

Exceptional service in the national interest



Regional Analysis of Energy, Water, and Land Bilateral Relations

Vincent Tidwell and Emily Silver

Sandia National Laboratories

Food, Energy, Water Nexus Workshop

Baltimore, MD, October 7, 2015



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Chapter 10: Energy, Water, and Land Use

<http://nca2014.globalchange.gov/report/sectors/energy-water-and-land>

- Convening Lead Authors
 - Kathy Hibbard, Pacific Northwest National Laboratory
 - Tom Wilson, Electric Power Research Institute

- Lead Authors
 - Elena Shevliakova, Princeton University
 - Kristen Averyt, University of Colorado Boulder
 - Robert Harriss, Environmental Defense Fund
 - Robin Newmark, National Renewable Energy Laboratory
 - Steven Rose, Electric Power Research Institute
 - Vincent Tidwell, Sandia National Laboratories

- Technical Report Authors
 - Richard Skaggs, Pacific Northwest National Laboratory
 - Ron Pate, Sandia National Laboratories
 - Tom Lowry, Sandia National Laboratories



Climate Change Impacts in the United States

CHAPTER 10 ENERGY, WATER, AND LAND USE

Convening Lead Authors

Kathy Hibbard, Pacific Northwest National Laboratory
Tom Wilson, Electric Power Research Institute

Lead Authors

Kristen Averyt, University of Colorado Boulder
Robert Harriss, Environmental Defense Fund
Robin Newmark, National Renewable Energy Laboratory
Steven Rose, Electric Power Research Institute
Elena Shevliakova, Princeton University
Vincent Tidwell, Sandia National Laboratories

Recommended Citation for Chapter

Hibbard, K., T. Wilson, K. Averyt, R. Harriss, R. Newmark, S. Rose, E. Shevliakova, and V. Tidwell, 2014: Ch. 10: Energy, Water, and Land Use. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yoke, Eds., U.S. Global Change Research Program, 257-281. doi:10.7930/JW8BSF.

On the Web: <http://nca2014.globalchange.gov/report/sectors/energy-water-and-land>



INFORMATION DRAWN FROM THIS CHAPTER IS INCLUDED IN THE HIGHLIGHTS REPORT AND IS IDENTIFIED BY THIS ICON

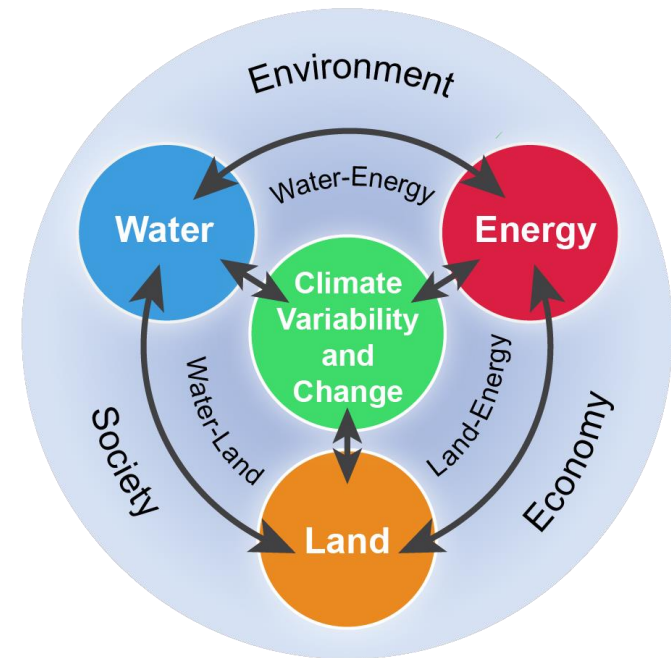
Objective



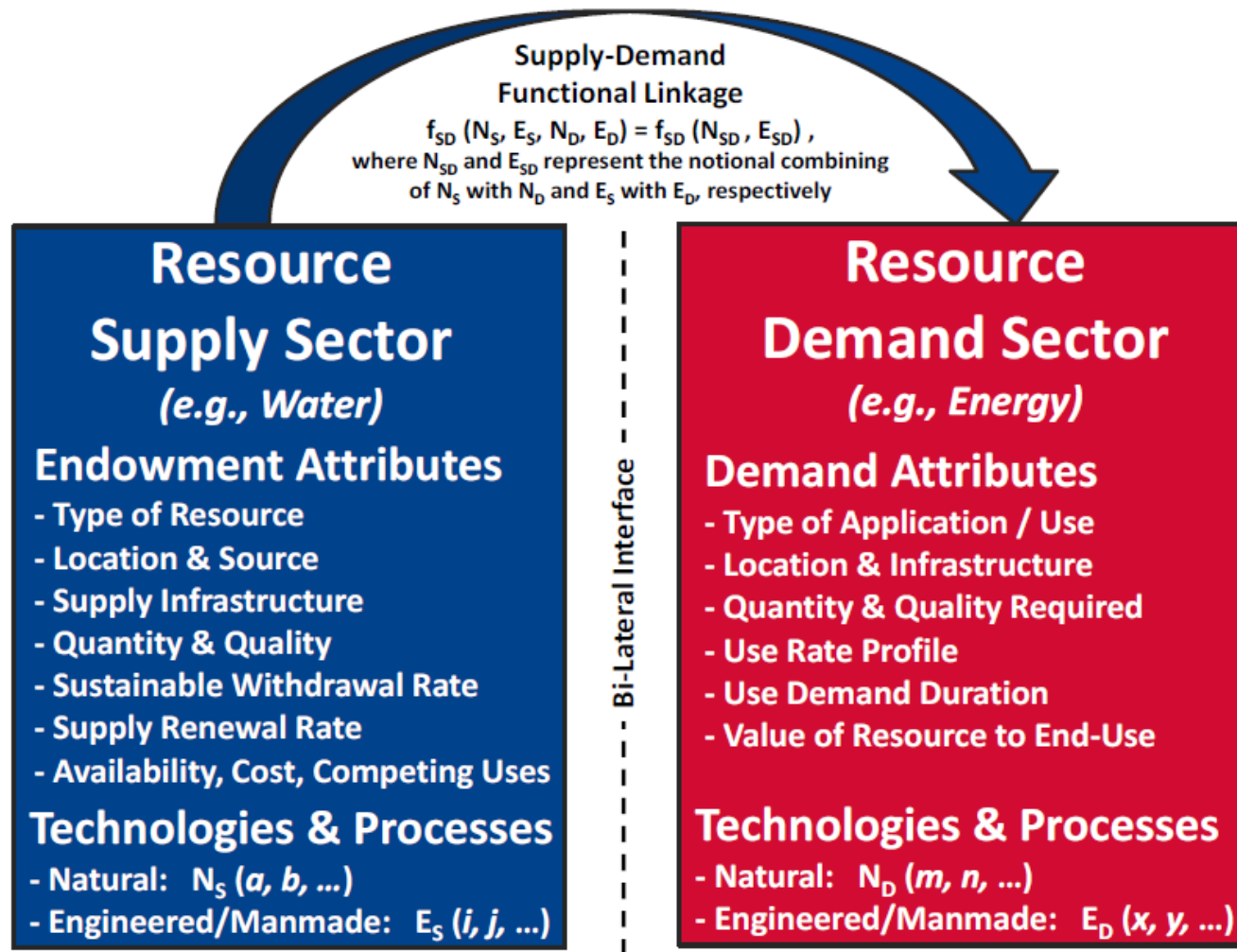
- Explore geospatial differences in energy-water-land interactions:
 - By NCA region, and
 - By state.

