SAND2010-2003P

Energy, Water and CO_2:

Using Integrated Assessment Modeling for Performance Mapping and Collaborative Scenario Development

Peter H. Kobos, Jesse D. Roach

and the larger team including Geoff Klise, Tom Dewers, Jim Krumhansl, Brian Dwyer, Jason Heath, Dave Borns, Andrea McNemar (NETL), Len Malczynski, Vince Tidwell, and many more

Collaborative Workshop, SNL & NETL

April 2010

*Kobos and Roach are the PI and Lead Analyst for the Water, Energy and Carbon Sequestration (WECS) model, respectively.

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Working Results as of early 2010.

National Nuclear Security Administration

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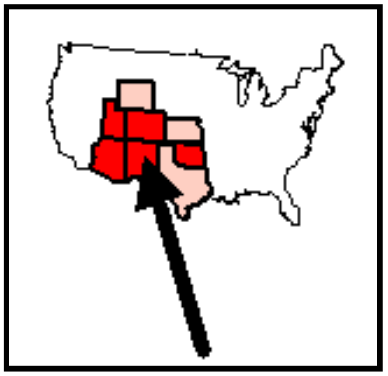
SNL and NETL Collaborative CO_2 Systems Analysis Projects

- The 'String of Pearls' model for the Southwest Regional Partnership on Carbon Sequestration (completed)
- The Water, Energy and Carbon Sequestration (WECS) project and regional water stress assessments (ongoing)
- Developing collaborations with the Energy, Power and Water Simulation Model (EPWSim) (ongoing)
- Other Potential Efforts

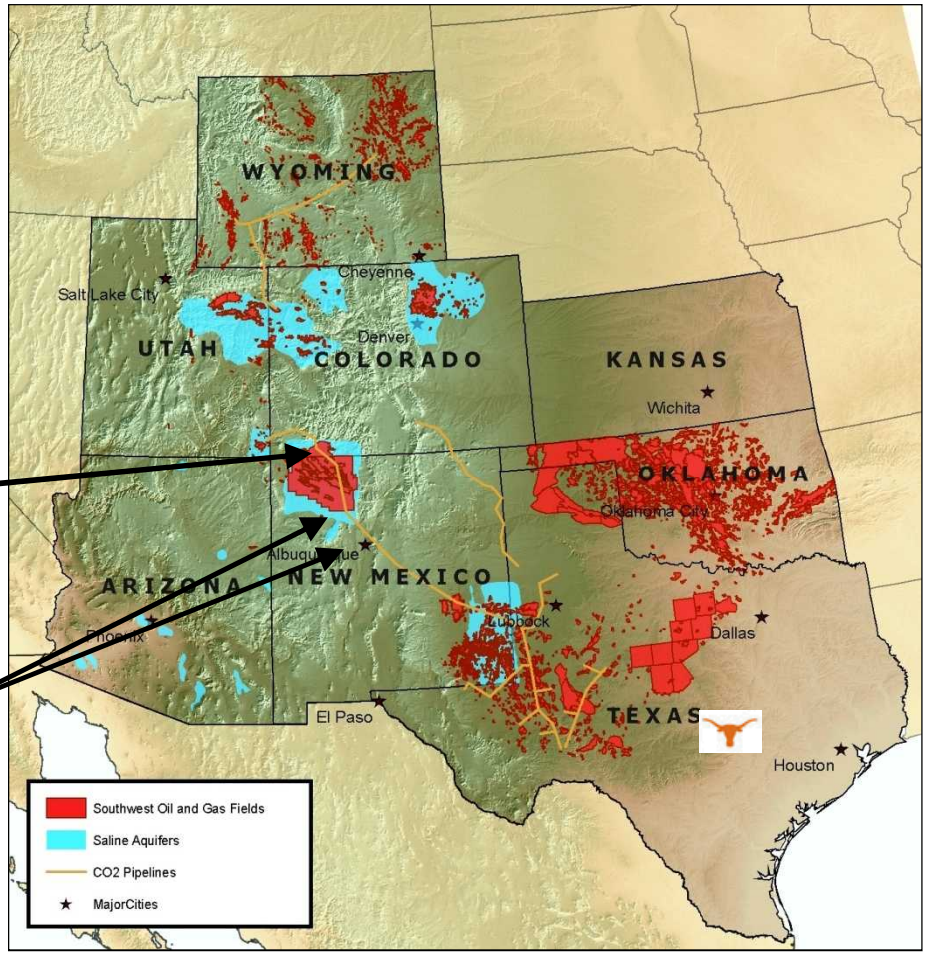
The Southwest Regional Partnership on Carbon Sequestration (SWP): *The String of Pearls*



CO_2 pipelines in NM, TX, CO, WY, UT

Potential Sequestration:

- Oil Fields
- Natural Gas Fields
- Saline Formations



- ***One of seven*** regional partnerships throughout the U.S.
- Evaluating ***available technologies*** to capture and to reduce CO_2 emissions
- ***Source to Sink*** matching (Power plants to Geological Formations)
- String of Pearls Model ***'Tells the Story'*** for the SW Partnership
  - → Technology
  - → Economics
  - → Scale of the Issues

