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Regional Variations of Water Scarcity and its Impact on Power Generation

Vincent C. Tidwell
Sandia National Laboratories

Water Conservation Technologies in the Energy Sector
Washington, DC , May 29, 2013

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

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- University of Texas
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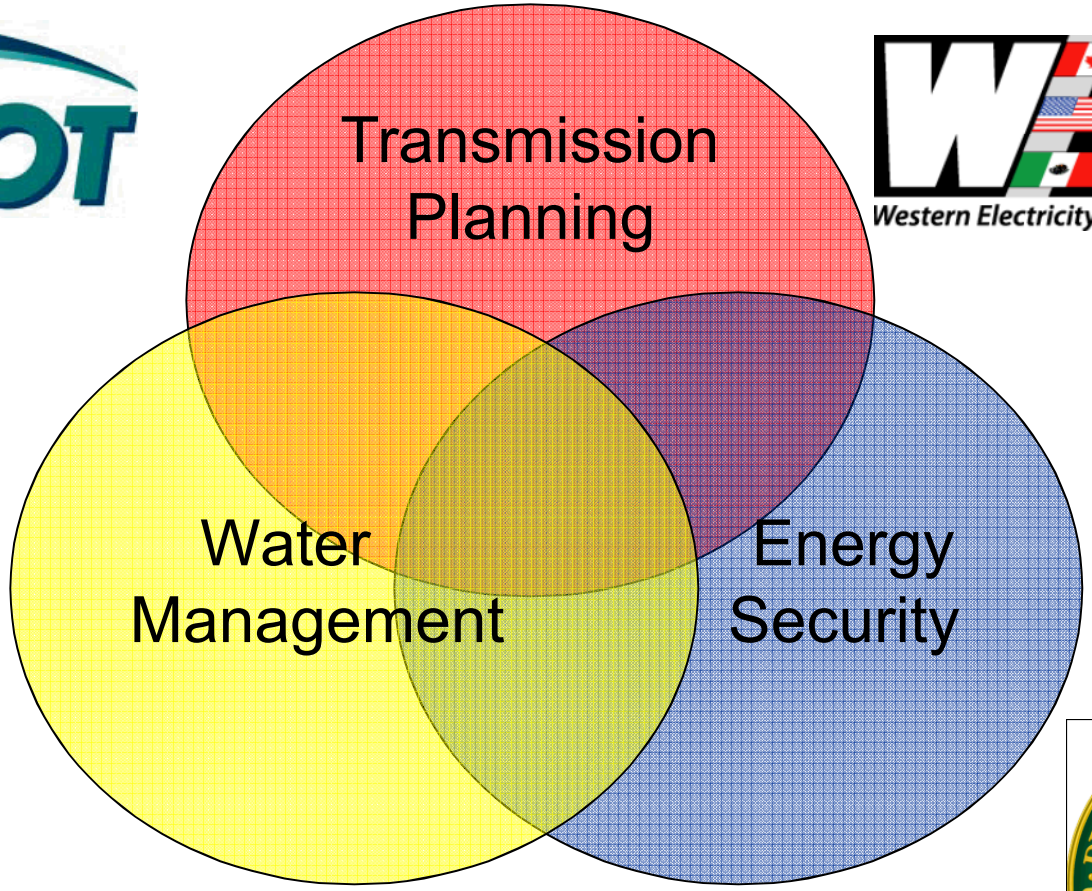
  - Carey King

Integrated Planning



ERCOT

WECC
Western Electricity Coordinating Council

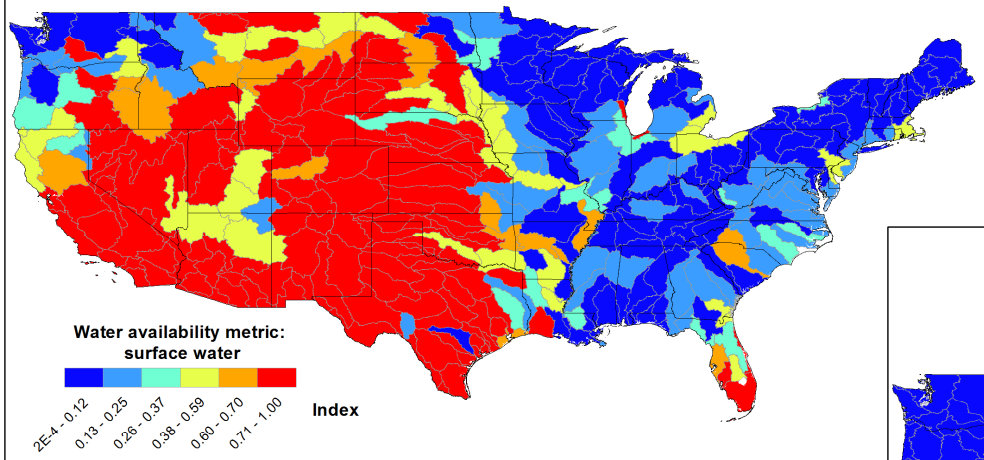
Western Governors' Association
Serving the Governors of 19 States and 3 US-Flag Pacific Islands