Bilateral Interactions

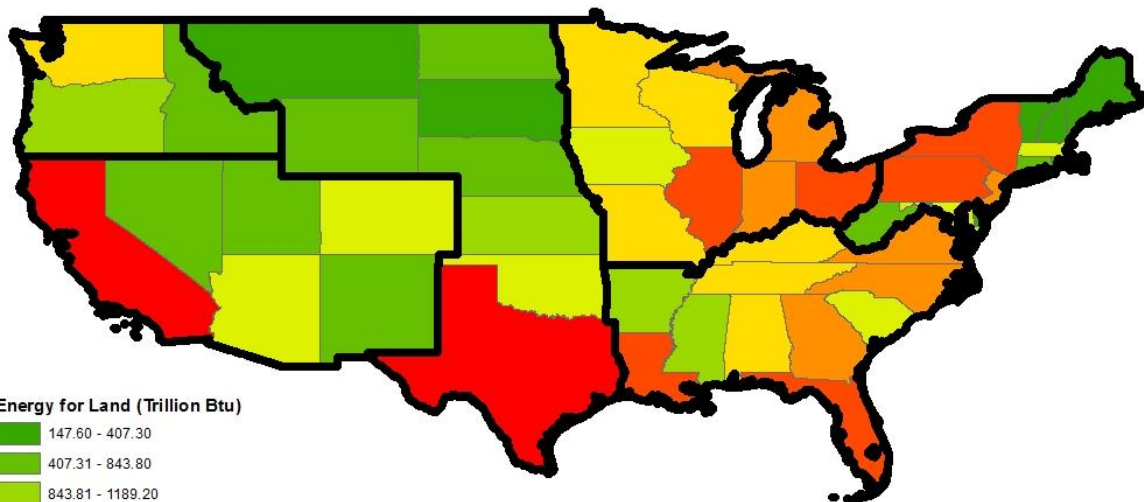
- Effect of **ENERGY** on **WATER** use
 - Water used for energy production (power plant cooling, mining, etc.)
- Effect of **WATER** on **ENERGY** use
 - Energy to move, lift and treat water
- Effect of **WATER** on **LAND** use
 - Blue water: irrigated cropland and reservoirs
 - Green water: dry land farming and forests
- Effect of **LAND** on **WATER** use
 - All water use except for energy
- Effect of **LAND** on **ENERGY** use
 - Energy consumption associated with land development
- Effect of **ENERGY** on **LAND** use
 - Land used for energy development (power plants, pipelines, etc.)



Framework for Interpretation

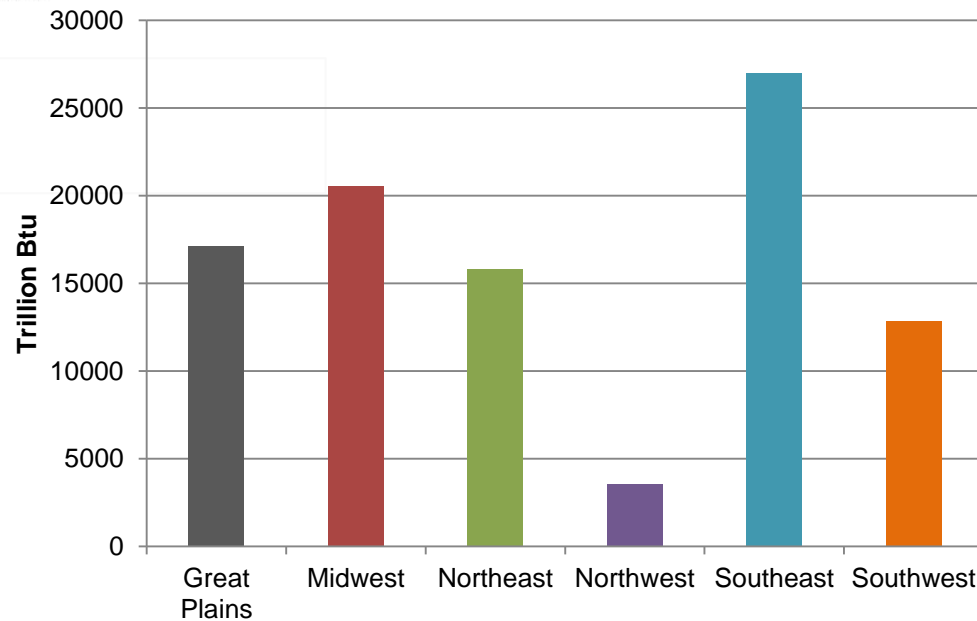


Effect of Land on Energy Use



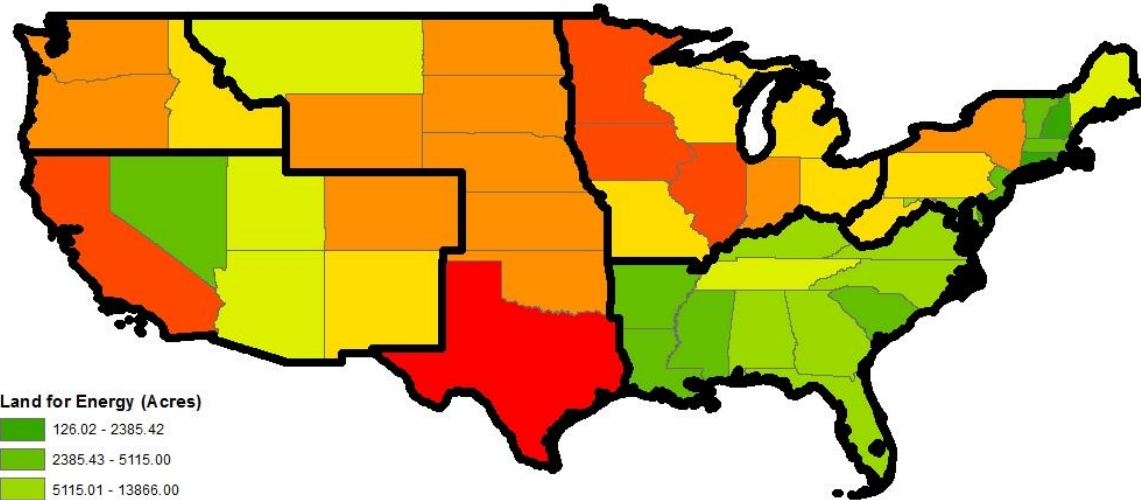
■ Primary energy consumption

Energy for Land (Trillion Btu)

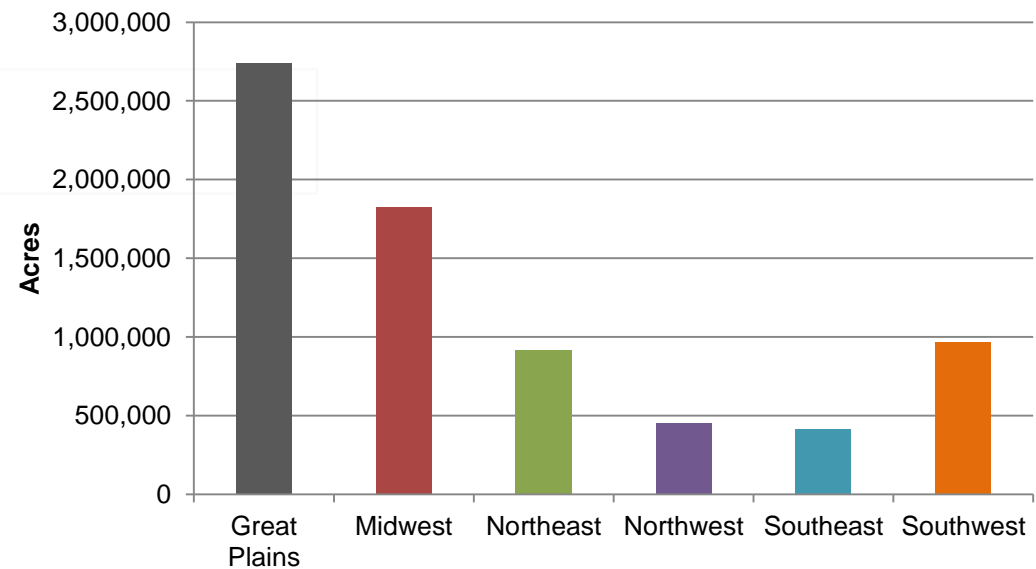
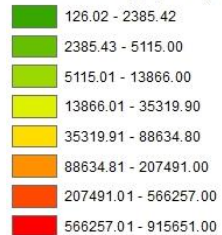