Developed by L. Malczynski, P. Kobos and D. Borns

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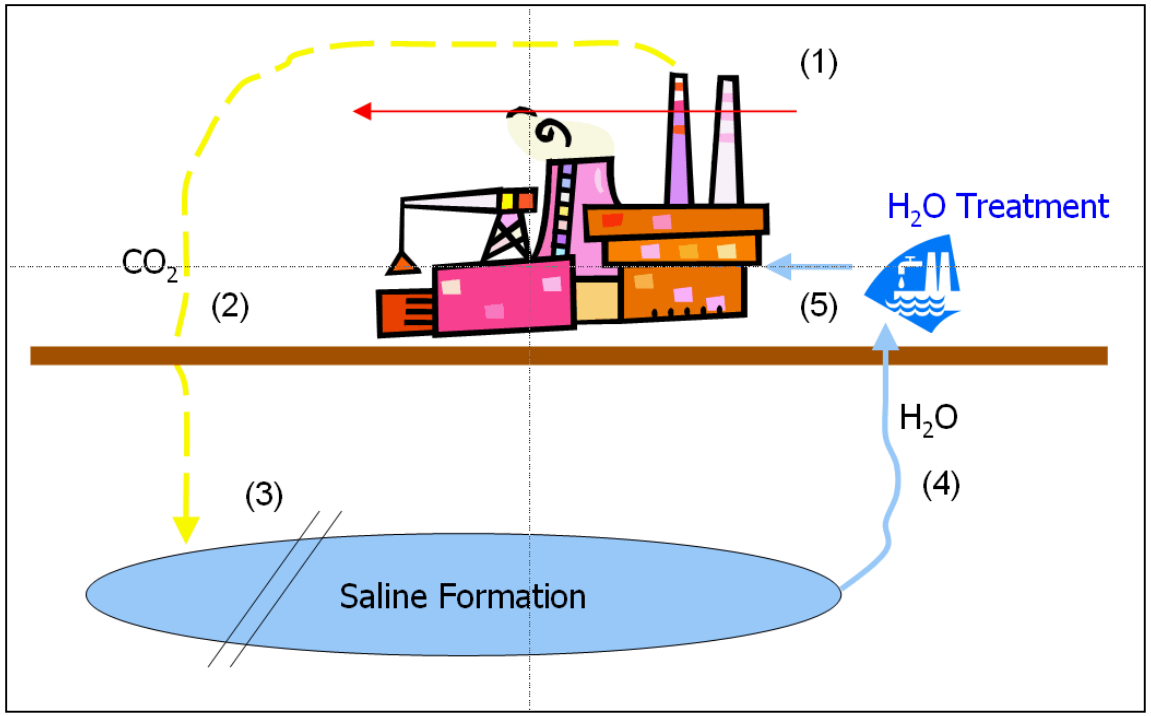
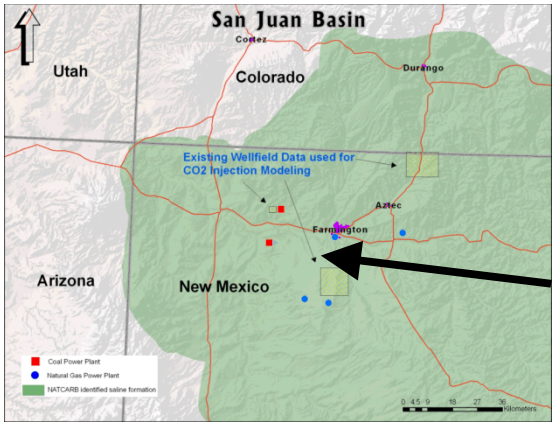
Water, Energy & Carbon Sequestration (*WECS*) Model:

Energy-Economic Modeling Conceptual Layout of the Project



Central Tasks:

1. CO_2 power plant emissions
2. CCS Potential
3. Saline Formation CO_2 sequestration potential
4. Pump Saline Formation for use at the power plant
5. Desalinate water for use at the power plant



San Juan Basin in NW New Mexico

Note: Carbon Capture and Sequestration (CCS)

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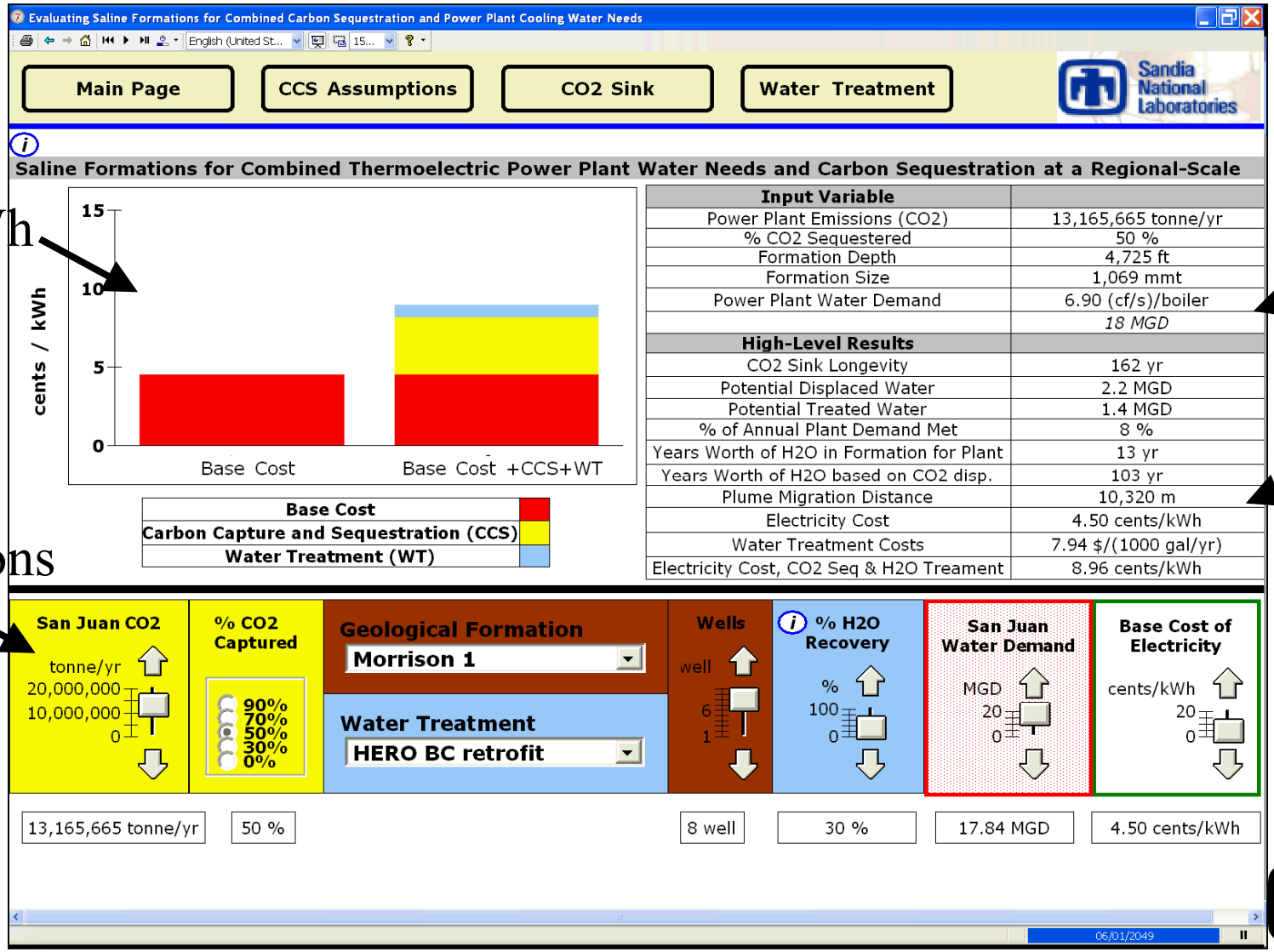
Water, Energy and Carbon Sequestration (WECS)