WSWC
Western States Water Council

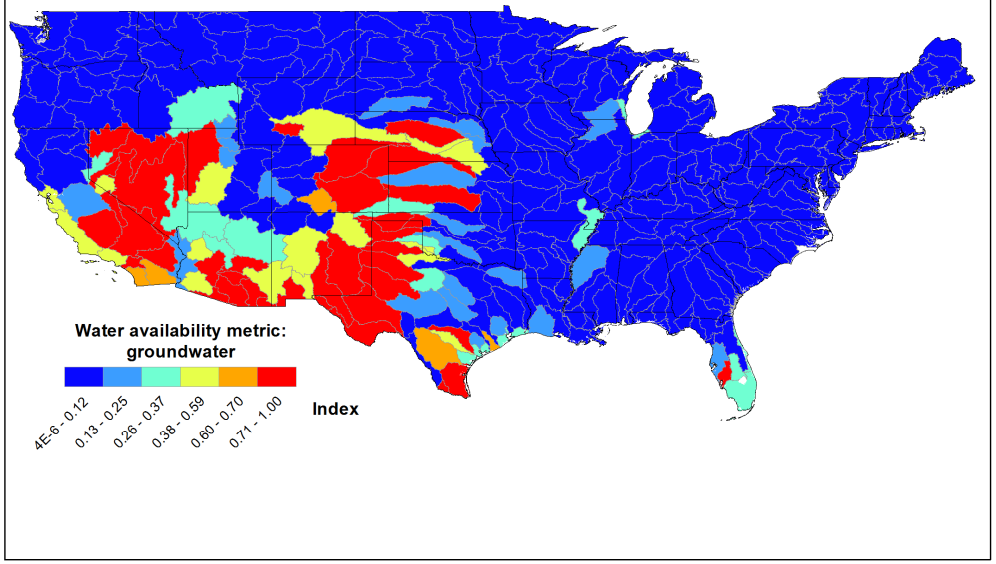
Department of Energy · United States of America