Effect of Energy on Land Use

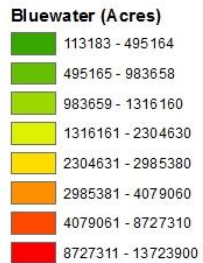
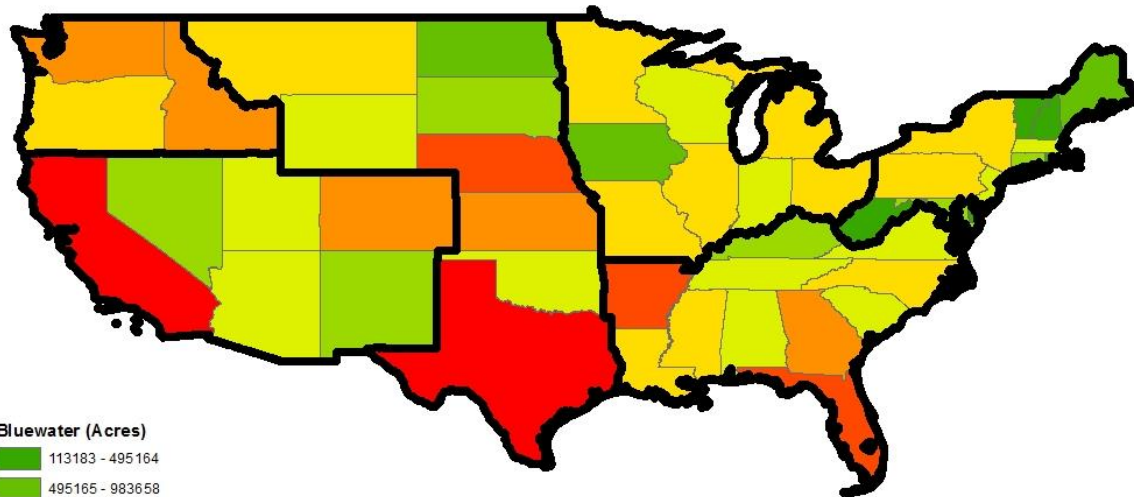
- Land for power plants
- Land for energy extraction
- Land for biofuel cultivation



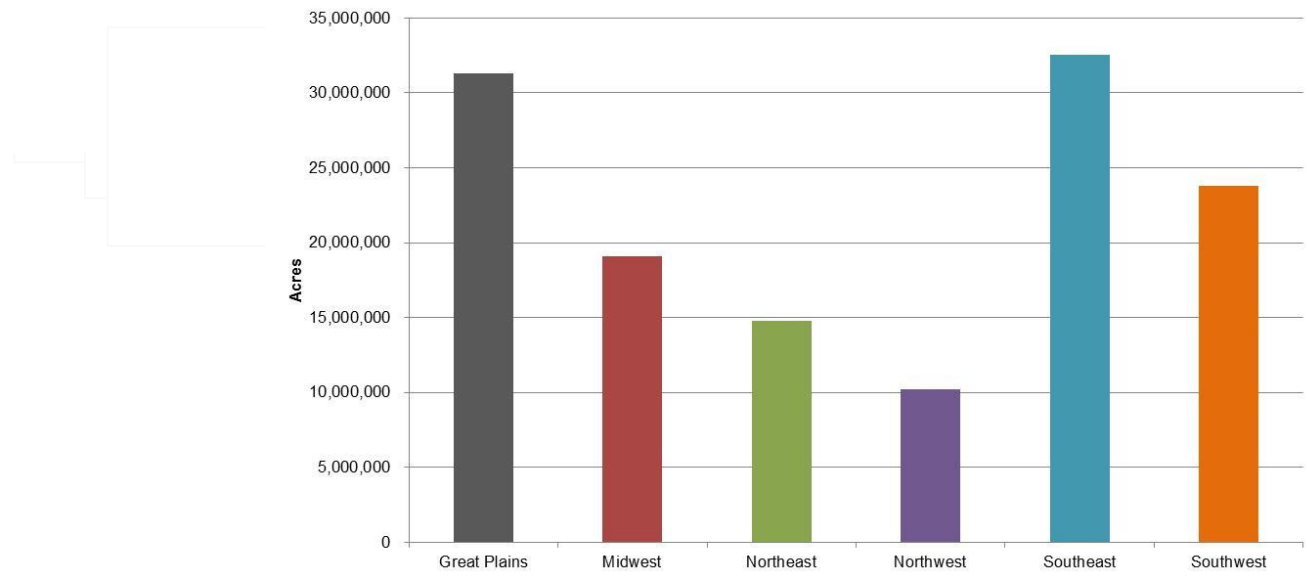
Land for Energy (Acres)



