

*Exceptional service in the national interest*



# *Connected Infrastructure Dynamics Modeling*

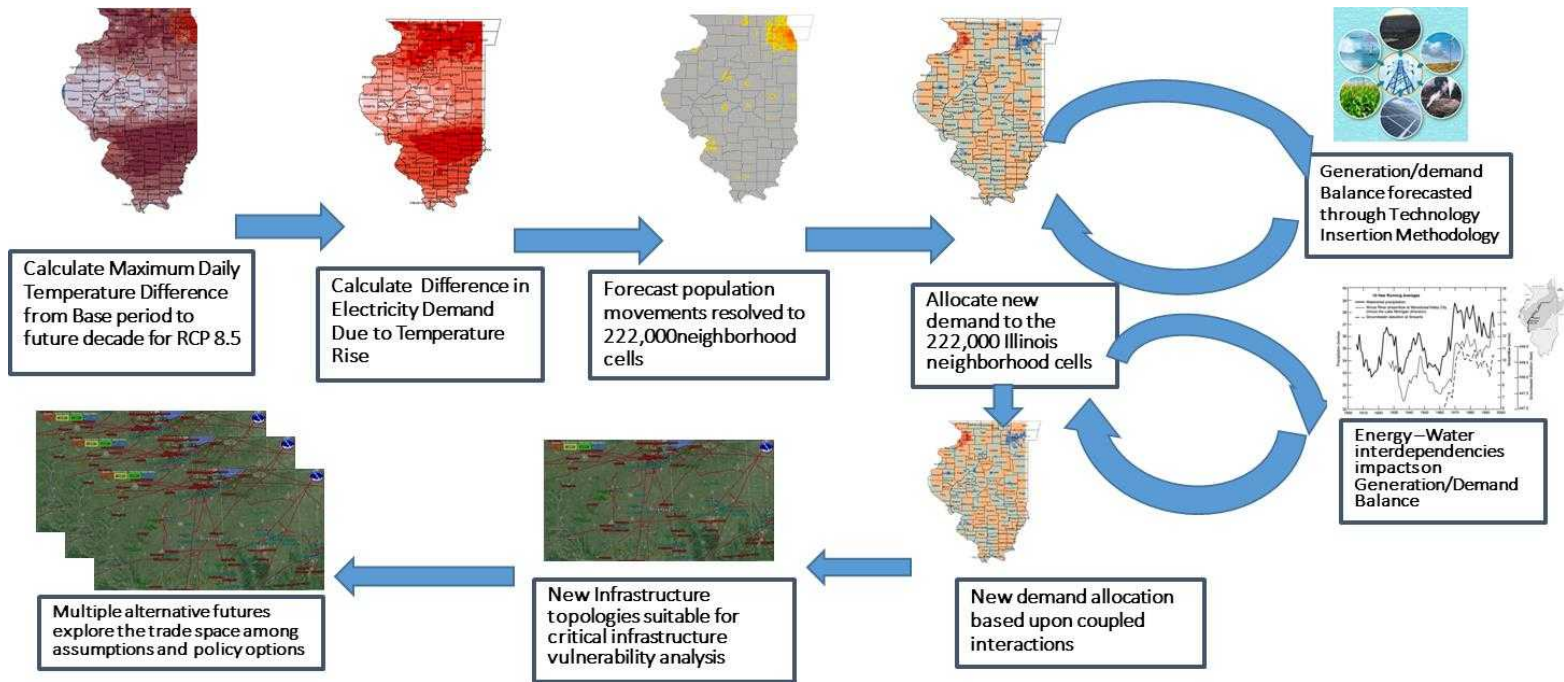
Vincent Tidwell, Melissa Allen, Loren Toole, John Bilberry, Tom Wilbanks,  
and Richard Middleton

*DOE BER Update  
Washington, DC , November 16, 2015*

# Motivating Questions

- What are the vulnerabilities posed to our nation's connected energy and water infrastructure by climate change?
- What adaptation strategies will reduce this risk?