Potential Limits to Development

Gauged Streamflow vs. Consumption



Sustainable Recharge vs. Pumping



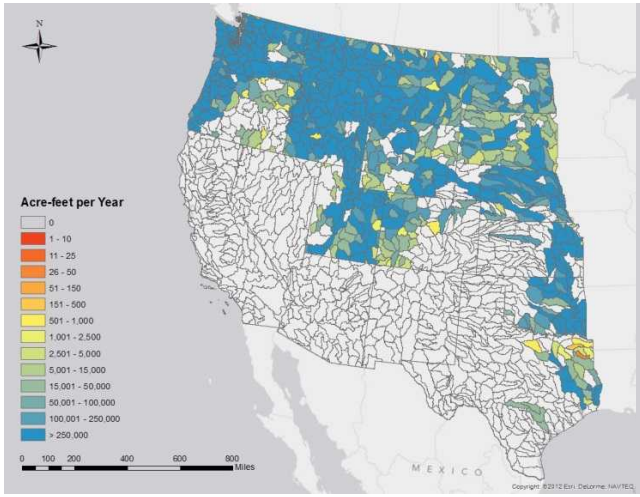
Key Water Sources

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

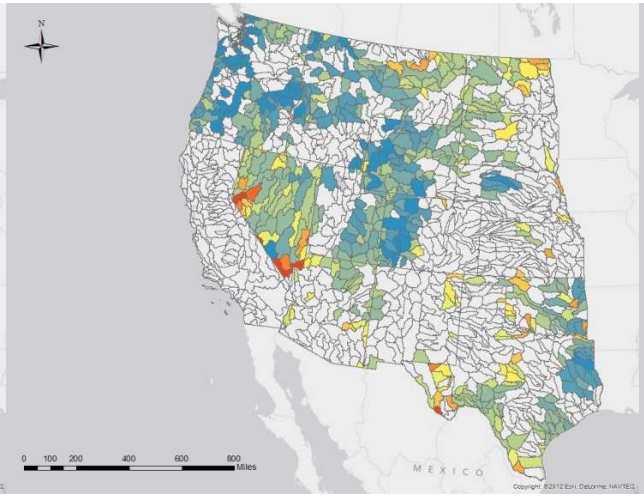
Relative Availability and Cost

Water Availability

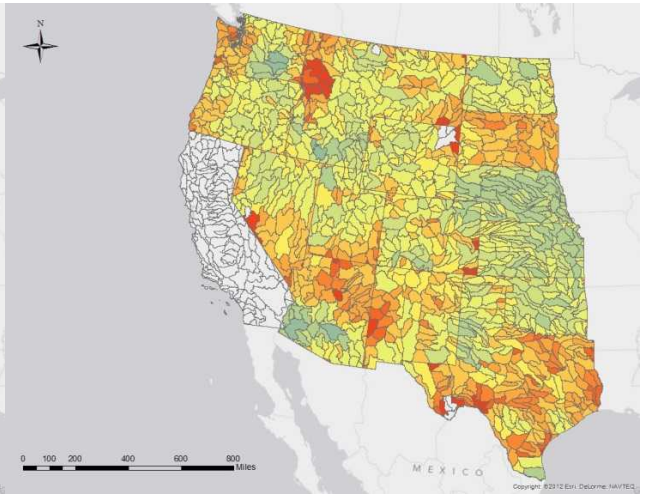
Unappropriated Surface Water



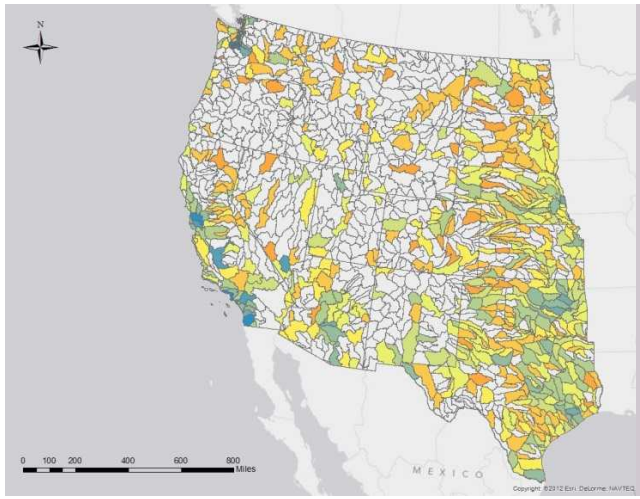
Unappropriated Groundwater



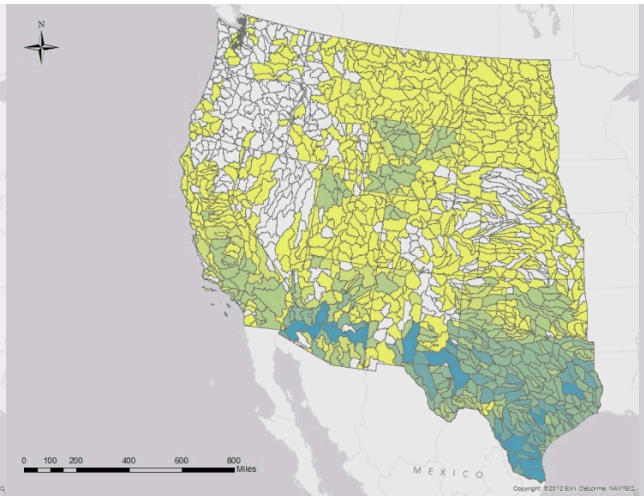
Appropriated Water



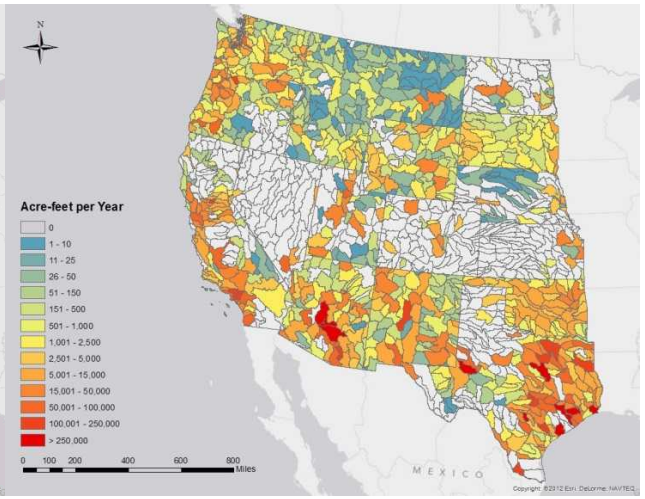
Municipal Wastewater



Brackish Groundwater