model interface, version 1



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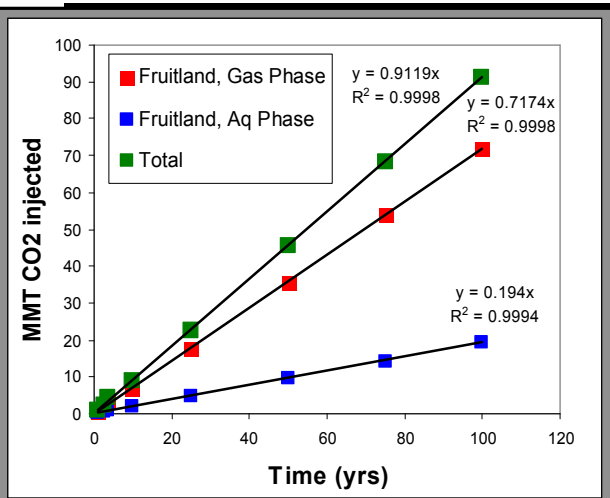
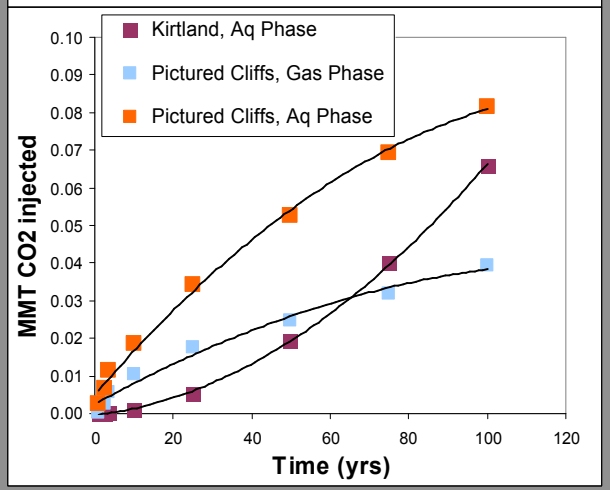
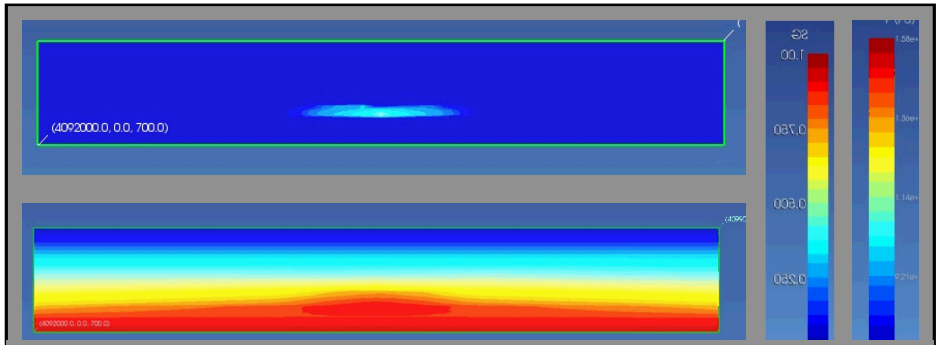
Geostudies (Geomodeling):

Modeling Supercritical CO_2 injection into San Juan Basin Saline Formations – Providing Insight for Plume Migration





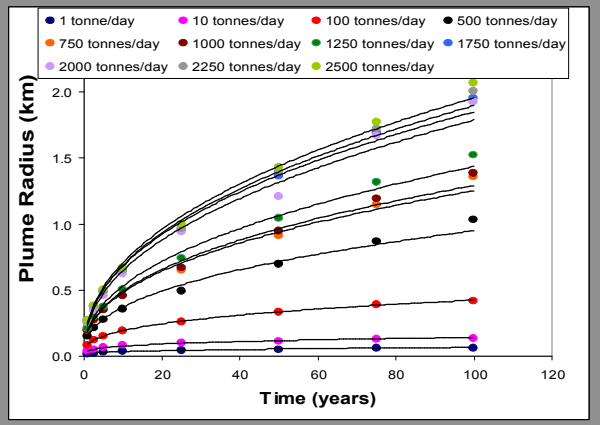
Mass conservation during injection at 2,500 tonnes /day into Fruitland Fm (shows partitioning into dissolved and $scCO_2$)



Example cross section of TOUGH2 model of injection within the Fruitland Formation, with anisotropic hydrologic properties.

Plume spreads laterally and up against the Kirtland Shale caprock (top) and induces a "mound" of overpressure (bottom).

