Hydrologic response to climate change in New Hampshire:

In Cooperation with the New Hampshire Department of Health and Human Services and Department of Environmental Services

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Outline of talk

1. Introduction and Concerns
2. Pilot New Hampshire Precipitation Runoff Model (PRMS) study
3. NH Pilot study findings
4. Summary and Next Steps

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Floods and Increased Variability in Streamflow

Drought and Extreme Variability in Low Flow

Erosion and Effects on Water Quality due to Changes in Flow Extremes

Hydrologic Response and Resulting Concerns

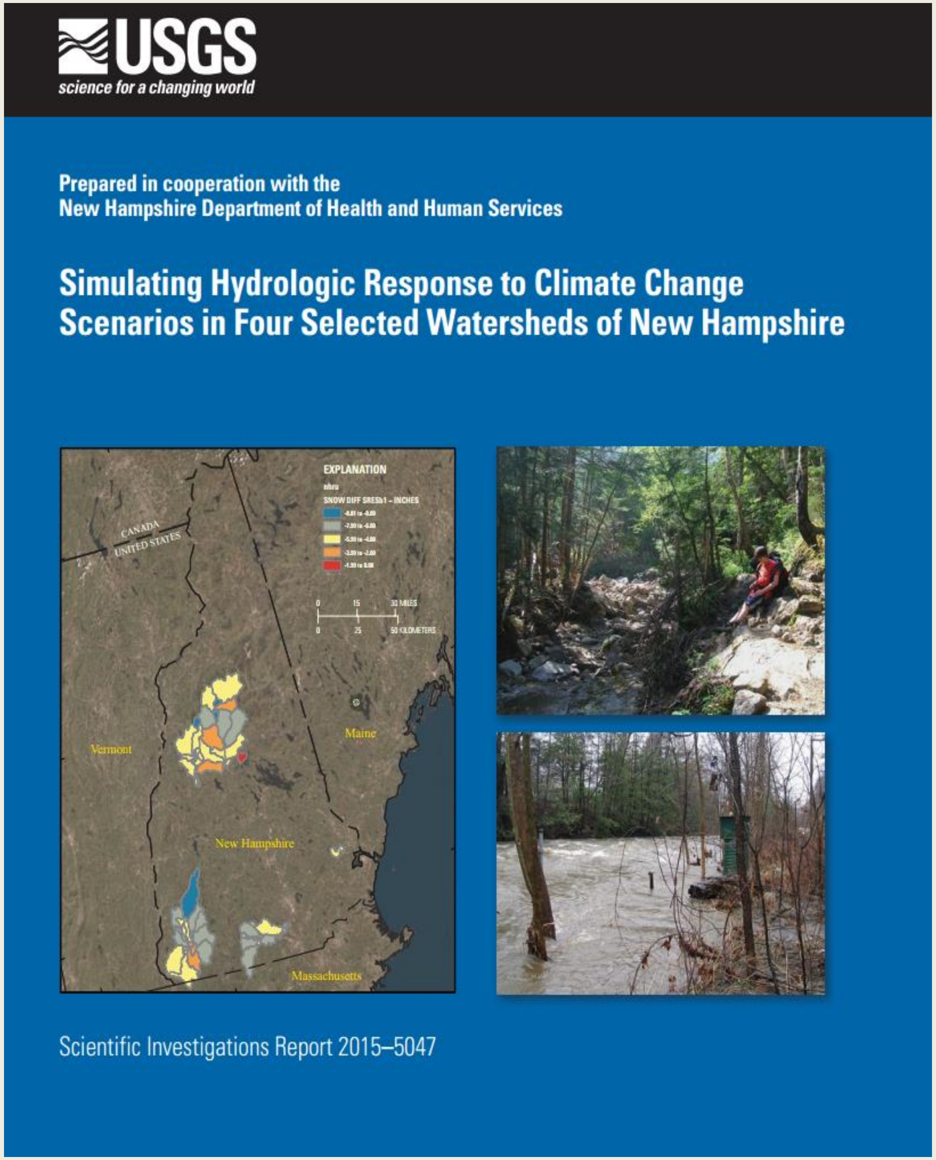
Hydrologic Change Variable	Hydrologic Response	Concerns
Soil Moisture	timing and frequency of soil drying and wetting	Impacts to surface moisture and maintenance of vernal pools, wetlands and moisture dependent species/vectors
Evapotranspiration	soil water balance and infiltration	Impacts to agriculture and annual water balance
Groundwater recharge	timing of replenishment of groundwater and availability of water to wells and streams	Impacts to availability of groundwater to wells, groundwater levels and quality
Snowfall and snowmelt	timing, amount, and predictability of snowfall snowmelt	Impacts to recration, seasonal recharge to groundwater and peak flows from snowmelt
Groundwater discharge to streams	timing and quantity of groundwater discharge to streams and maintenance of baseflow	Impacts on fish survivability, in stream habitat,
Shallow groundwater runoff and surface runoff	timing and amount of surface runoff and runoff from shallow groundwater zones	Impacts on sources and quality of water running off to streams
Streamflow	magnitude and timing of low flows, floods, and seasonal means	Water availability for human use and habitat, impacts on stream channel erosion and road maintenance