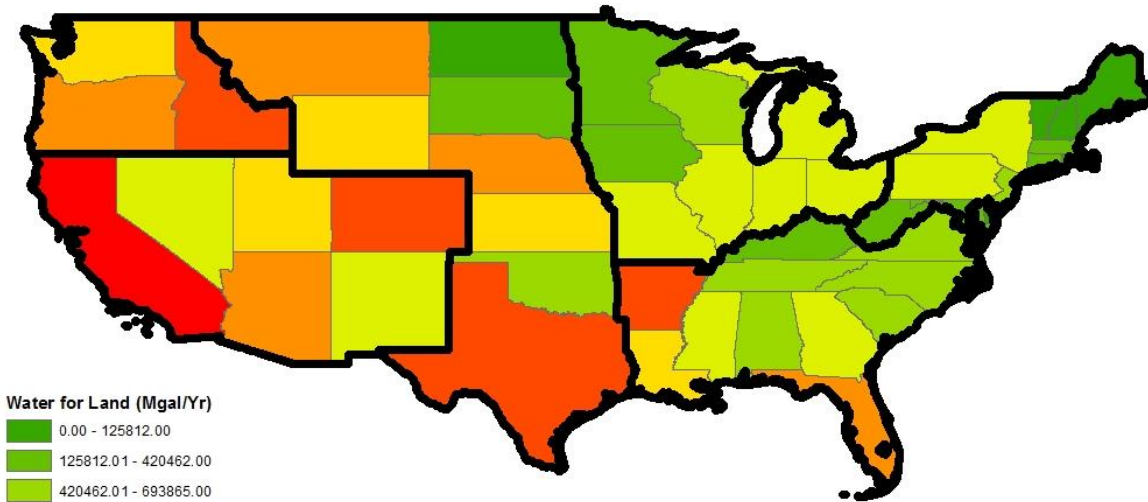
Effect of Water on Land Use



- Blue Water:
 - Irrigated farmland,
 - Reservoirs,
 - Urban land



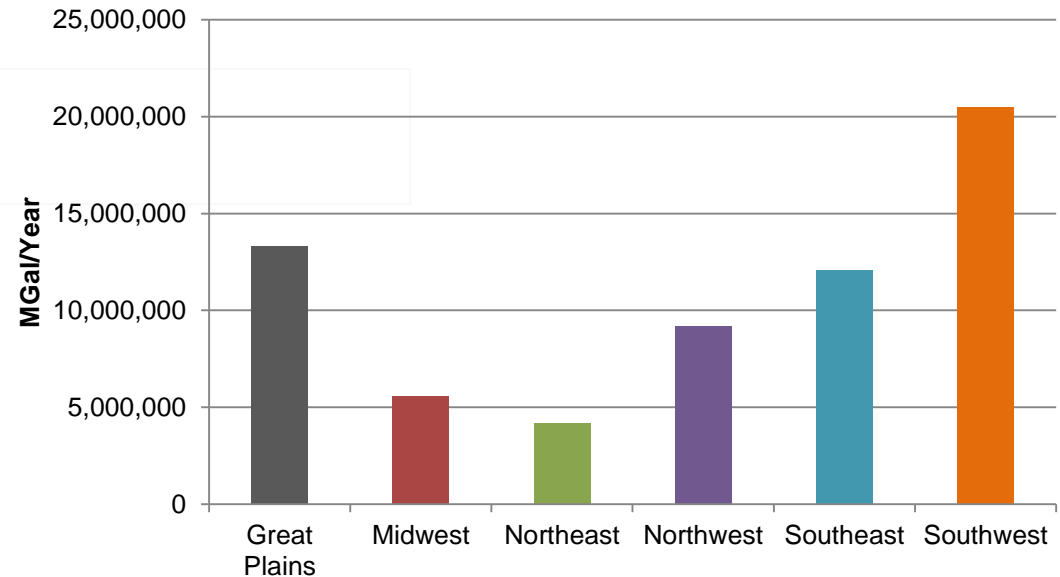
Effect of Land on Water Use



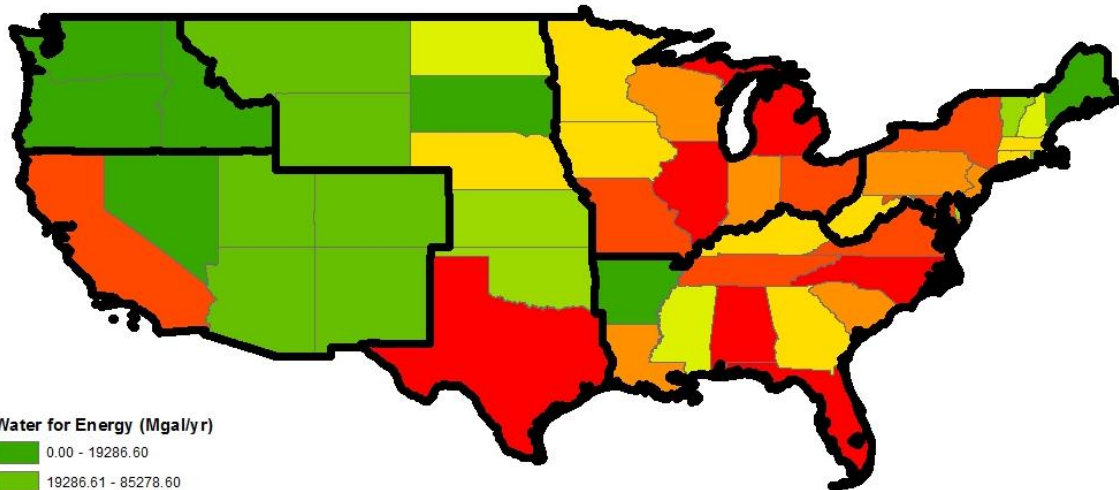
Water for Land (Mgal/Yr)



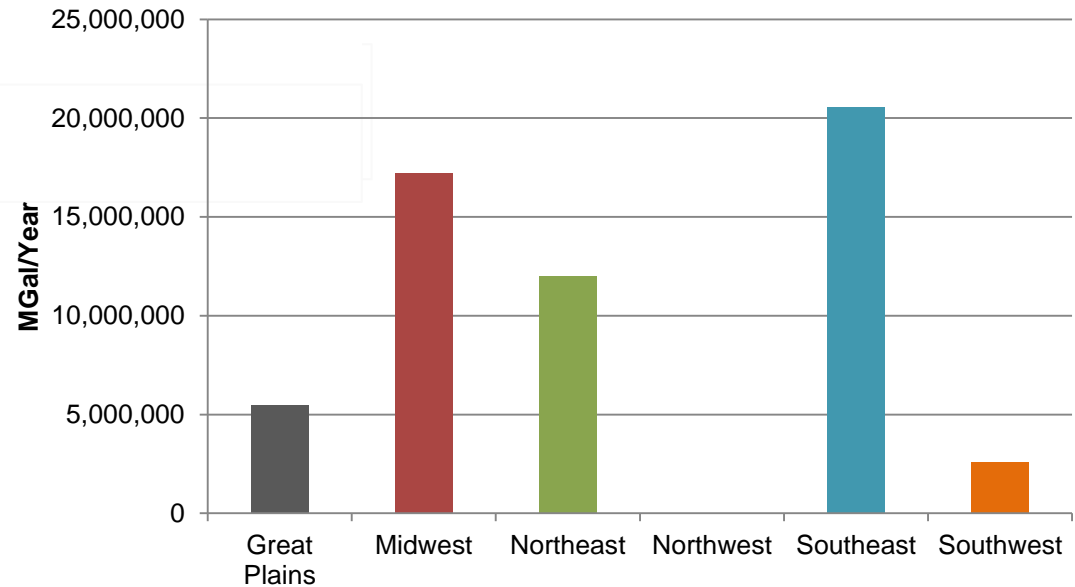
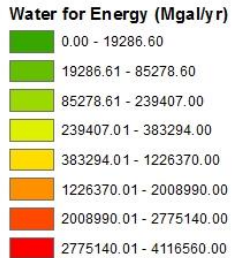
- Water withdrawals excluding energy sector