## *Connected Infrastructure Dynamics Modeling Framework*



# Methods

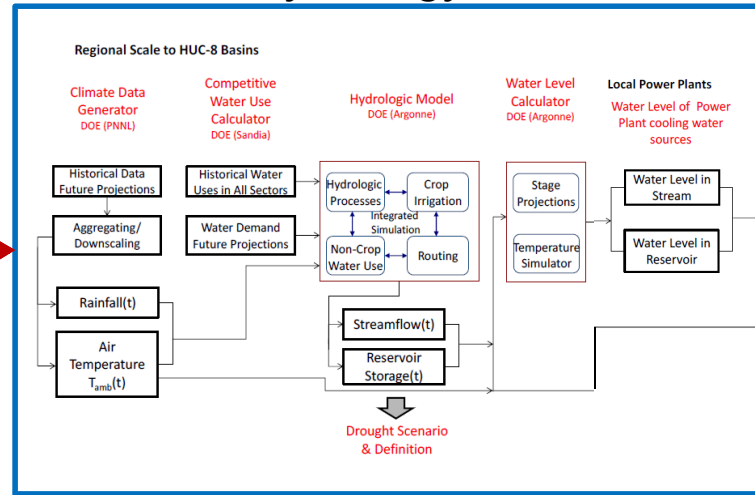
Downscaled  
CMIP-5  
RCP 8.5  
Climate Data

Electricity  
Demand

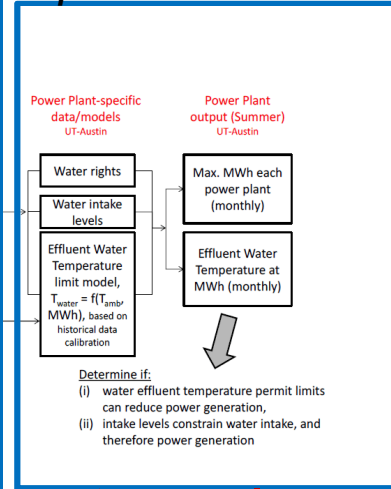
## LandScan & LandCast

- Customer change,
- Demand dynamics

## Hydrology Model



## Power Plan Operations Model



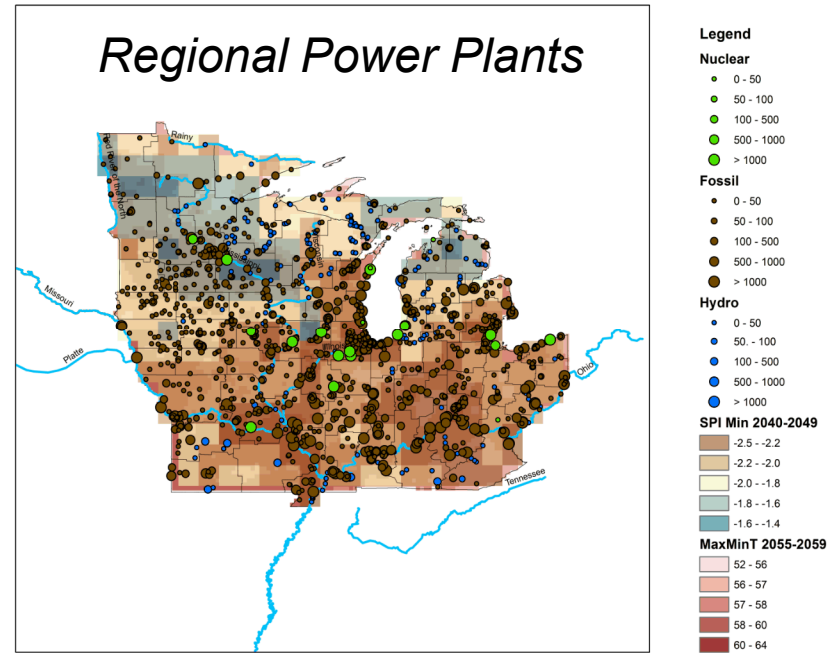
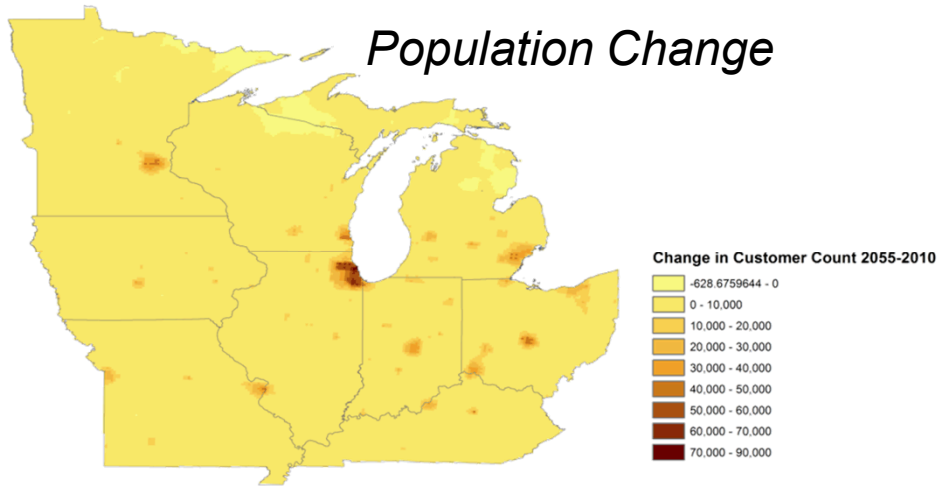
## Adaptation Pathways