Pilot Study

This project is was developed from a pilot study (just published):

Bjerklie, D.M. et al, 2015, **Simulating hydrologic response to climate change scenarios in four selected watersheds of New Hampshire**: U.S. Geological Survey Scientific Investigations Report 2015–5047, 53 p., http://dx.doi.org/10.3133/sir20155047.

http://pubs.er.usgs.gov/publication/sir20155047



Objectives of Pilot study

- Predict sub-basin-scale response of surface and groundwater systems to potential climate change, and assess sensitivity to land use/land cover change in New Hampshire.

- Develop a tool to assess the impact of future climate scenarios statewide at a consistent and compatible sub-basin scale.

Model Development

- Four study watersheds selected: Pemigewasset River, Ashuelot River, Oyster River, and Souhegan River.
- Watersheds sub-divided into hydrologic response units (sub-catchments) called HRUs.
- Model HRU scale averaging 20 square miles.
- Model input: daily air temperature and precipitation.
- Natural characteristics of each HRU represented by parameters in the model derived from GIS information for the state :
    - land cover type (forest, shrub, impervious surface, bare ground etc.),
    - soils,
    - geology,
    - topography,
    - drainage network
    - climate and hydrologic information.

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Application of Simulated Data

- Assess Statewide Changes in Risk for Increased Flooding and Erosion
- Frequency Analysis of Simulated Flow data for Engineering and Maintenance of Culverts, Bridges, and Roadways
- Use by environment and health planners to assess human risks, impacts and interventions