$scCO_2$ plume migration distance as a function of injection rate for Fruitland site



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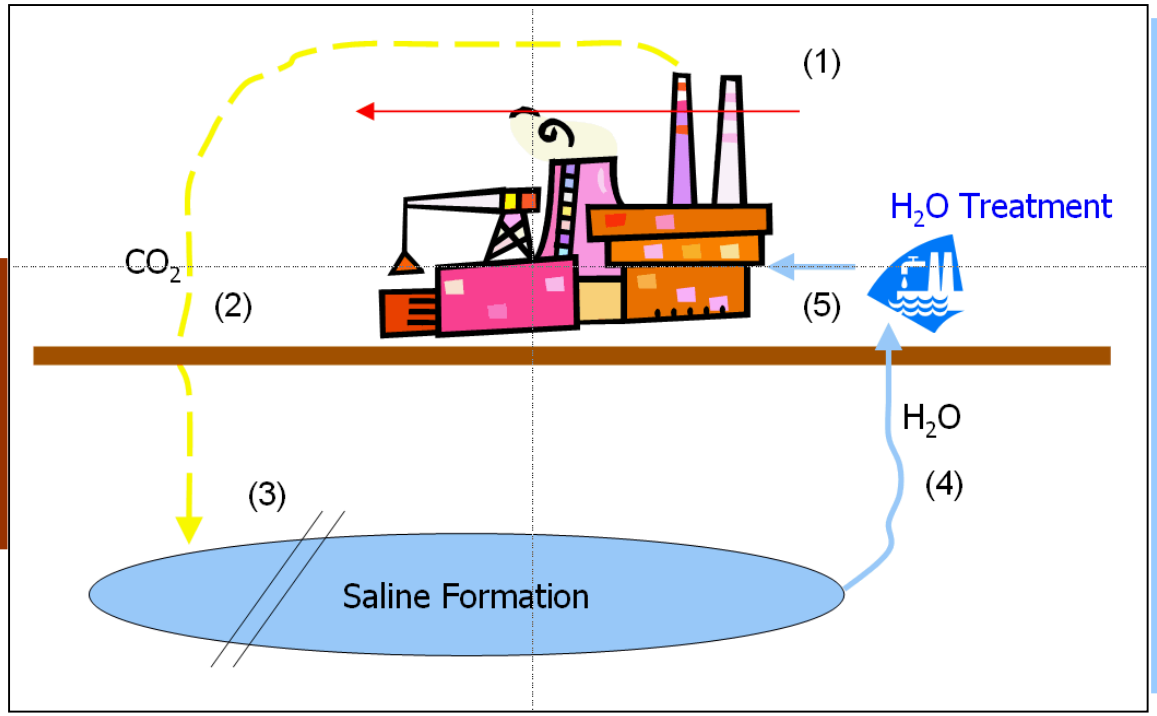
WECS (v1) Highlights

(1) Carbon Capture and Sequestration (CCS), 20%+ Energy Penalty, ↑ costs ~100%, ↑H_2O demands

(2) CCS, 50% capture and sequestration, ~4 mmt/yr



(5) Produced Water Treatment, ↑ costs ~10%, meet potentially a portion of Power Plant's annual H_2O demand

(3) Morrison Formation, 3,000+ mmt, 100s yrs. worth of CO_2 sequestration capacity

(4) <1 - 4 Million Gallons per Day for ~50-100s yrs., Assuming 30% recoverable water potential

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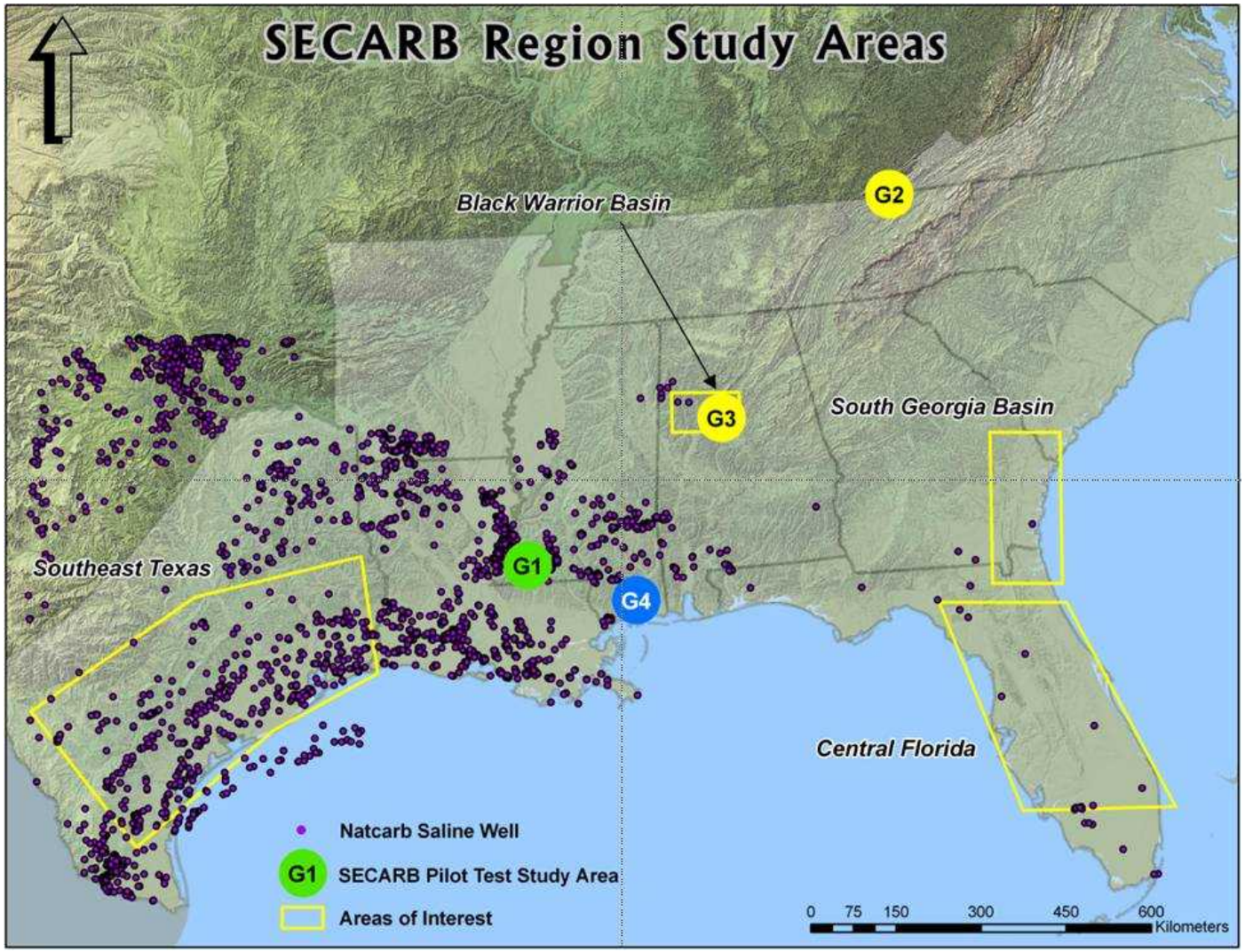
Regional Water Stress Project:

Focusing on the SECARB region as a comparison to the San Juan Basin in the initial WECS Model



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National-Level Modeling Effort:

*Expanding beyond single regions into a larger, National-Level Modeling effort **"WECS II"***

Number of sources (power plants)

Number of CO_2 sinks (saline formations)

	One Source	Many Sources
One Sink	**WECS project and model**	
Many Sinks	**Generic Power plant model**	**Phase1: National retrofit scenarios** **Phase2: National retrofit and build scenarios** **Phase 3-5: Refining the model for release**

WECS II:
Progress Schematic

NatCarb
- Data Quality Assessment
- Selection Criteria

→ **Well Selector Tool** → **Power Plant 'WECS II' Model Frame** → **National Assessment Tool**

NatCarb well records query tool

Input criteria

Select NatCarb well records with the following criteria:
(Click on numbers in blue to change with keyboard, or use buttons for more options.)

Latitude (N):	25° to 71°	Select Latitude
Longitude (E):	-163° to -70°	Select Longitude
Well depth (ft):	2,000' to 30,000'	Select Depth
Water salinity (TDS):	10,000 ppm to 35,000 ppm	Select Salinity
In 51 U.S. states (which can include D.C.)		Select States

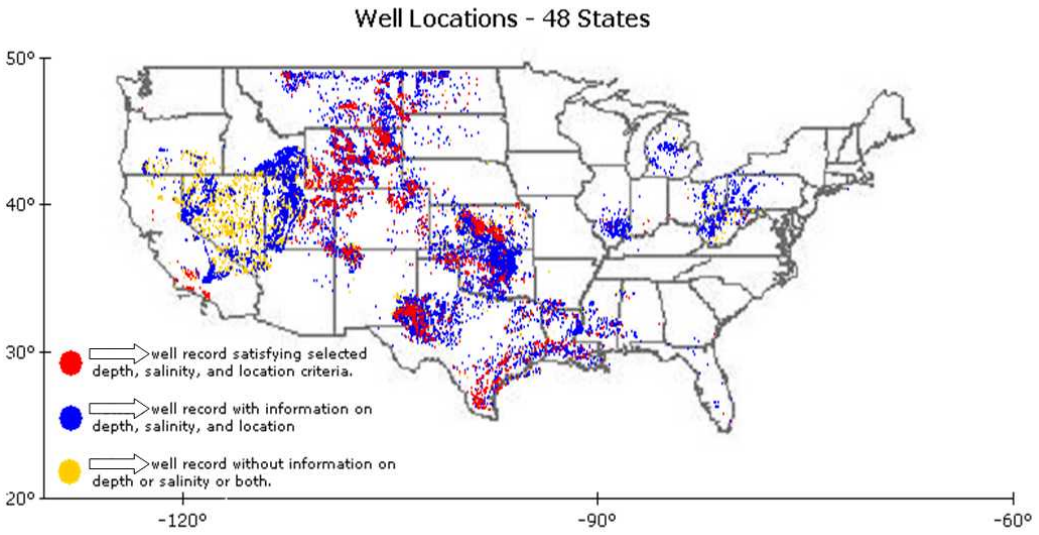
Output

Statistics of wells satisfying input criteria:

10,949	well records fit selected criteria
9.2 %	of wells in selected area meet the depth and TDS criteria (histograms)
8.8 %	of all NatCarb well records fit selected criteria
107,218	well records eliminated by TDS criteria
72,494	well records eliminated by depth criteria
5,983	well records eliminated by latitude/longitude criteria
0	well records eliminated by State location criteria
125,066	total unique NatCarb well records