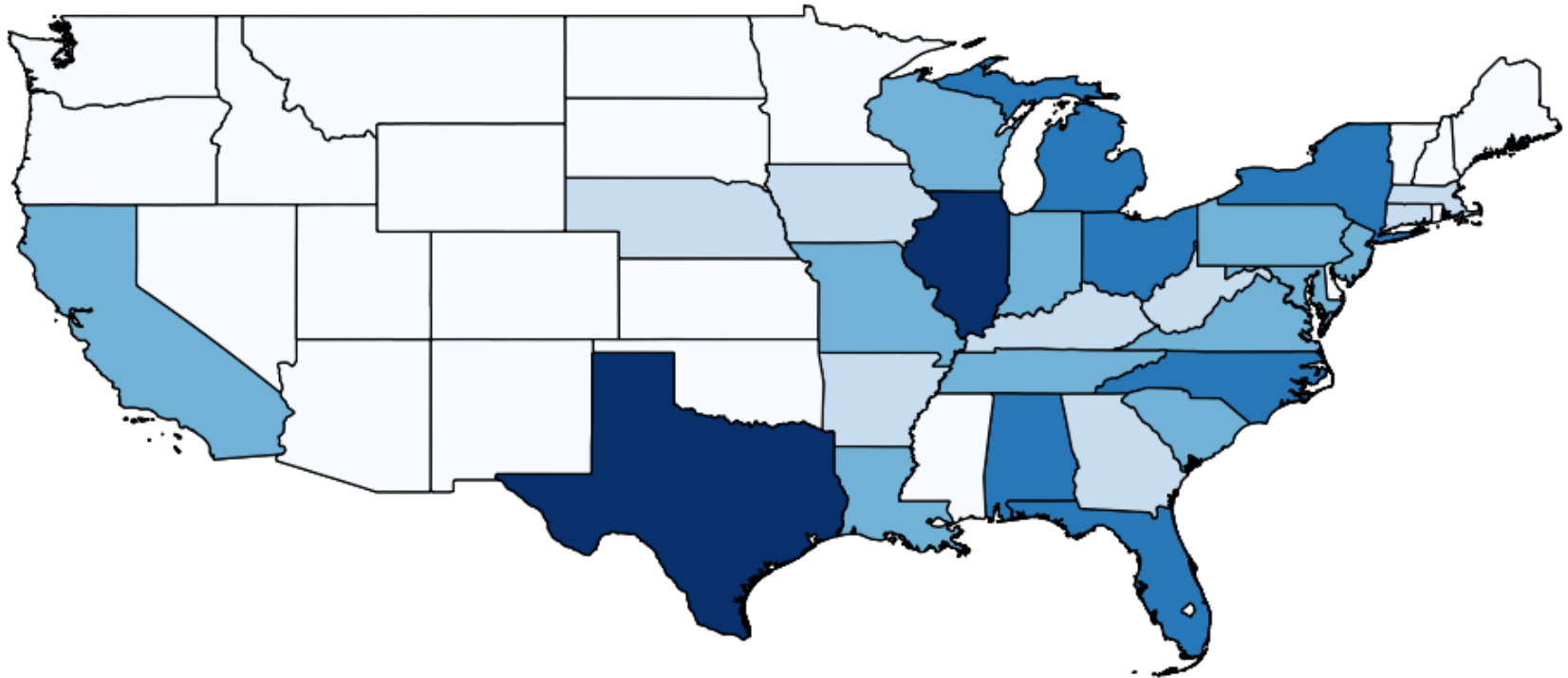
Effect of Energy on Water Use



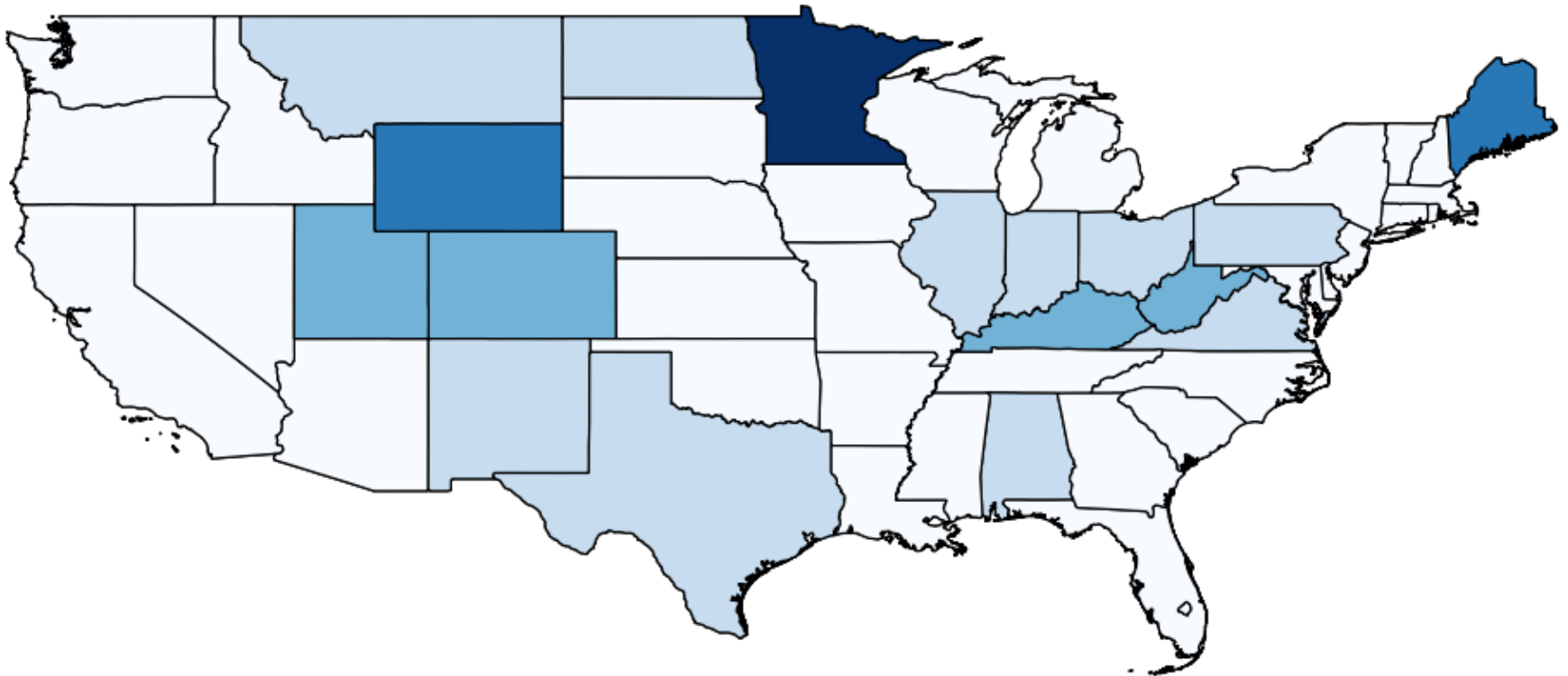
- Thermoelectric water use
- Water for fuel extraction
- Water for biofuel production



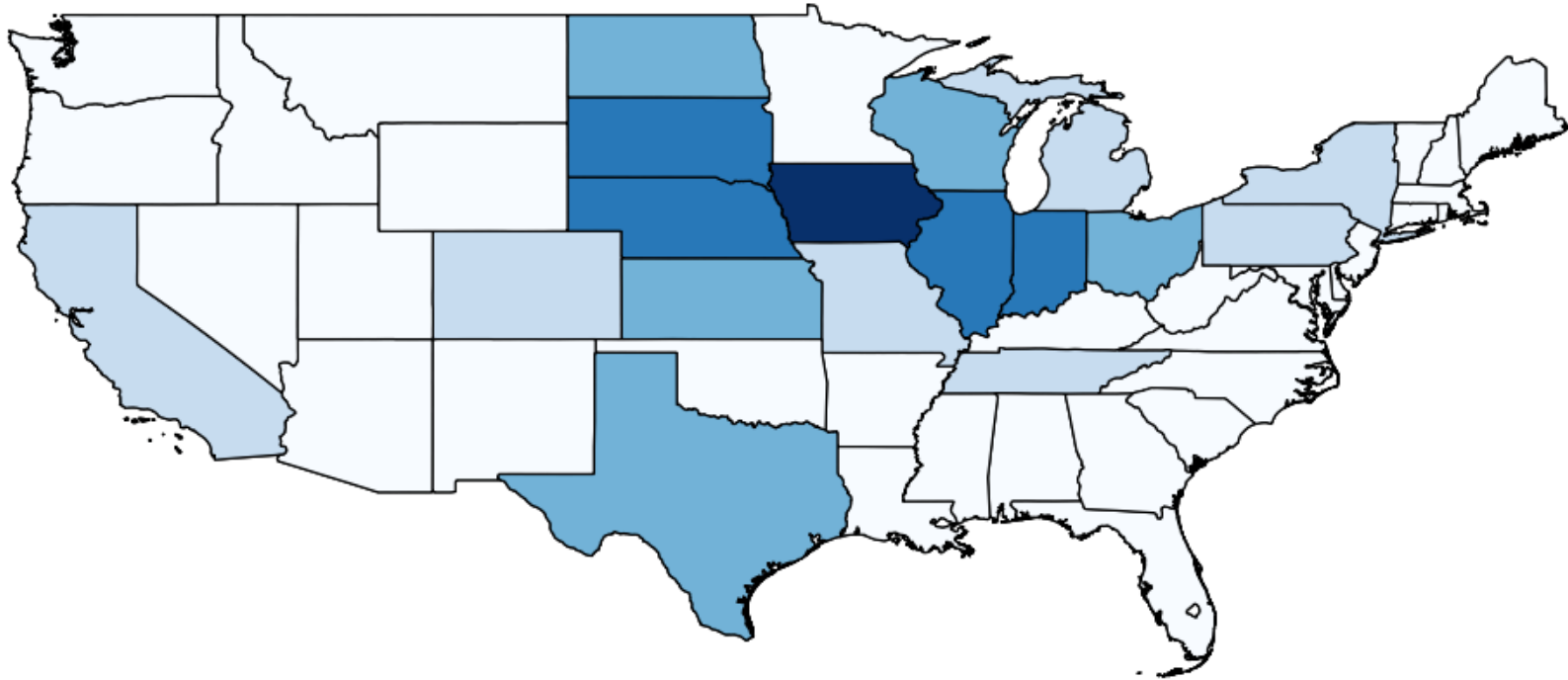
1. Effect of Energy on Water (Water for Energy) Mgal/yr : Thermoelectric