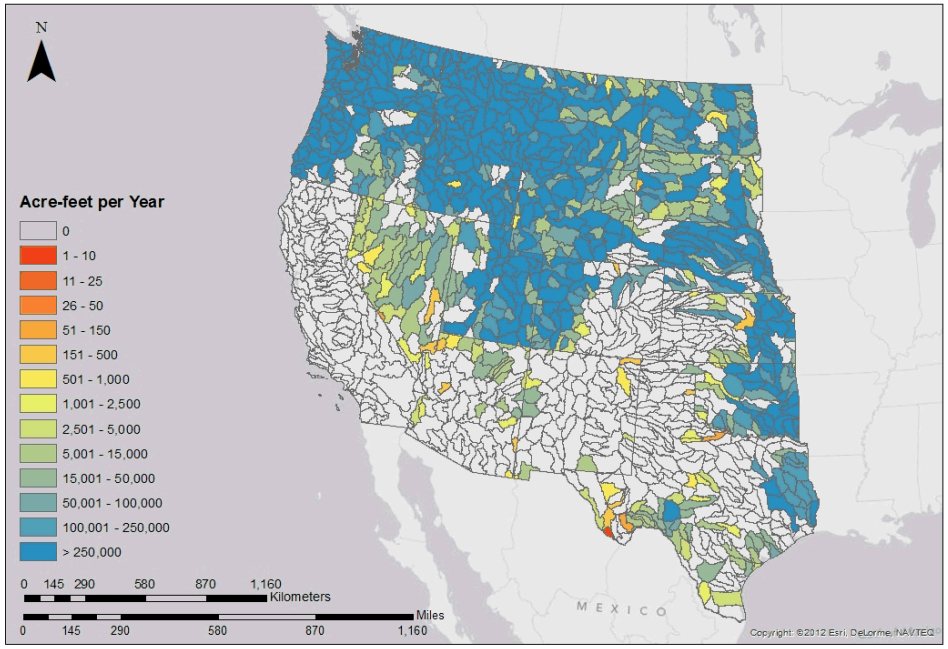


Consumptive Demand 2010-2030

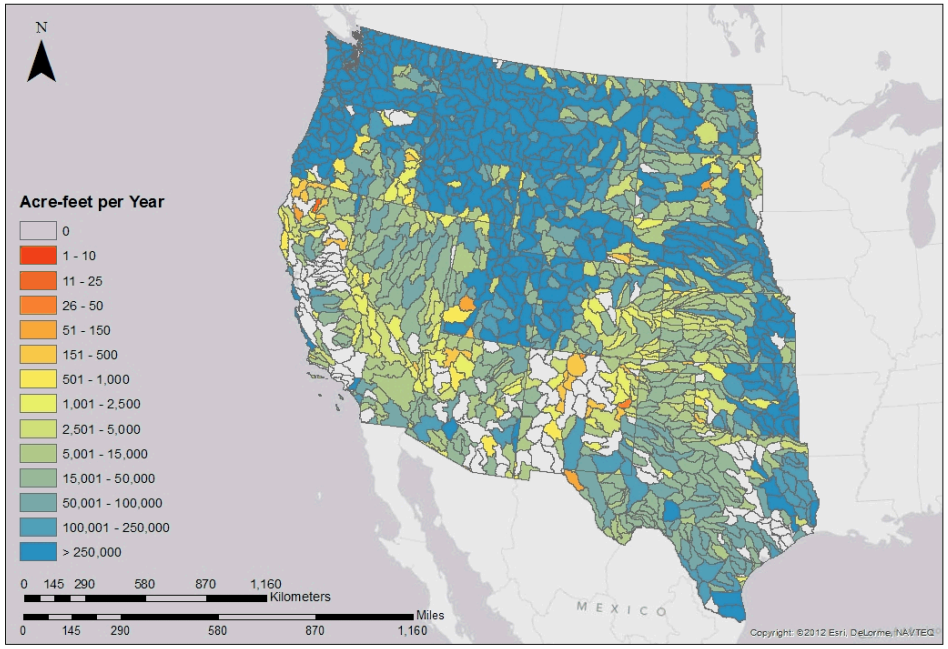


Water for Development

Unappropriated Water Sources - Change in Demand, 2030

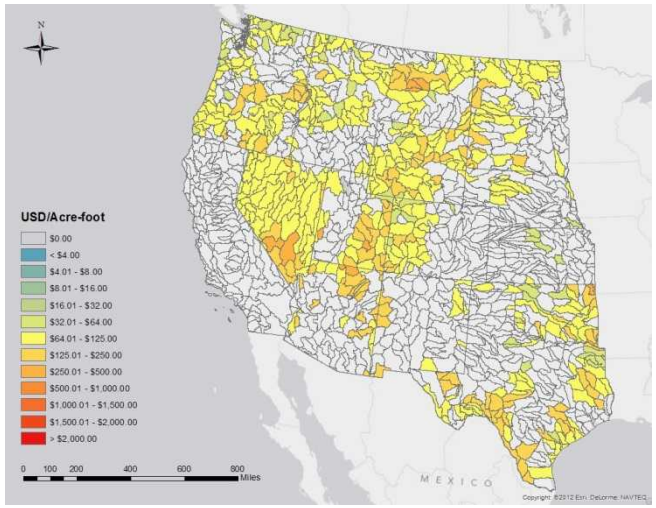


All Water Sources - Change in Demand, 2030

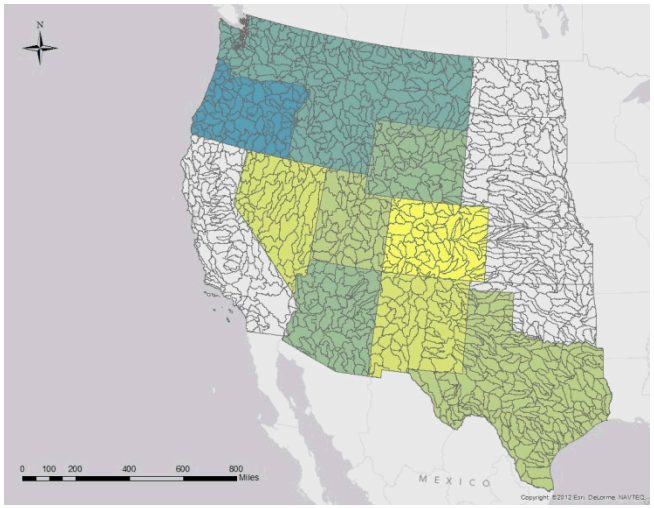


Relative Cost of Water

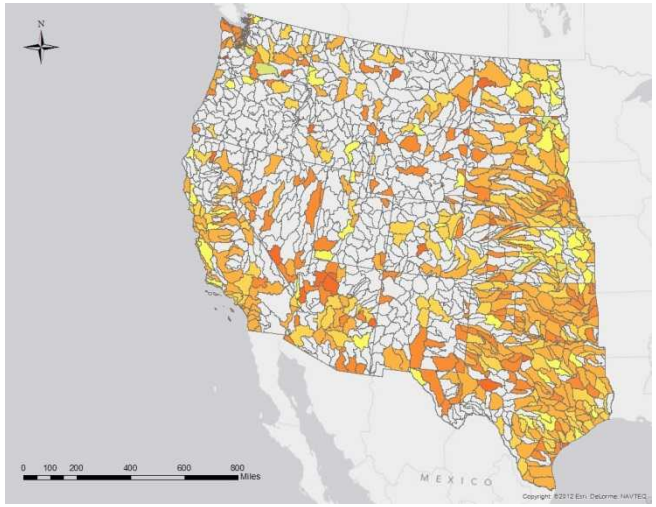
Unappropriated Groundwater



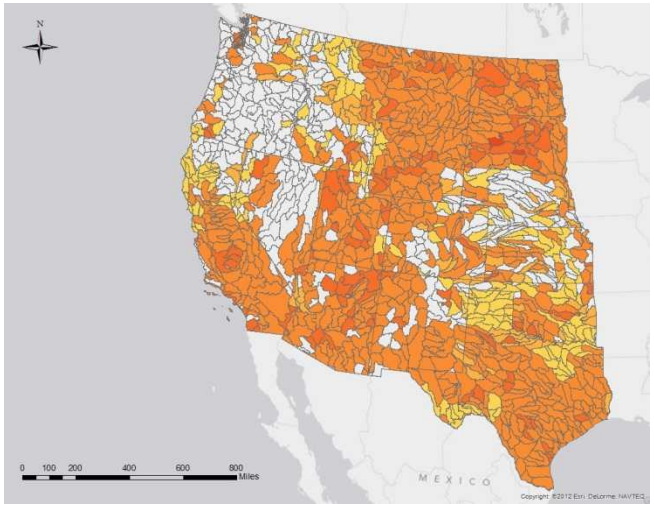
Appropriated Water



Municipal Wastewater



Brackish Groundwater



Environmental Risk Metric

Risk Calculation Methodology

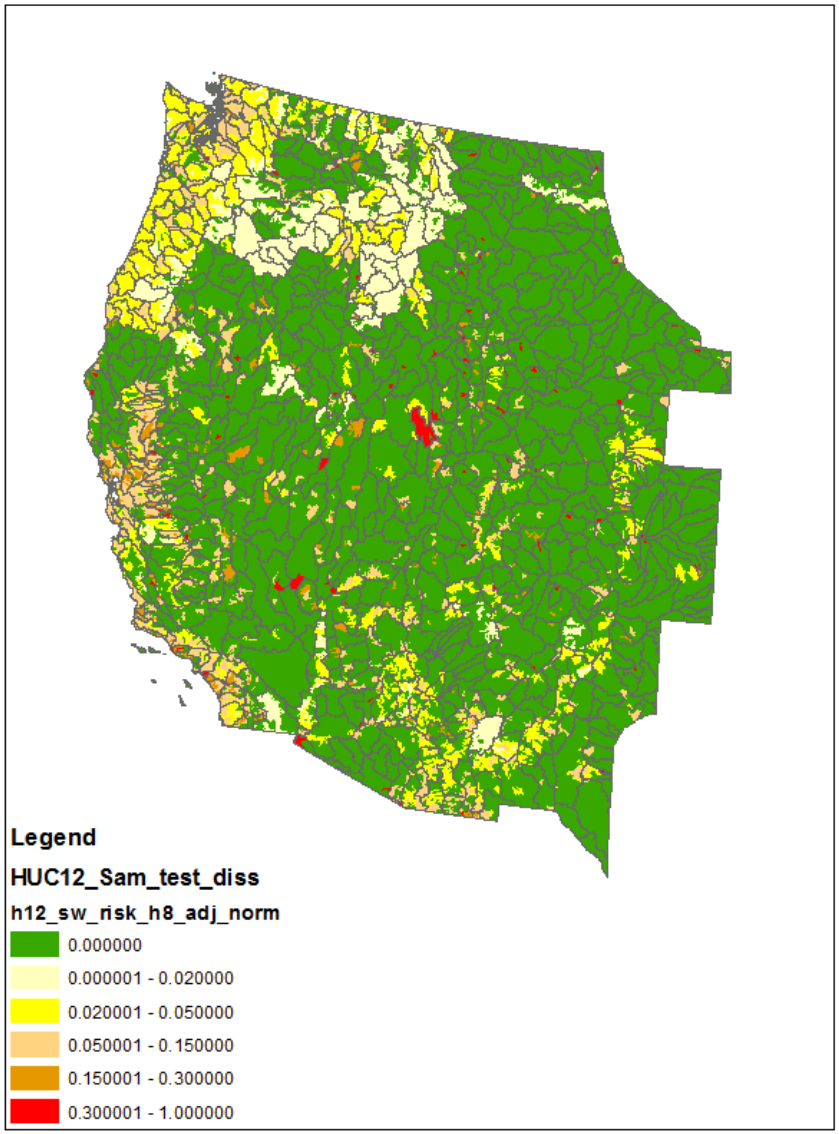
- Only species utilizing aquatic and riparian habitats are considered
- **Overall Risk** to a region from Water Extraction **(OR) = IR +** AR Eq1
- **Individual Risk (IR)** to a region is product of 4 Species Vulnerability Categories (**sij**'s) and 3 Habitat Vulnerability Categories (**hik**'s)
- **IR = ∑[(sij1 + sij2 + sij3 + sij4 + CF) * (hik1 + hik2 + hik3sw/gw) * EE]** Eq2

  sij1 = Diversity
  sij2 = Imperilment
  sij3 = Endemicity
  sij4 = Sensitivity

  hik1 = Area
  hik2 = Critical habitat
  hik3 = Habitat type
  hik3 risks are separate for surface- (sw) and groundwater (gw)