### TIP Technology Impact

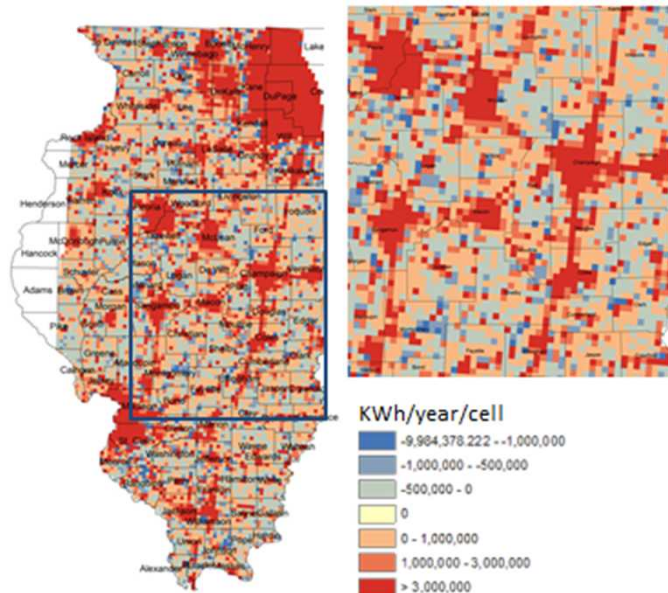
- Generation, demand
- New technology by end-use
- System margin

