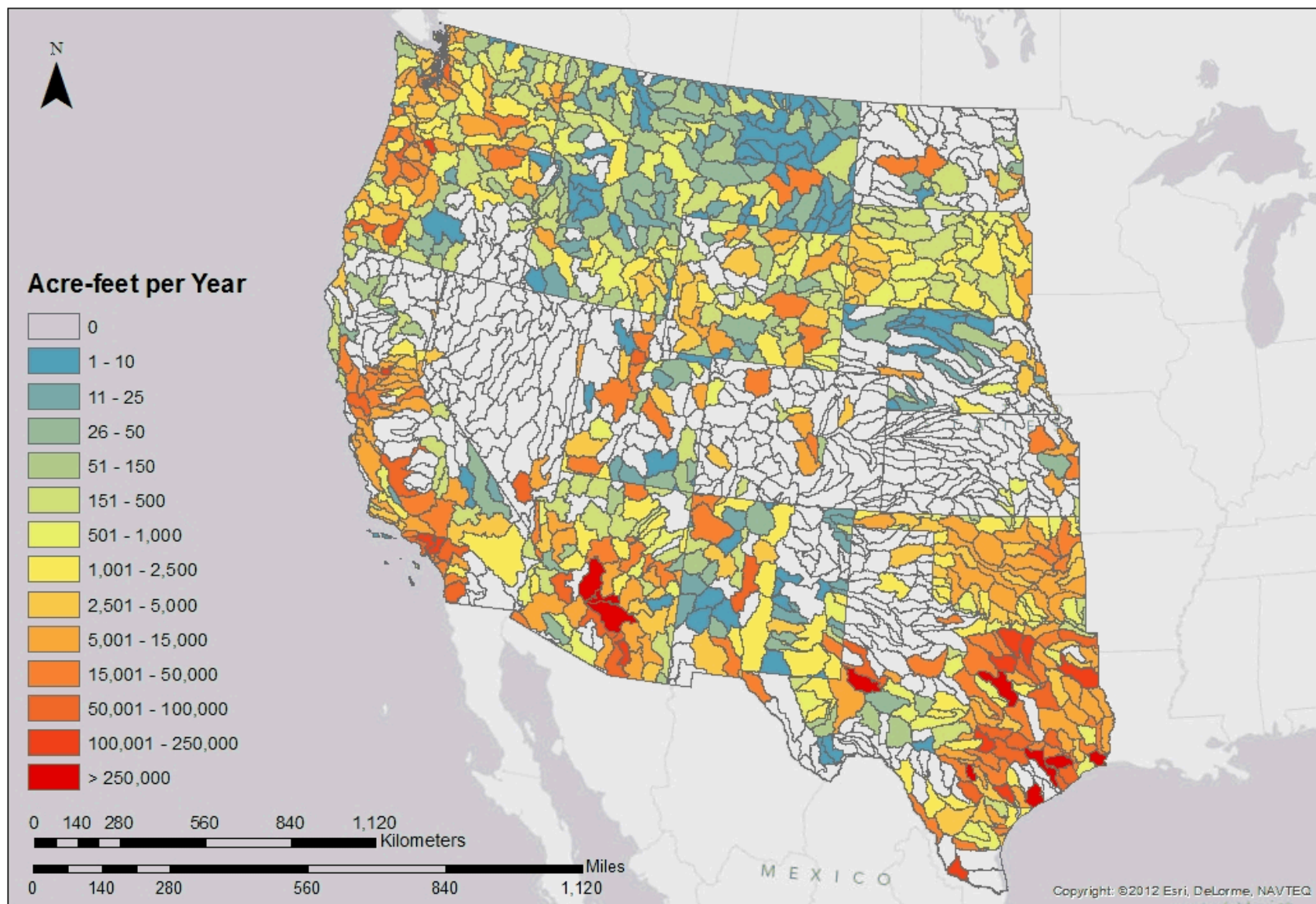
Brackish Groundwater Availability



Brackish Groundwater Cost