Histograms | Maps | Export Records

Background and Documentation



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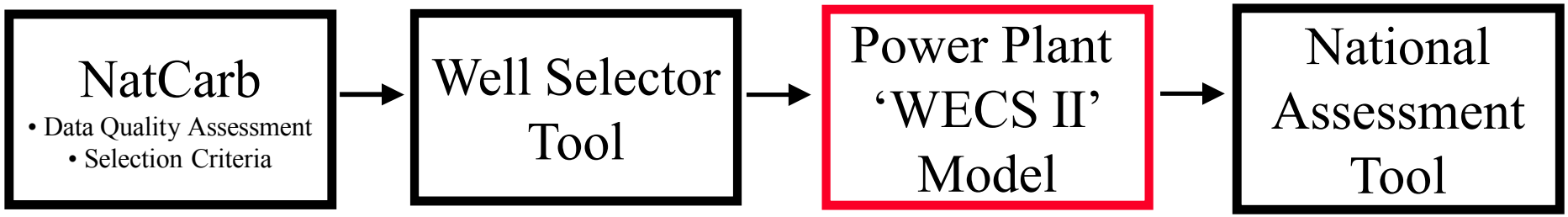
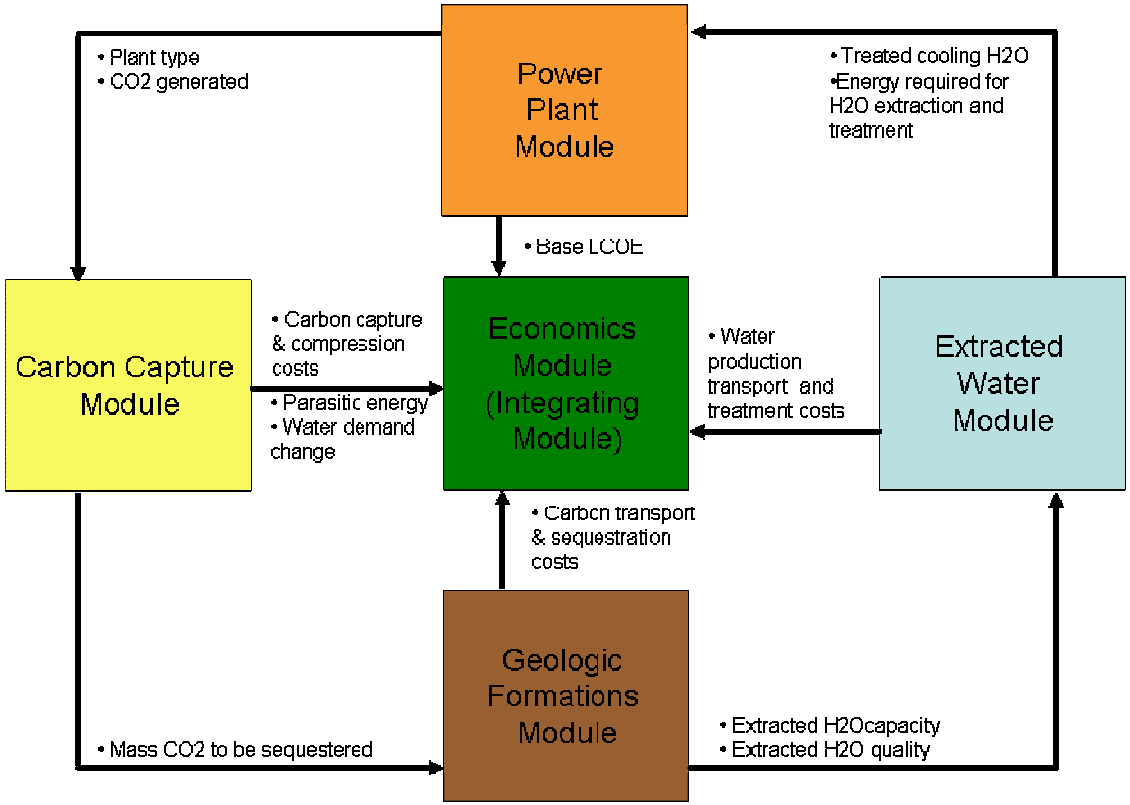
WECS II:
Progress Schematic