Electricity Supply Deficit

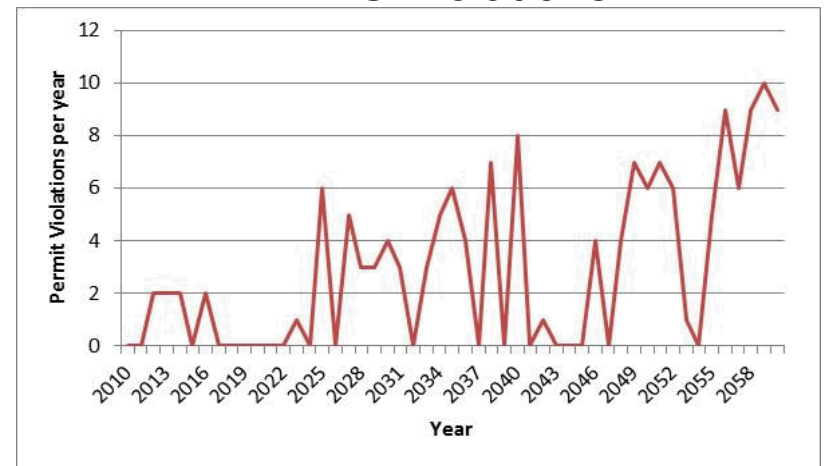
# Climate and Growth Effects



*Electricity Demand Change*



*NPDES Violations*



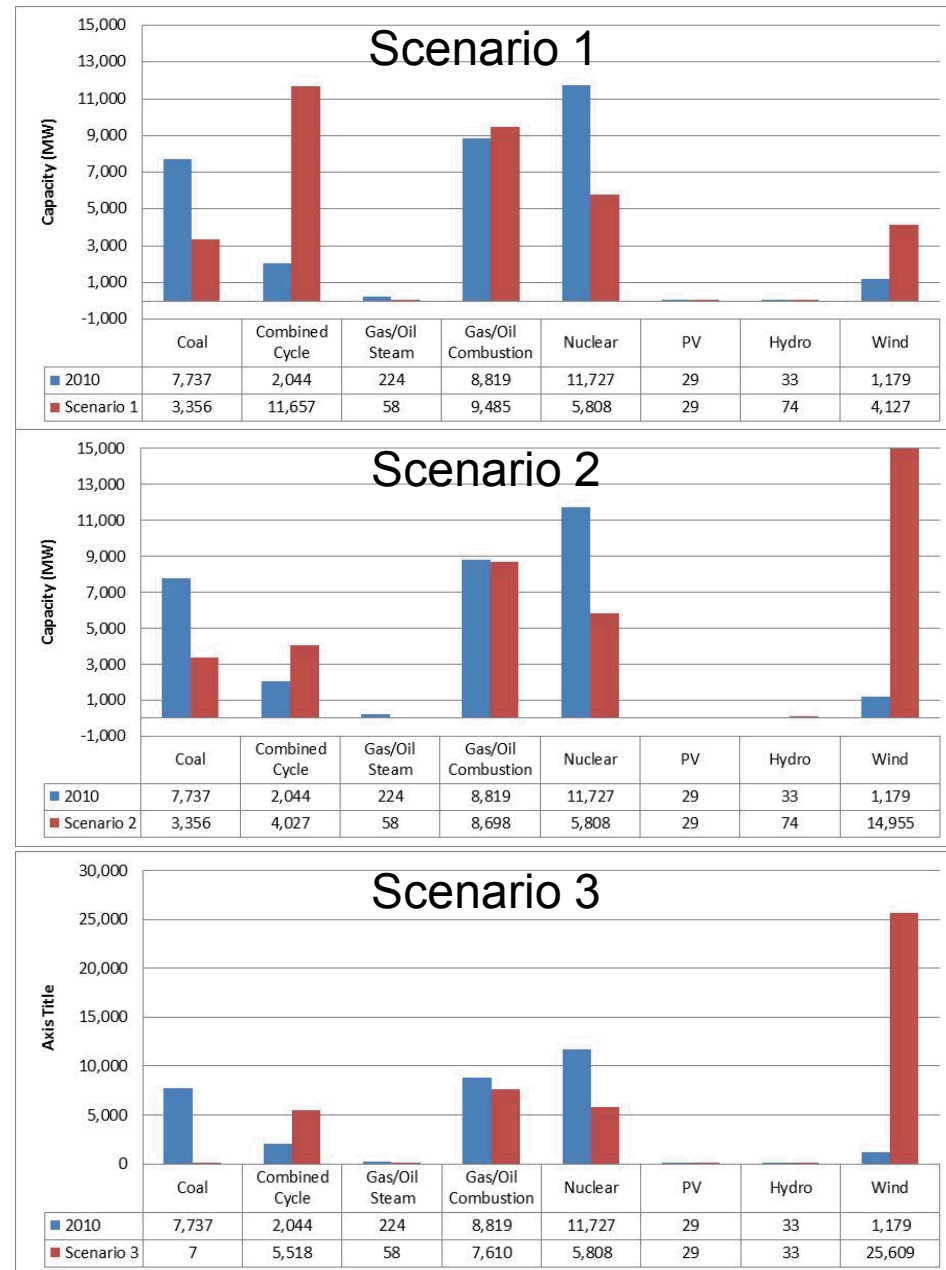
# Scenarios

- Three Eastern Interconnection Planning Collaborative generation scenarios:

- Scenario 1: assuming expected trends in future,
- Scenario 2: Federal renewable portfolio standard
- Scenario 3: Federal cap on carbon emissions (42% reduction in 2030 and 80% by 2050)