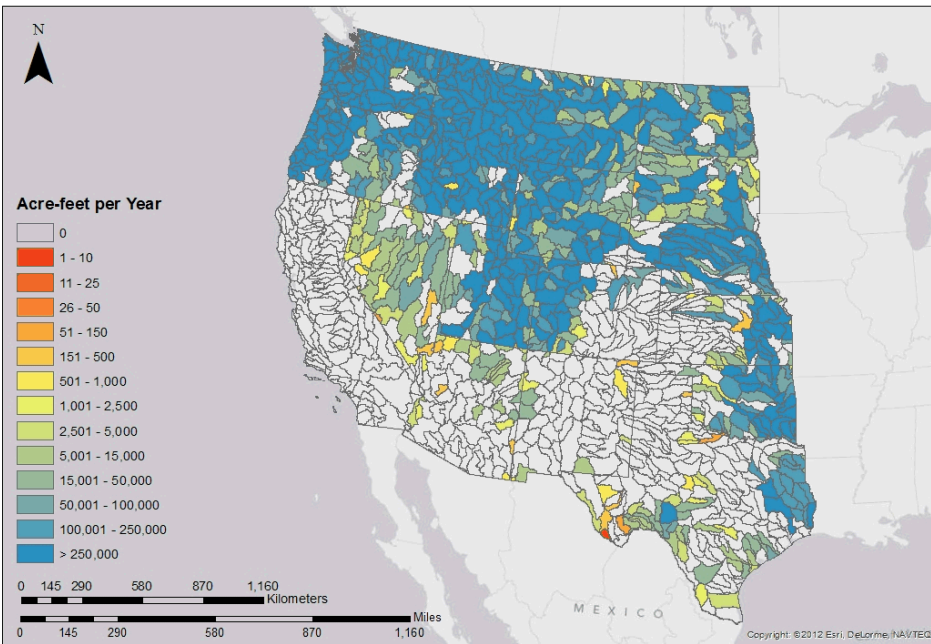


Change in Demand through 2030

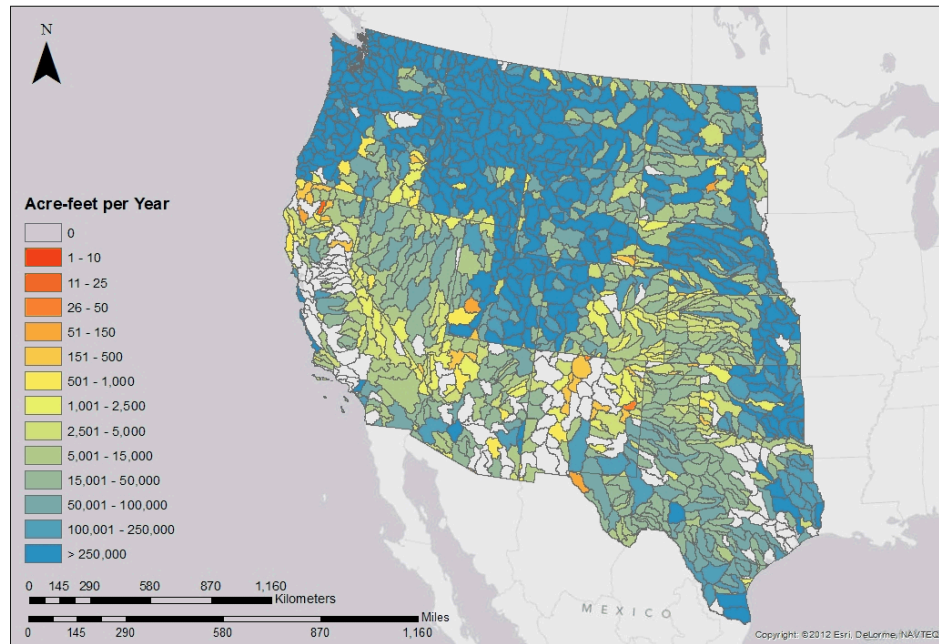