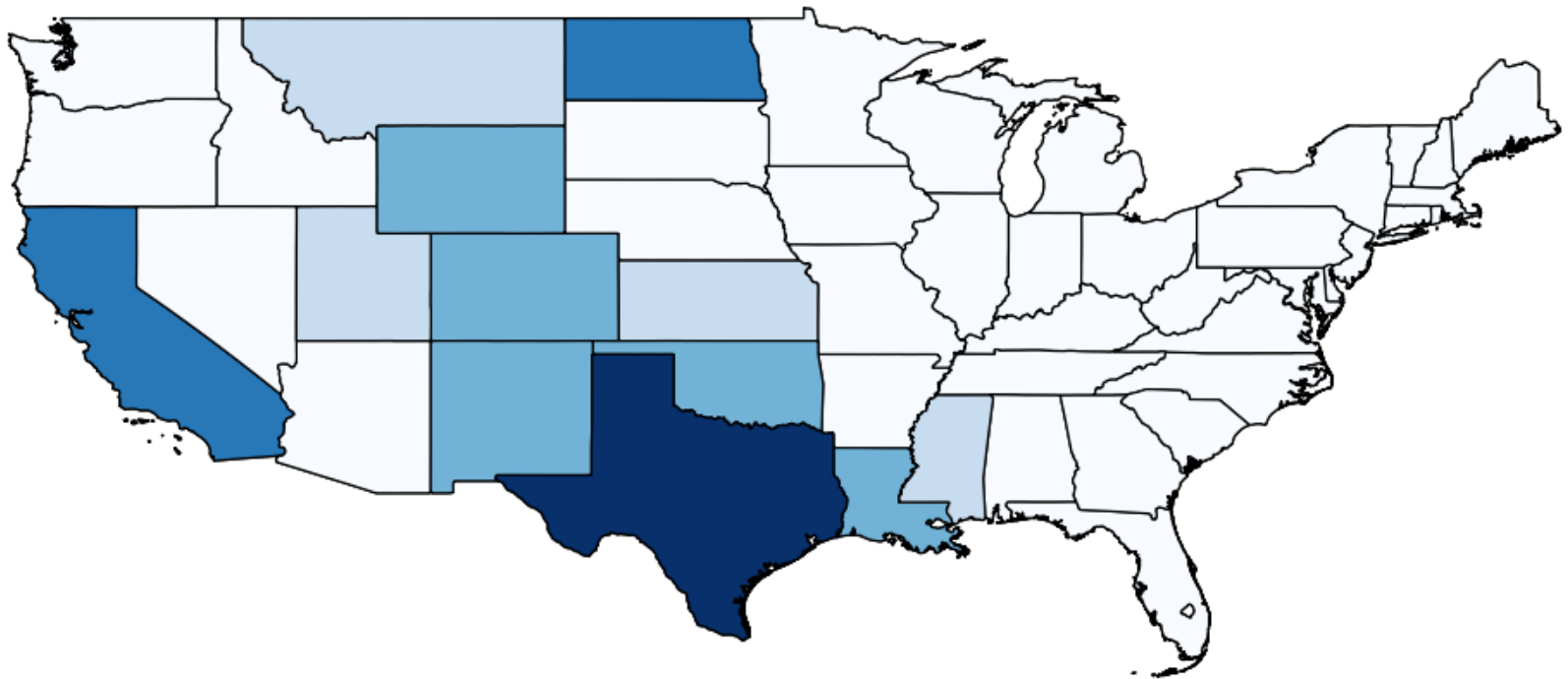
1. Effect of Energy on Water (Water for Energy) Mgal/yr : COAL



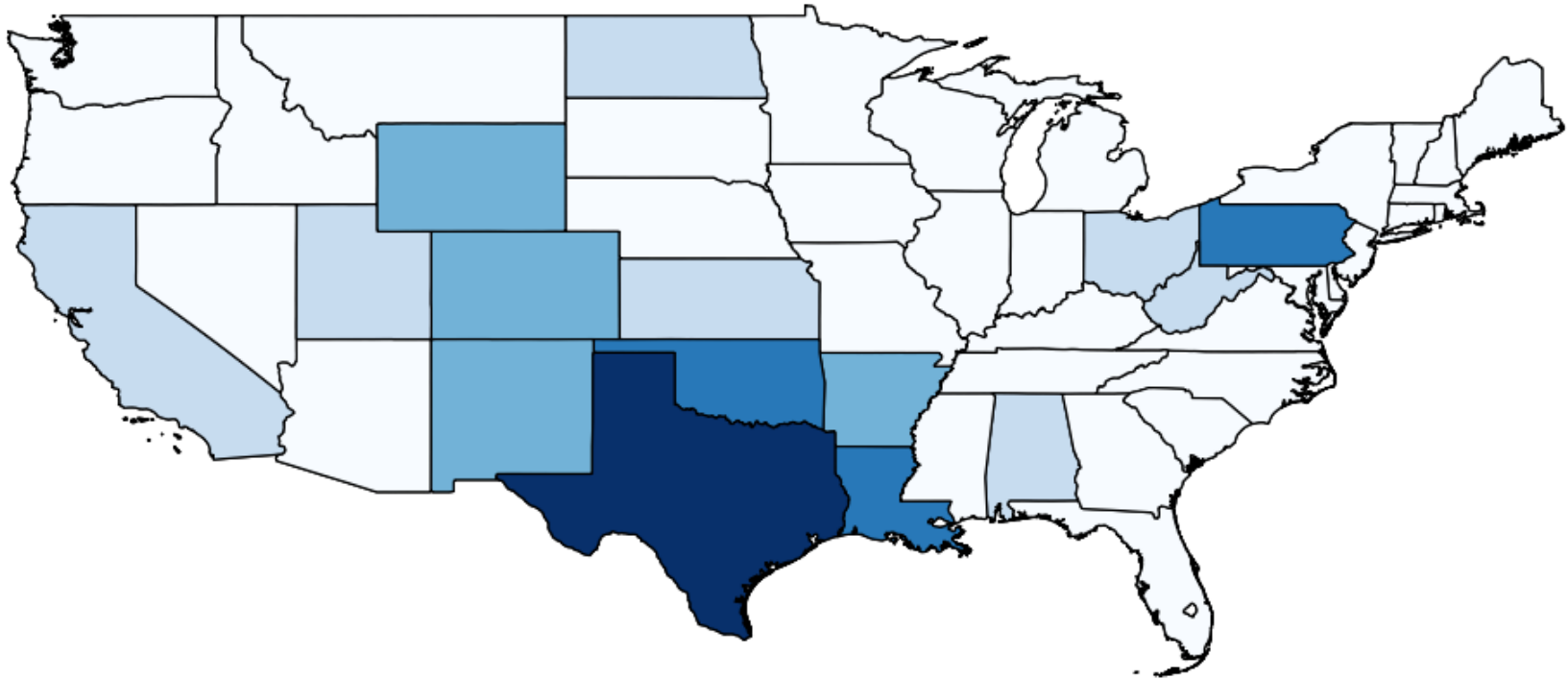
1. Effect of Energy on Water (Water for Energy) Mgal/yr : Ethanol



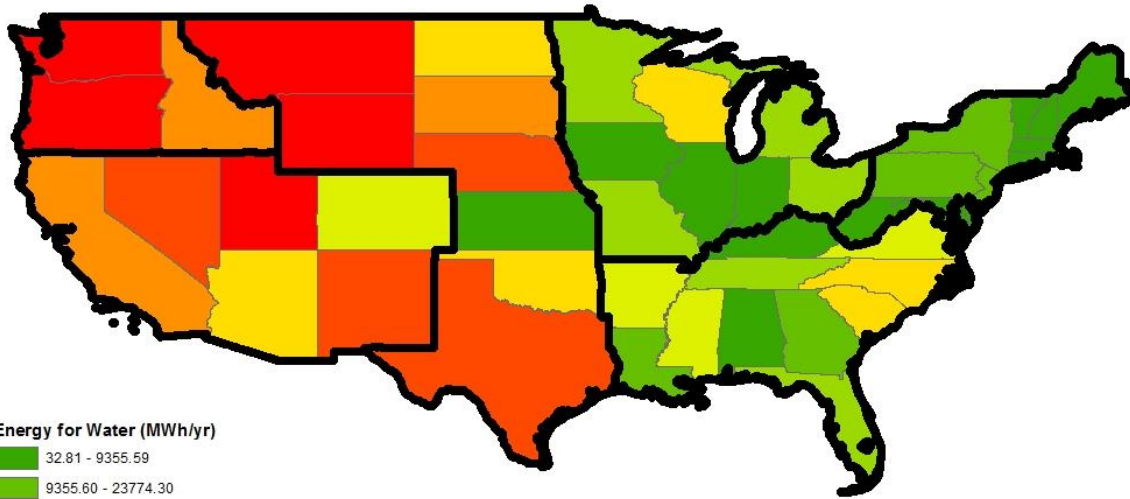
1. Effect of Energy on Water (Water for Energy) Mgal/yr : Oil