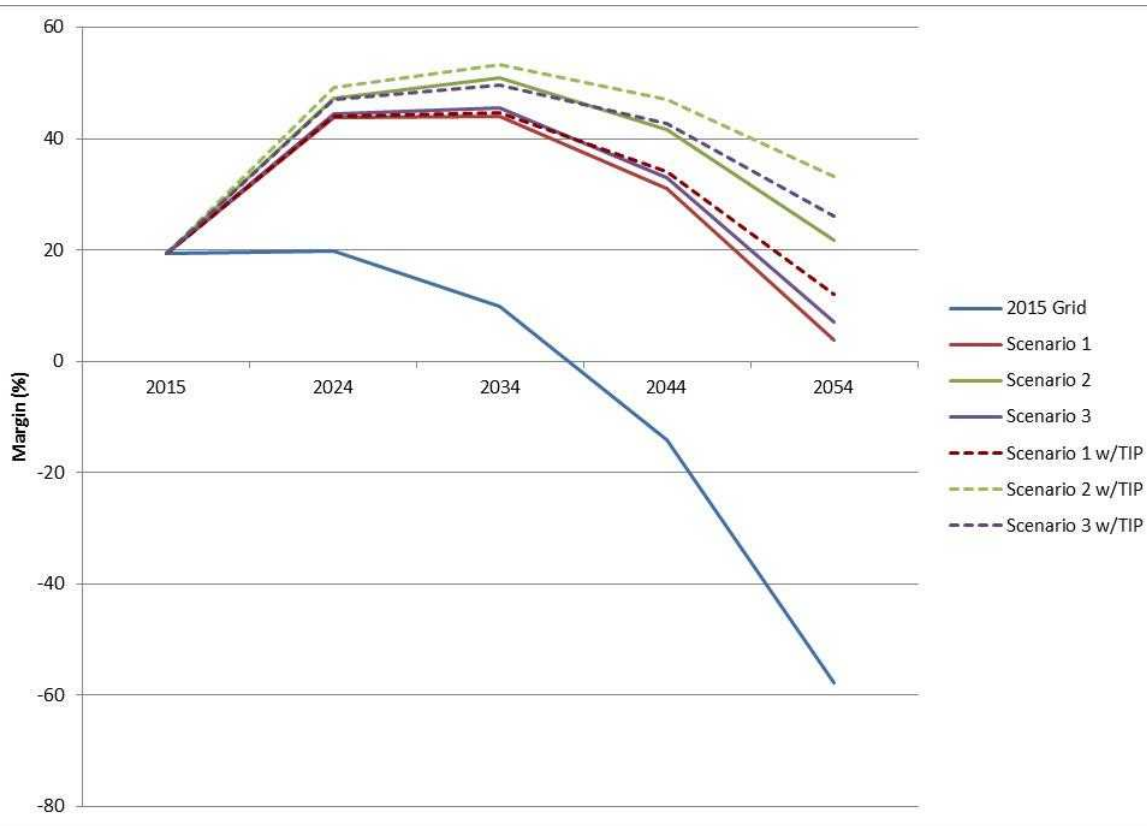
- Demand side management

- Solar PV
- Electric vehicles
- Demand side management
- Demand response

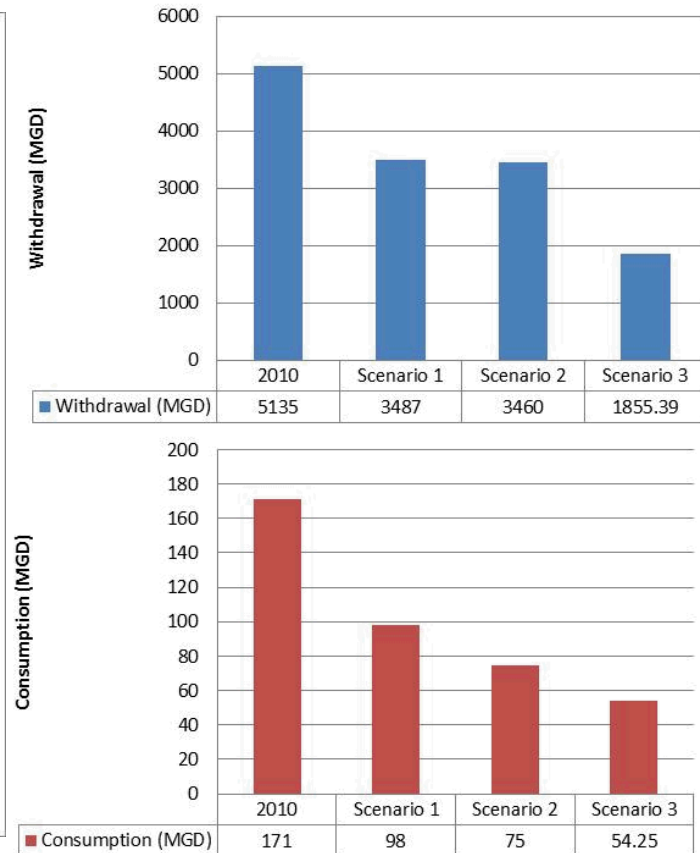


# Vulnerability and Adaptation

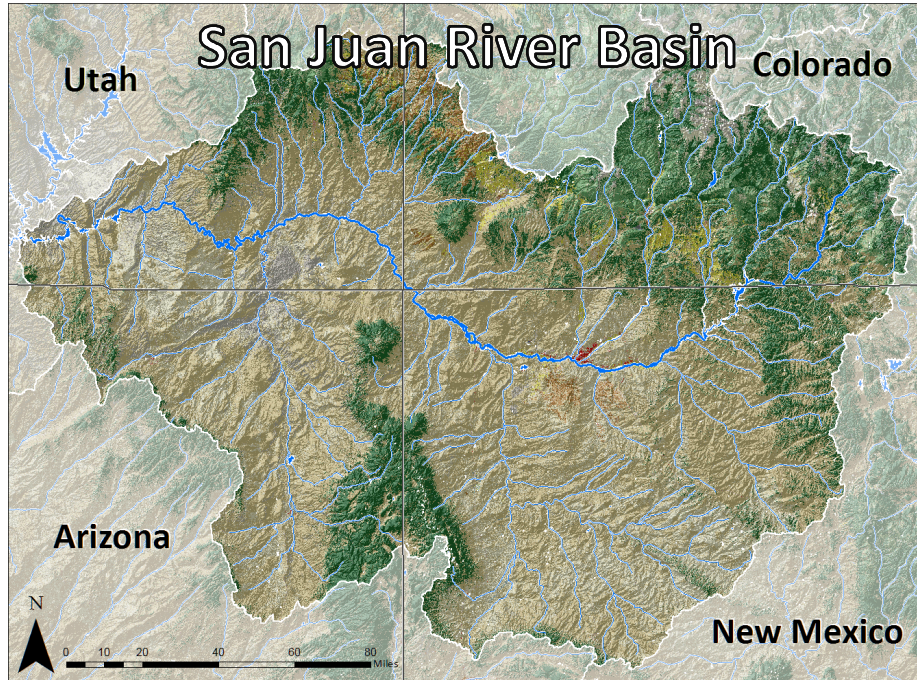
## System Margins



## System Water Use



# San Juan River Project



*Partners: National labs, industry,  
federal agencies*

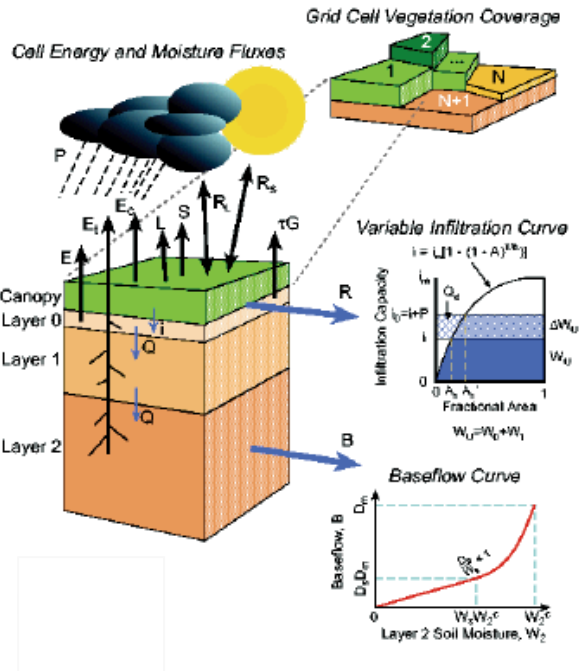


## ■ Questions:

- Impact of climate change and disturbance on San Juan inflows.
  1. Static vegetation,
  2. CMIP5 vegetation change, and
  3. Integrated disturbance.
- Changes to deliveries for:
  - San Juan Power Plant,
  - Four Corners Power Plant,
  - Hydropower production,
  - Oil and gas development, and
  - Competing needs.
- How best can the system adapt:
  - Technology options, and
  - System operations.