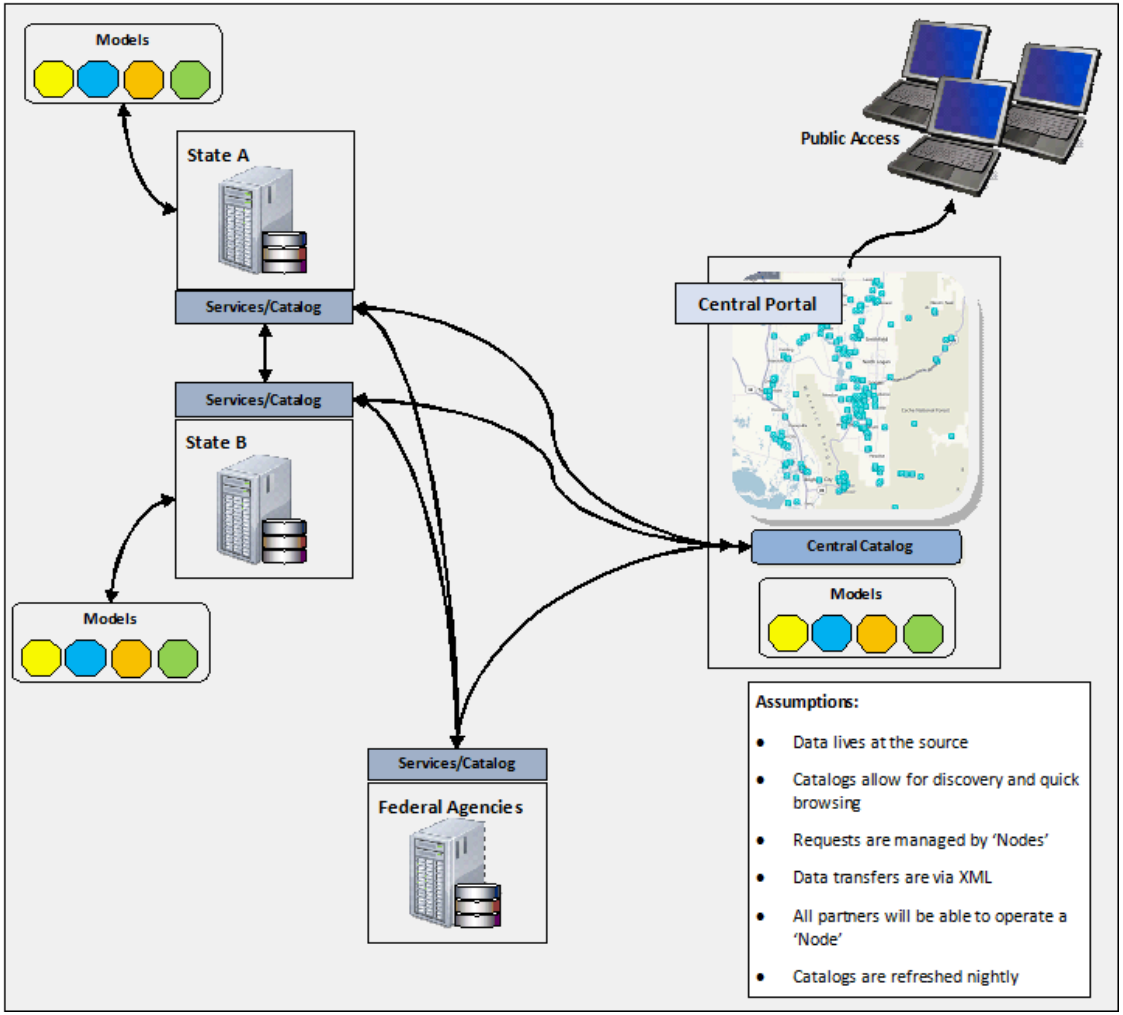
- Edge-effect filter EE_8 **factors (0.5, 1) and** EE_{12} **factors (1, 2)**
- Association Risk (AR) **= 0.5 * IR** of Immediate Downstream Polygon Eq3
- Correction Factor (CF - Binary), Edge-effect (EE) filter, and Association Risk (AR) – Not used for this analysis

HUC-12 Risk Map (From Surface Withdrawals)



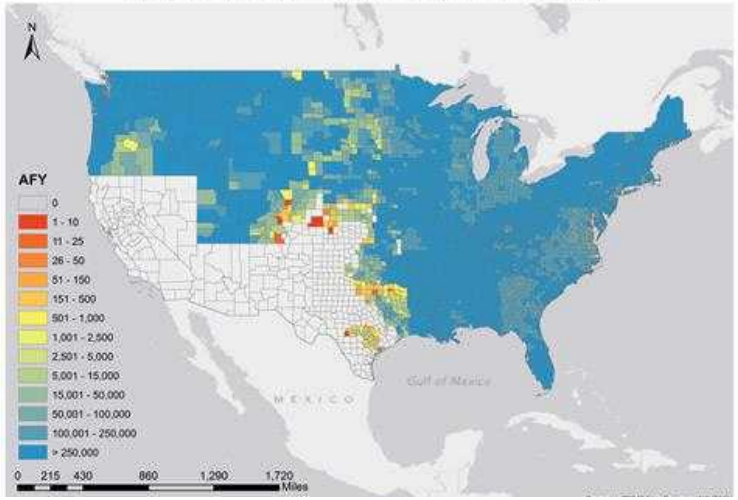
Water Use Data Exchange (WaDE)