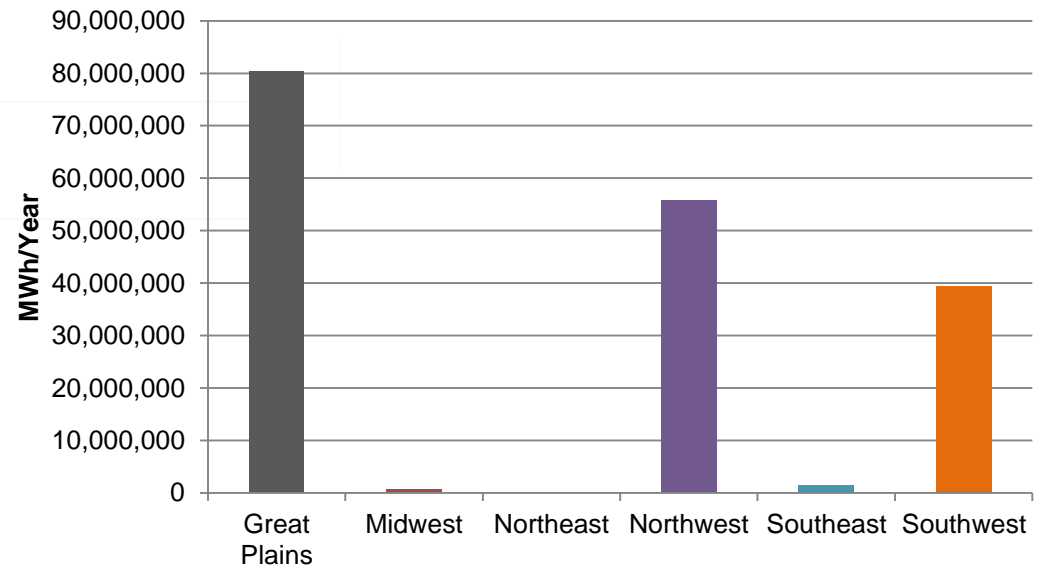
1. Effect of Energy on Water (Water for Energy) Mgal/yr : Natural Gas



Effect of Water on Energy Use

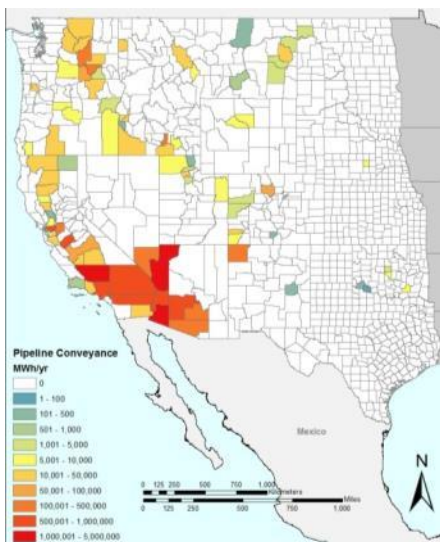


- Energy to pump irrigation water
- Energy to move and treat:
 - Drinking water
 - Wastewater

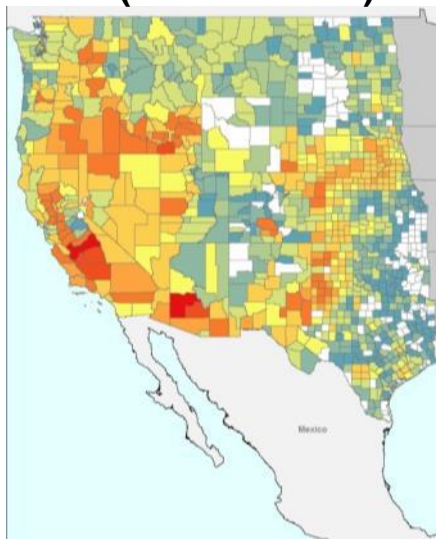


Energy for Water

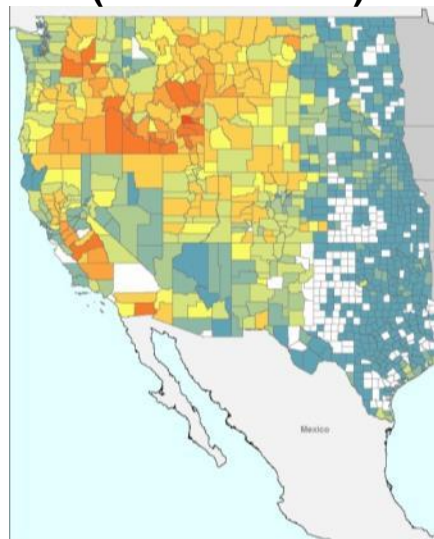
Large-Scale Conveyance



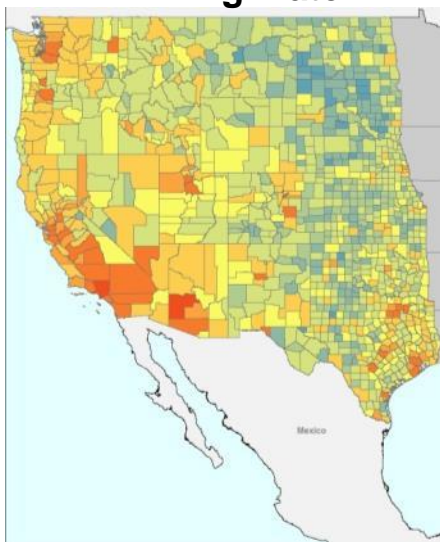
Agricultural Pumping (Groundwater)



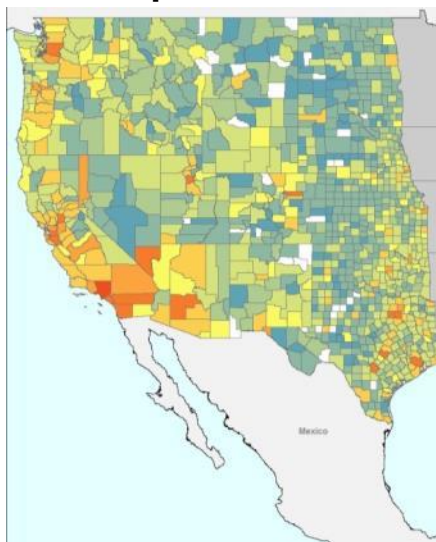
Agricultural Pumping (Surface Water)



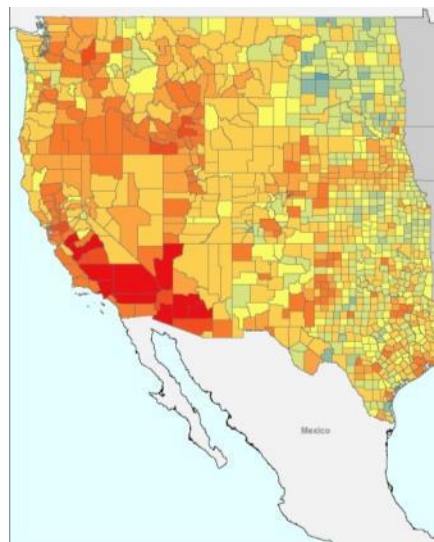
Drinking Water



Municipal Wastewater



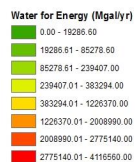
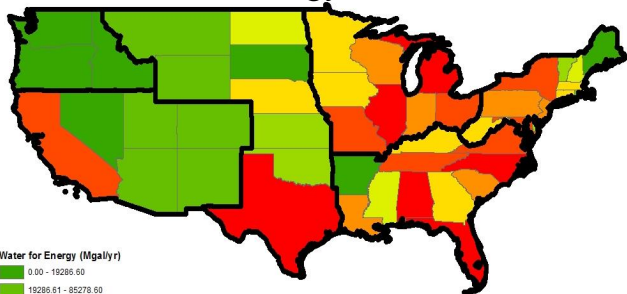
All Water Services



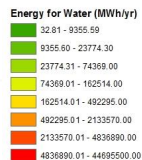
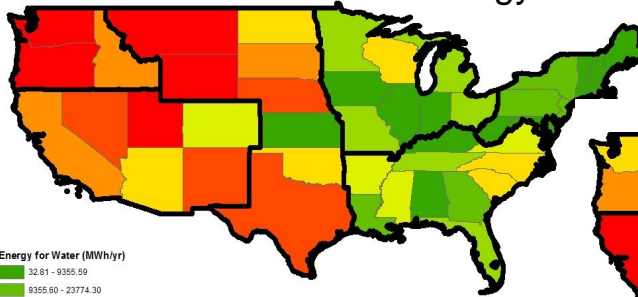
~6% of electricity use goes to providing water services.