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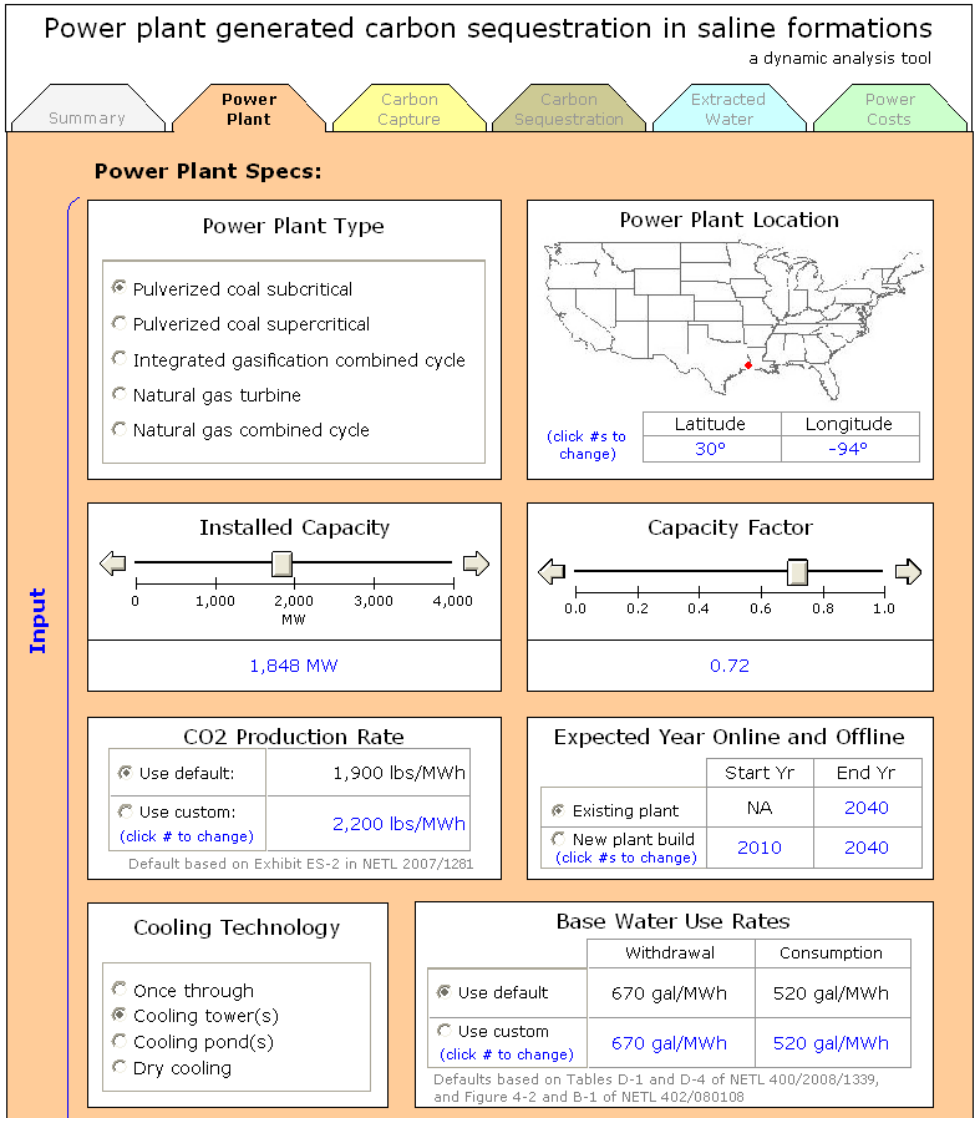
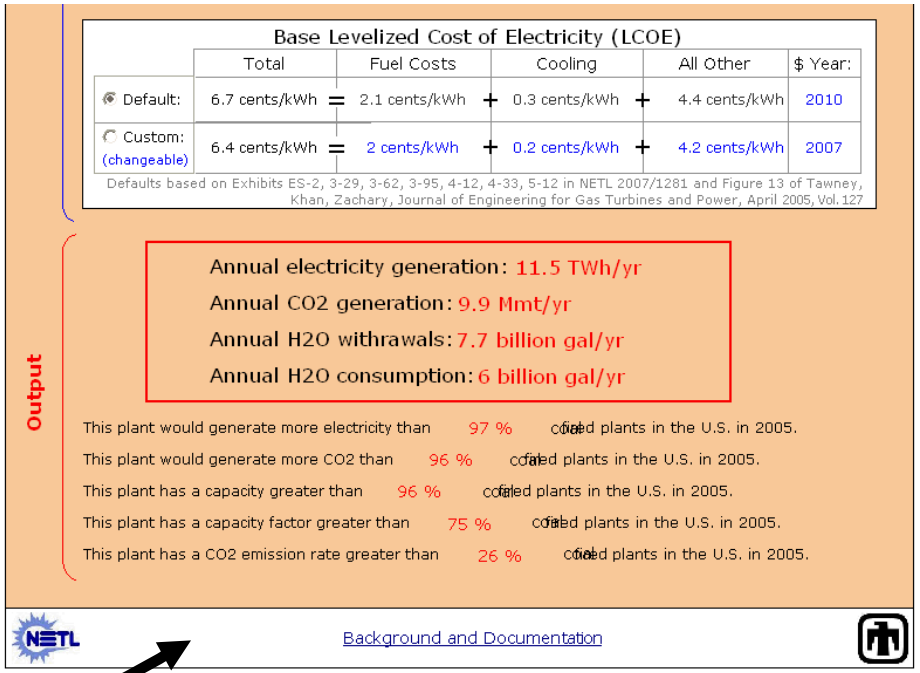
WECS II: Progress Schematic

Power Plant 'WECS II' Model → National Assessment Tool





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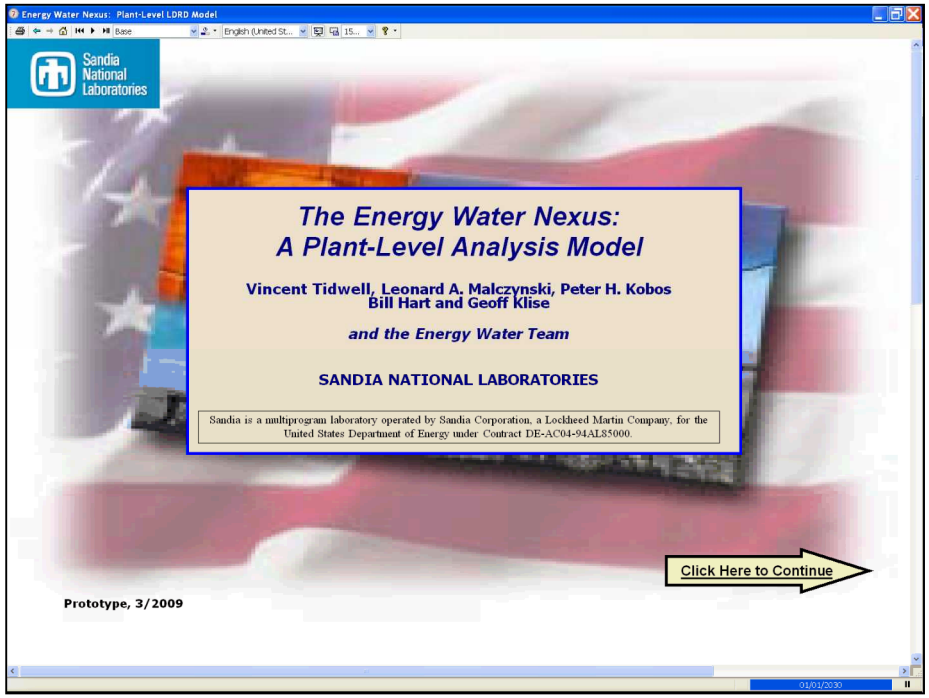
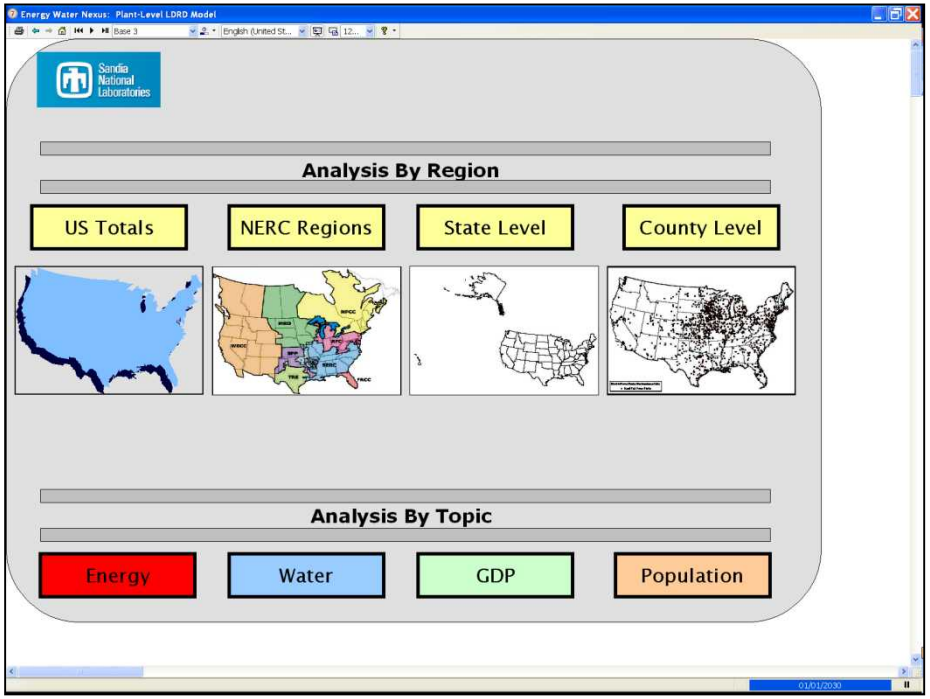
Integrated Water-Energy Planning:
Energy, Power and Water Simulation Model (EPWSim)