- 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

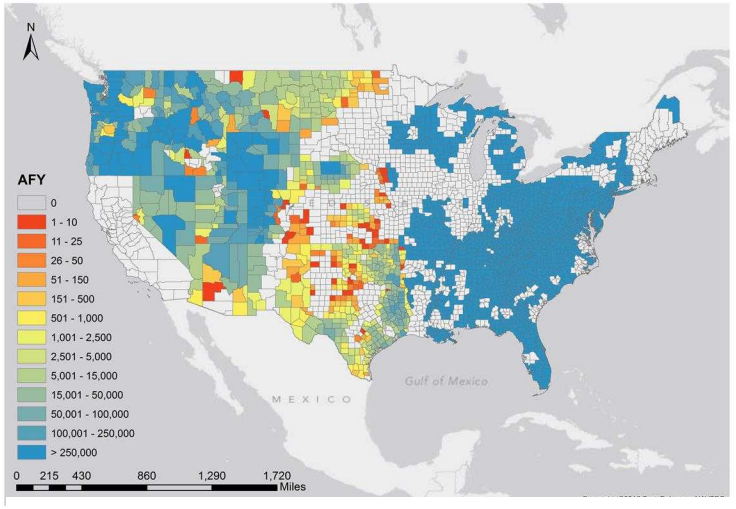


Water Availability

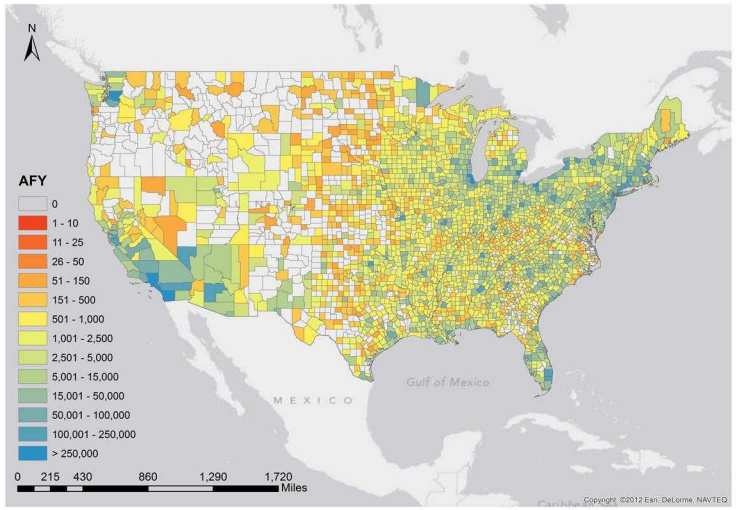
Unappropriated Surface Water Availability