State-Level Comparison

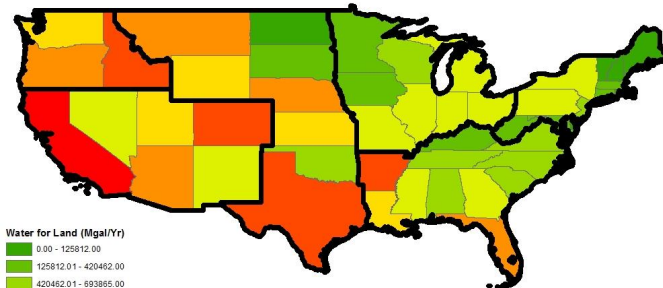
Effect of energy on water use



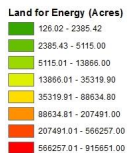
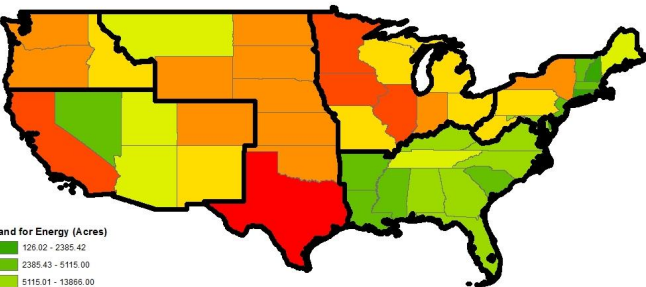
Effect of water on energy use



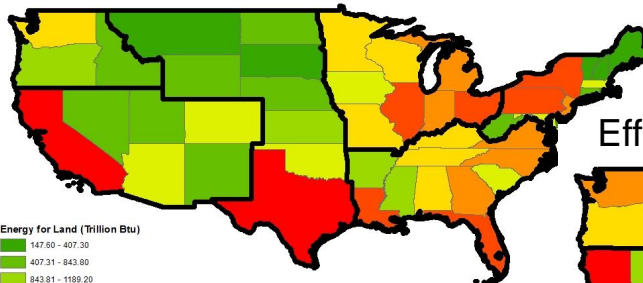
Effect of land on water use



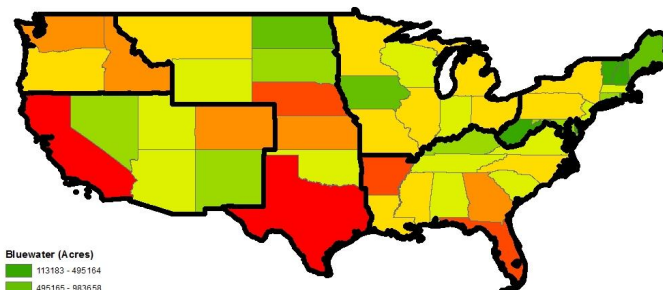
Effect of energy on land use



Effect of land on energy use

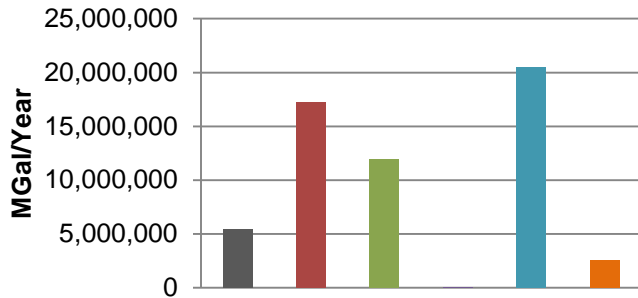


Effect of water on land use

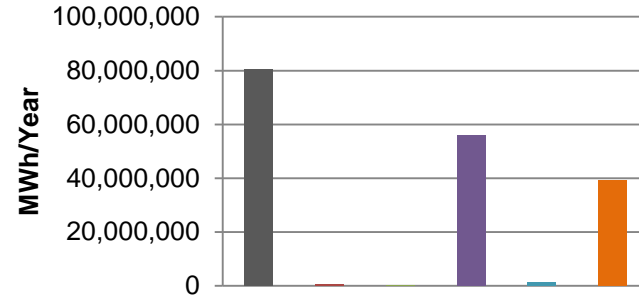


NCA Region Comparison

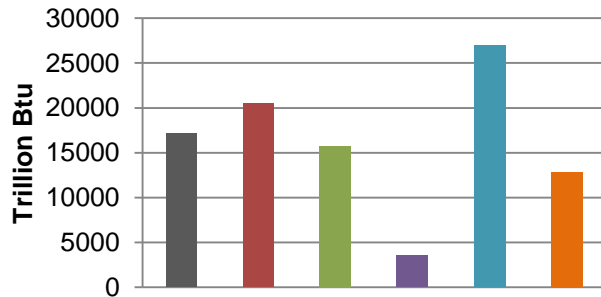
Effect of energy on water use



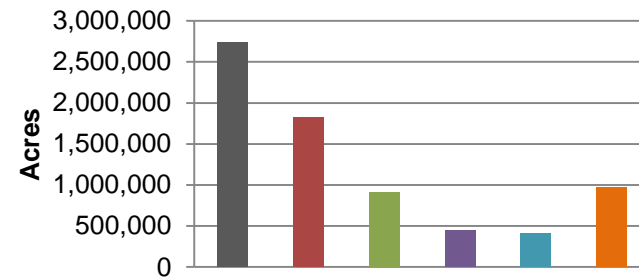
Effect of water on energy use



Effect of land on energy use

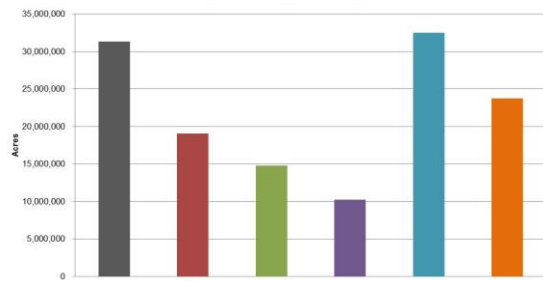


Effect of energy on land use

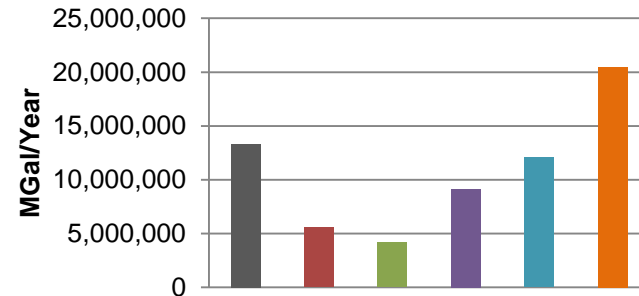


- Great Plains
- Midwest
- Northeast
- Northwest
- Southeast
- Southwest

Effect of water on land use: Bluewater



Effect of land on water use



Project data available at:
http://energy.sandia.gov/?page_id=1741

Vincent Tidwell
 Sandia National Laboratories
vctidwe@sandia.gov
 (505)844-6025