Integrated Water-Energy Planning:

"Plant-Level Analysis Model"

Water Demand by Sector

- *Summaries and Detail: from the National Level to the Power Plant*
- *GDP, Population Growth Changes*
- *Technology Deployment Scenarios*

Project PI: Vince Tidwell (SNL)

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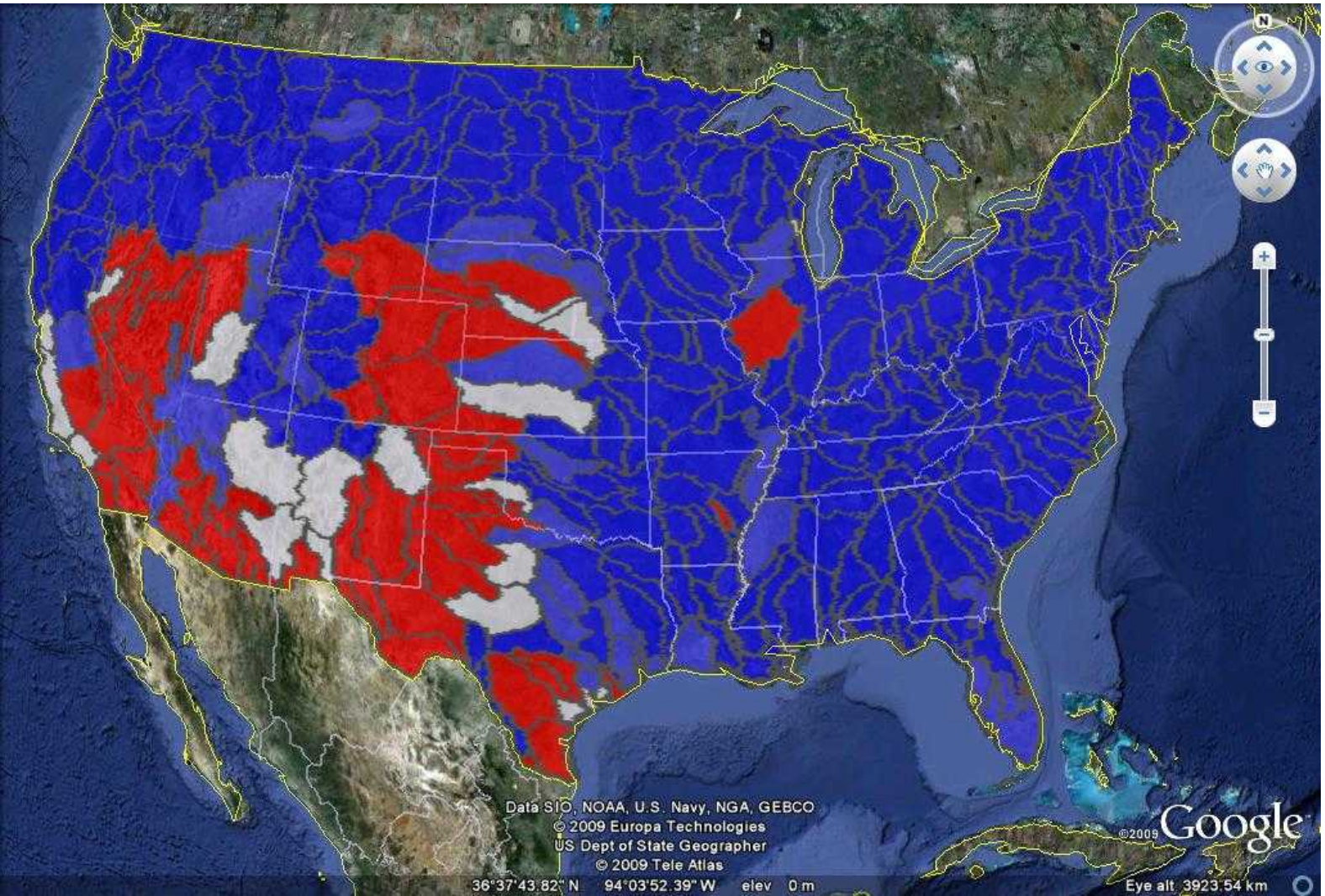
Exploring the Energy-Water Nexus:

Ratio of Sustainable Recharge to Groundwater Demand

→ National to Local Watersheds

→ Availability of Uncommitted Water

→ Energy & Water Issues



Supply/Demand

- <1
- 1-3
- 3-10
- >10

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Thank You

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Working Results.

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