Water for Development

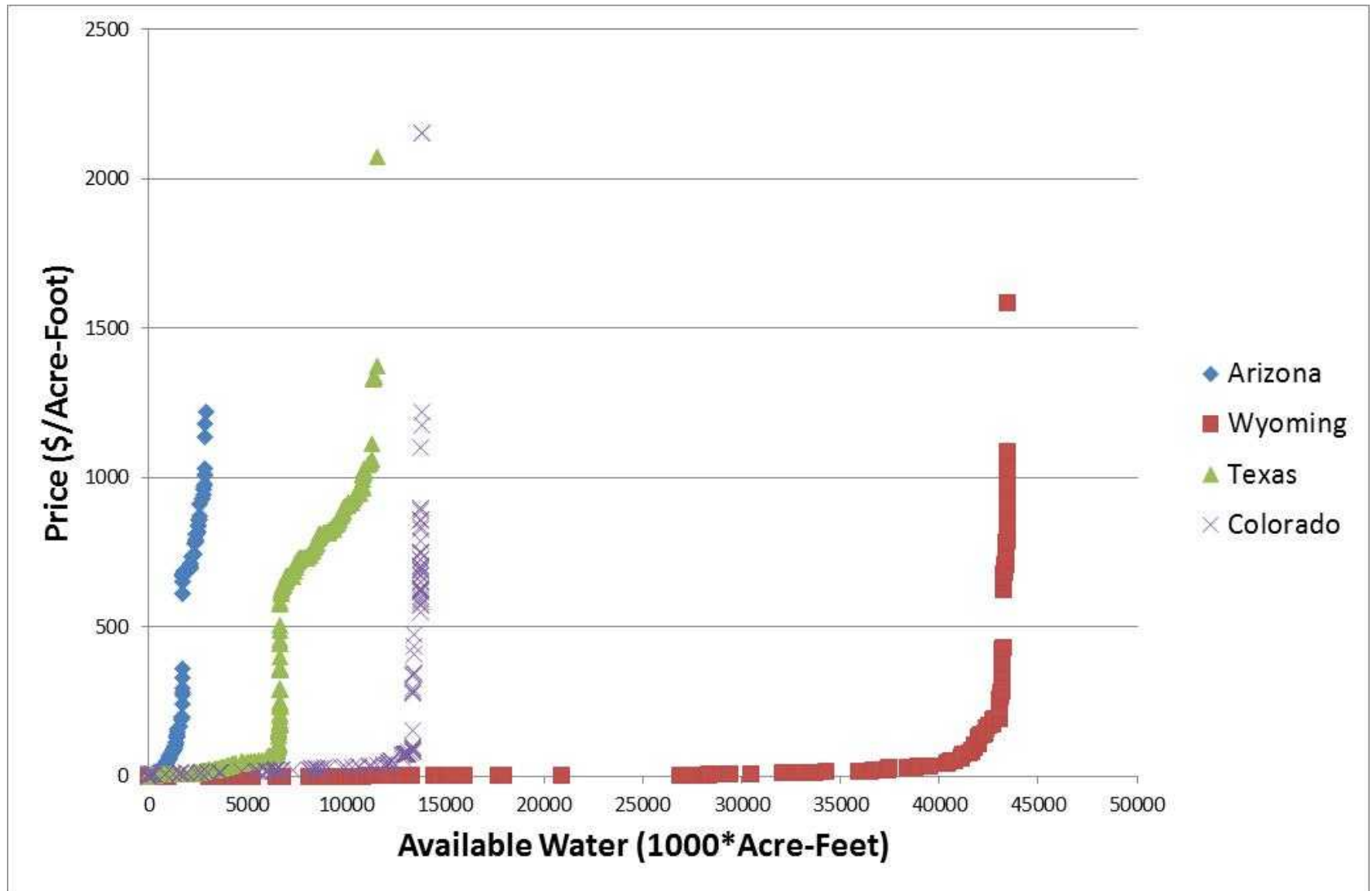
Unappropriated Water Sources - Change in Demand, 2030