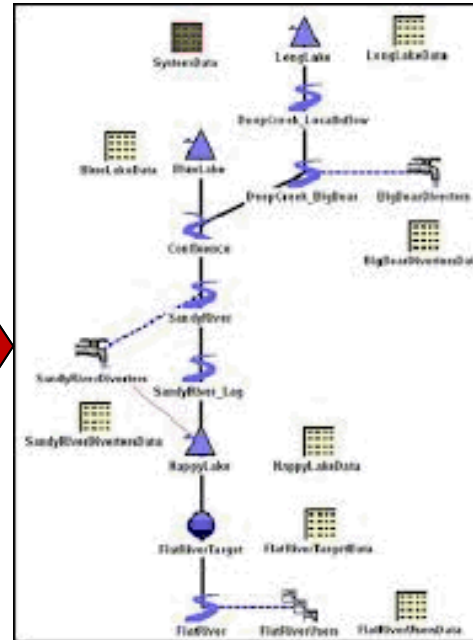
# Model Integration

## Watershed Dynamics



**Los Alamos Model**

## Reservoir/River Operations



**Bureau of Reclamation  
RiverWare Model of San Juan**

## Deliveries

- Electric Power
- Native American
- Farming
- Municipal
- Instream
- Recreation

**Climate  
Scenarios**



# Anticipated outcomes

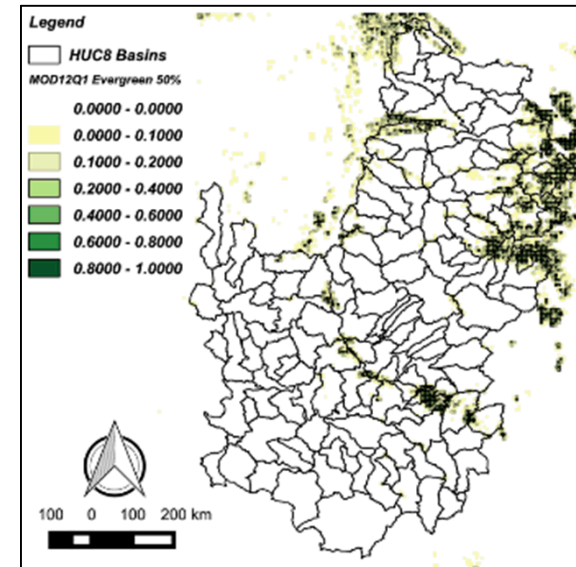
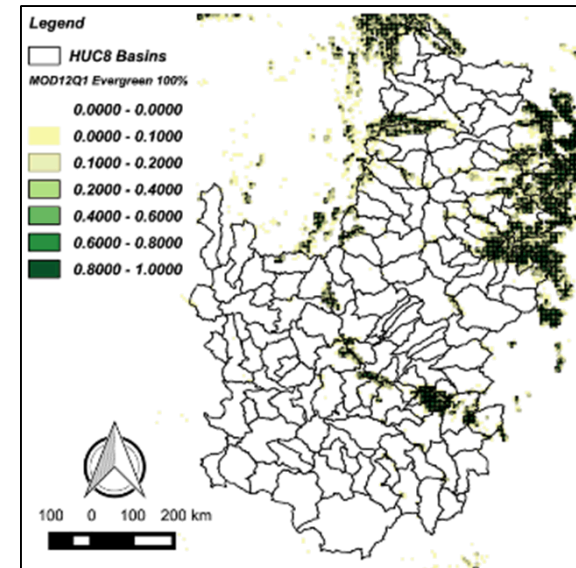
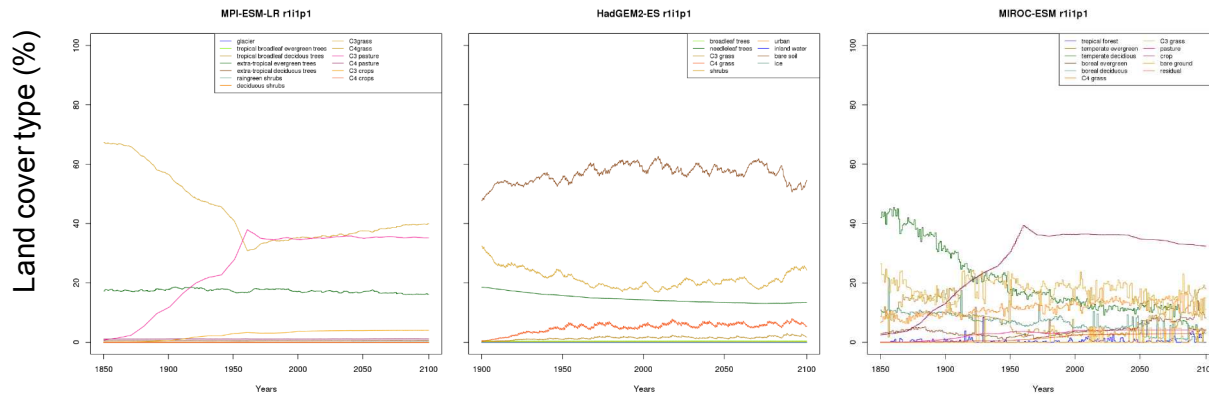
- Understand impact of changing climate *and* disturbance on the energy-water nexus
- Analysis of critical watershed transitions for both mean *and* extremes
- Design resilient planning system by coupling natural and engineered systems
- Multi-agency collaboration



# Integrated Disturbance Science

1. Bulk alter vegetation
2. CMIP5 projections (2100), three GCMs, one emission scenario
3. Integrated disturbances over time (predominantly temperature-drought mortality)

*Climate change and vegetation from three GCMs*



# Preliminary hydrologic response

- Minor impact from CMIP5 vegetation changes
- Significant impact of disturbance

Baseline climate

CMIP5

Integrated disturbance