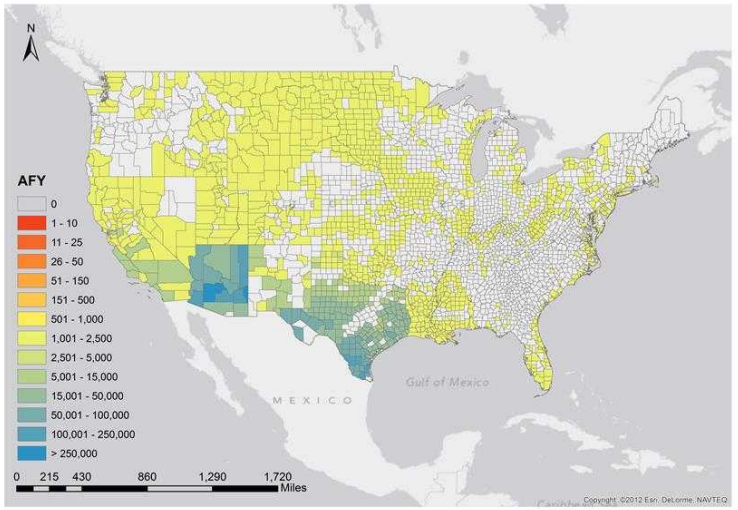
Potable Groundwater Availability



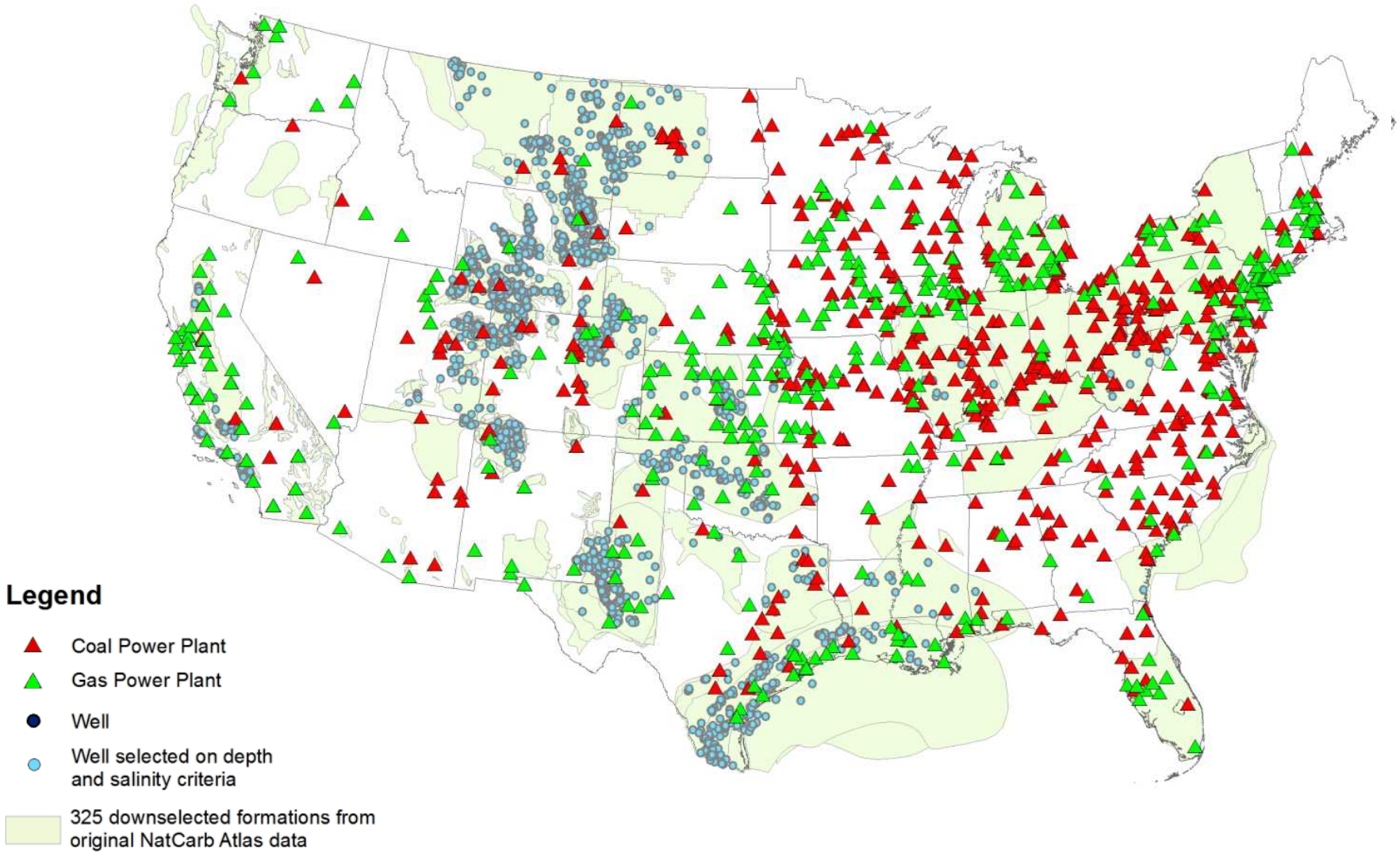
Wastewater Availability

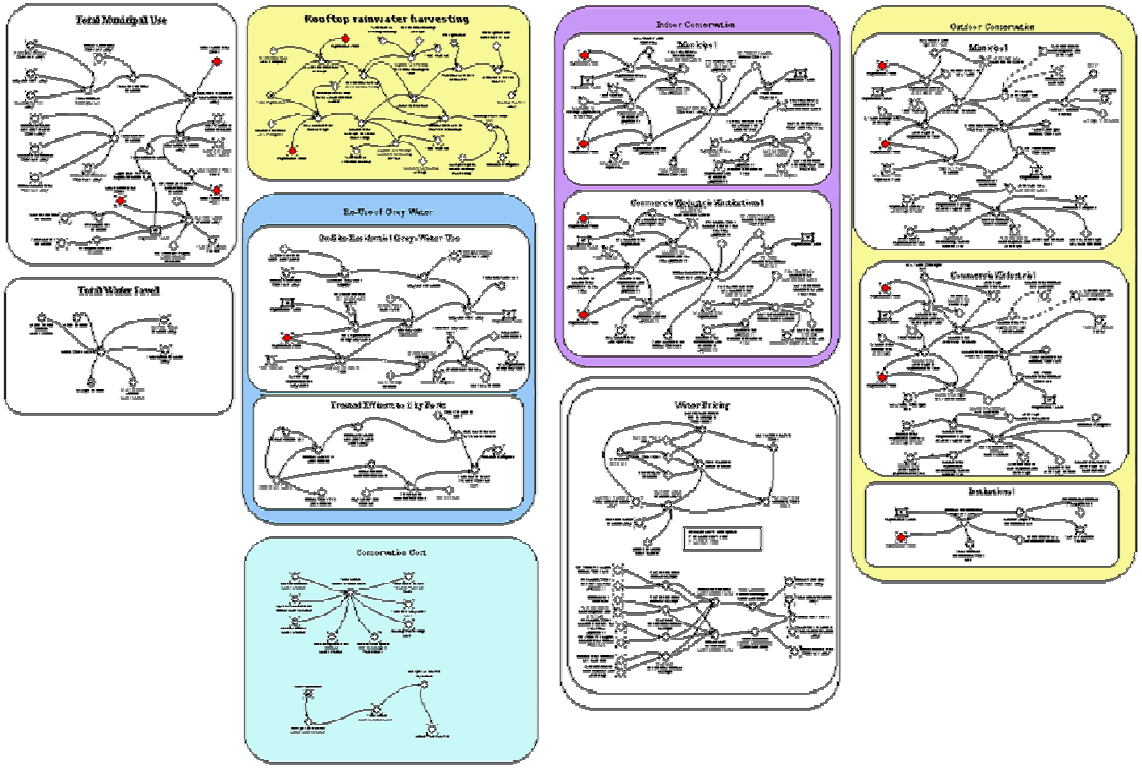


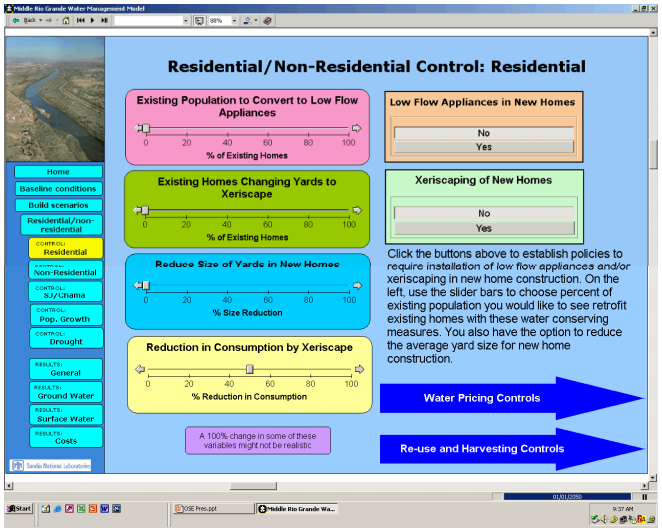
Brackish Groundwater Availability



U.S. CO_2 Saline Formation Sinks







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