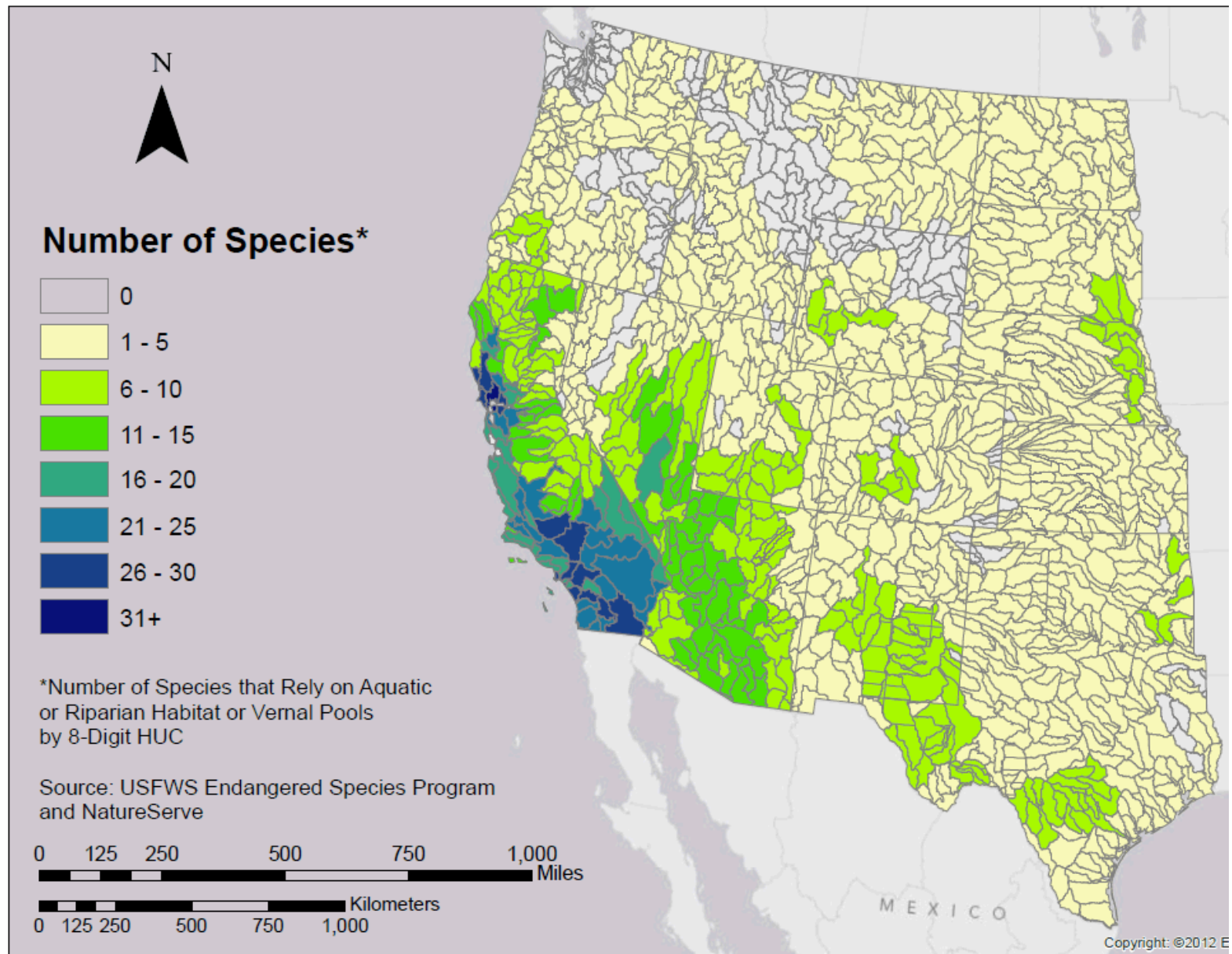
All Water Sources - Change in Demand, 2030



State-Level Supply Curves

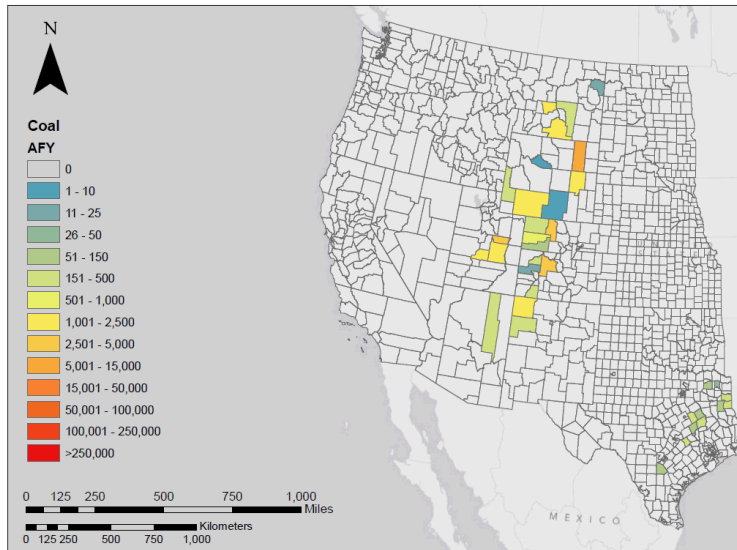


Endangered Species by 8-Digit HUC

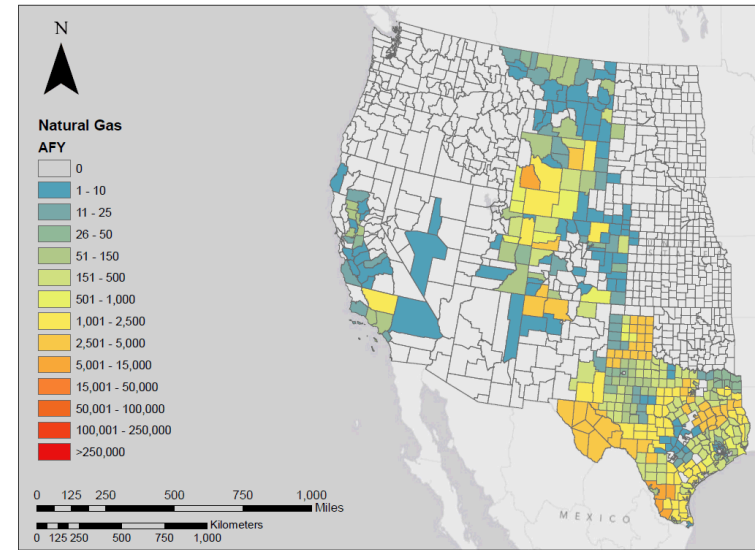


Water for Fuel Extraction

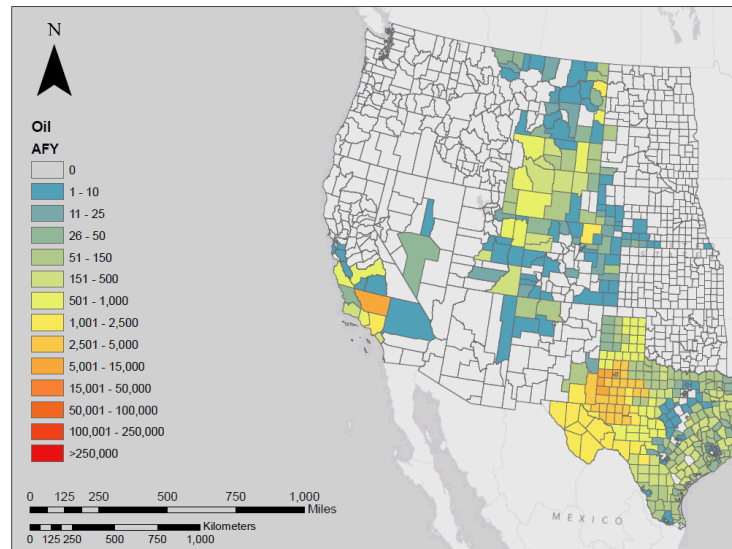
Water Use COAL



Water Use NATURAL GAS

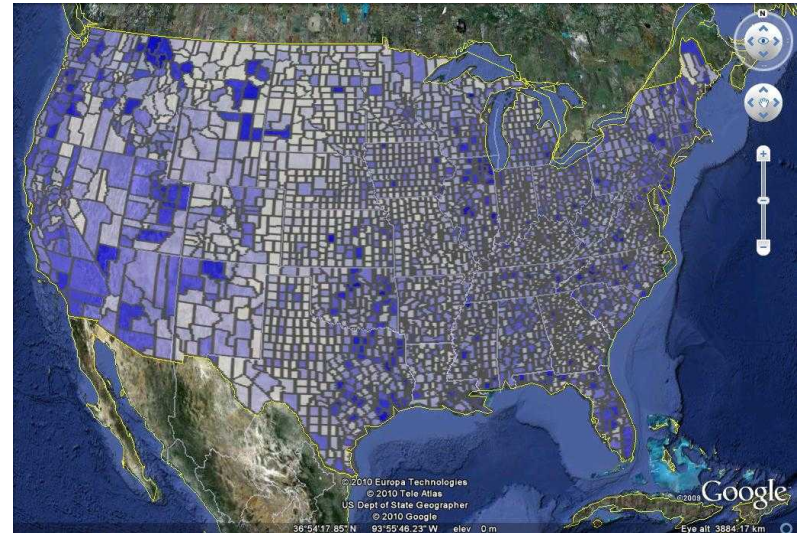
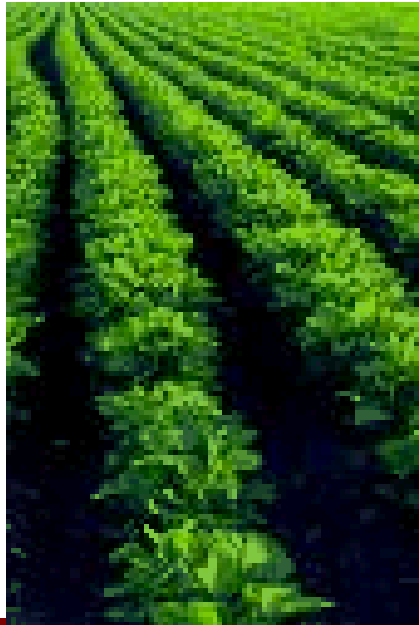


Water Use OIL



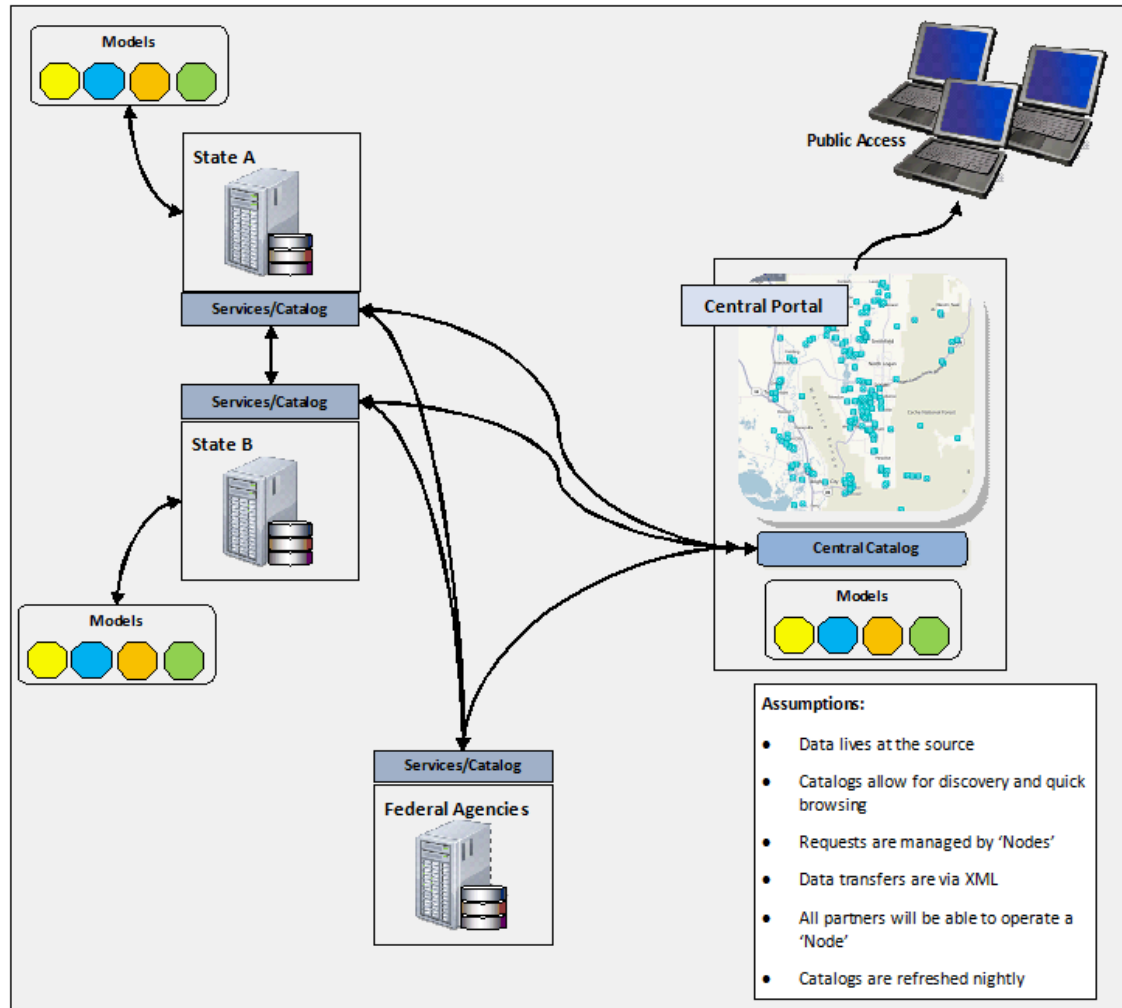
Energy for Water Calculator

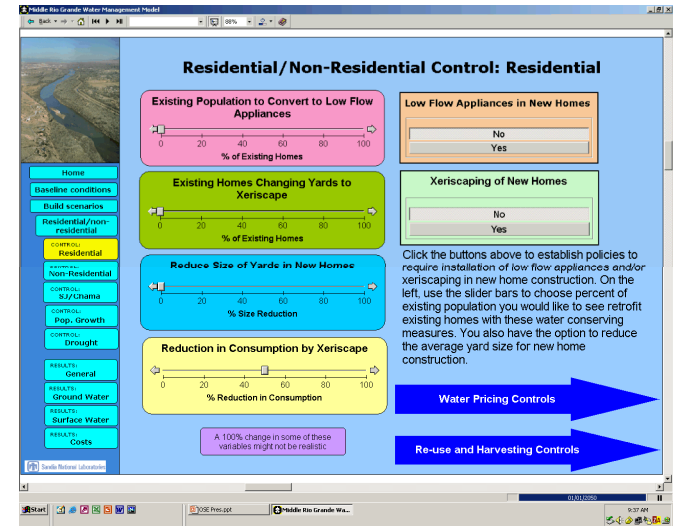
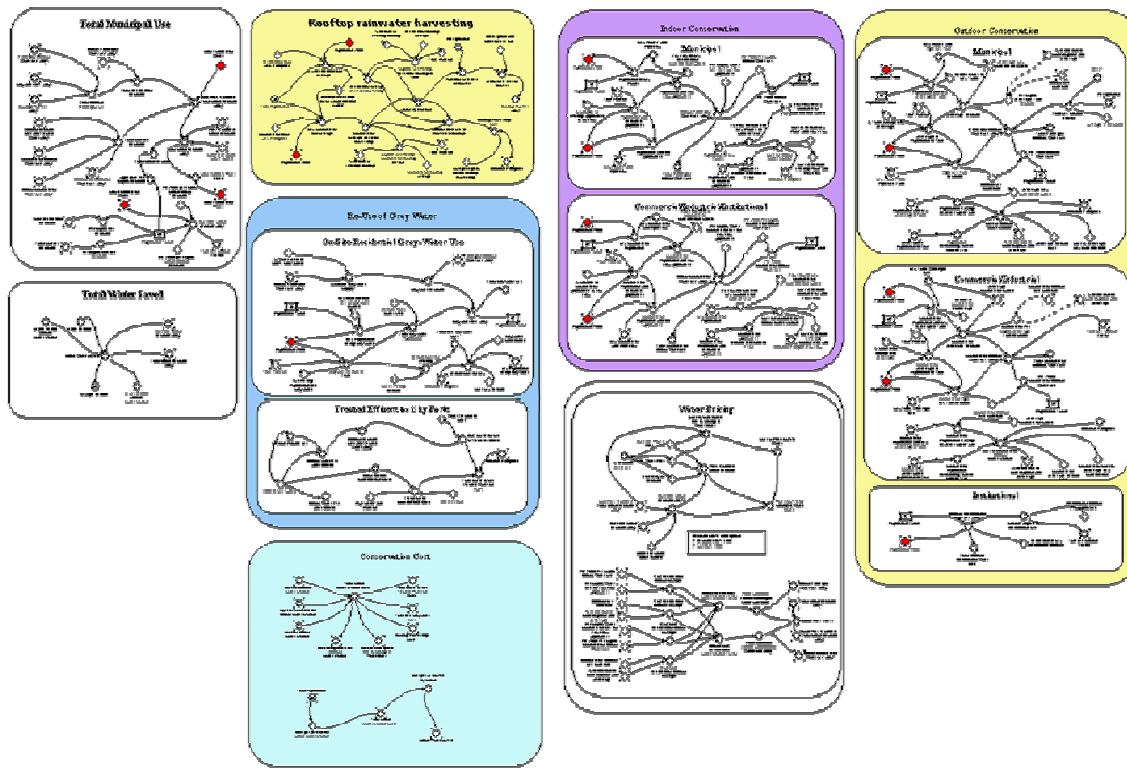
- ***Update Energy for Water Model***
- ***Energy for Large Projects***
- ***Energy for Agriculture***



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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