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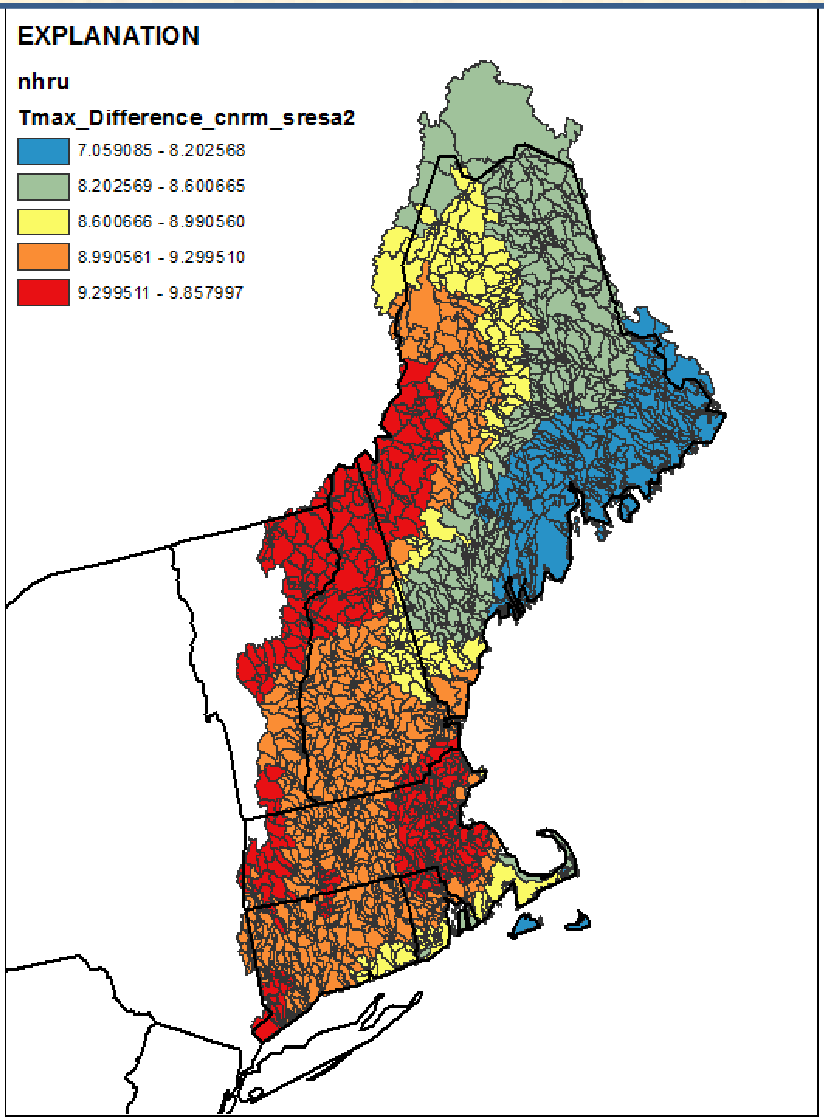
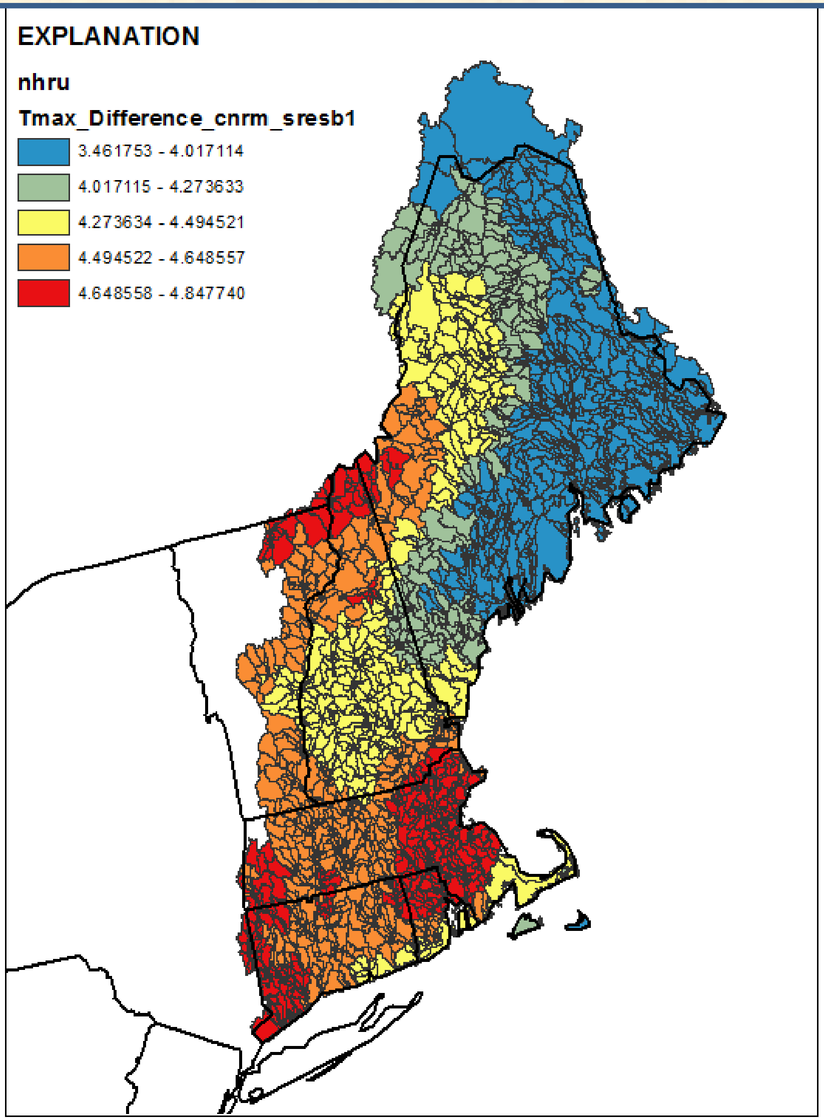
Predicted 20-year Change in max daily air Temperature

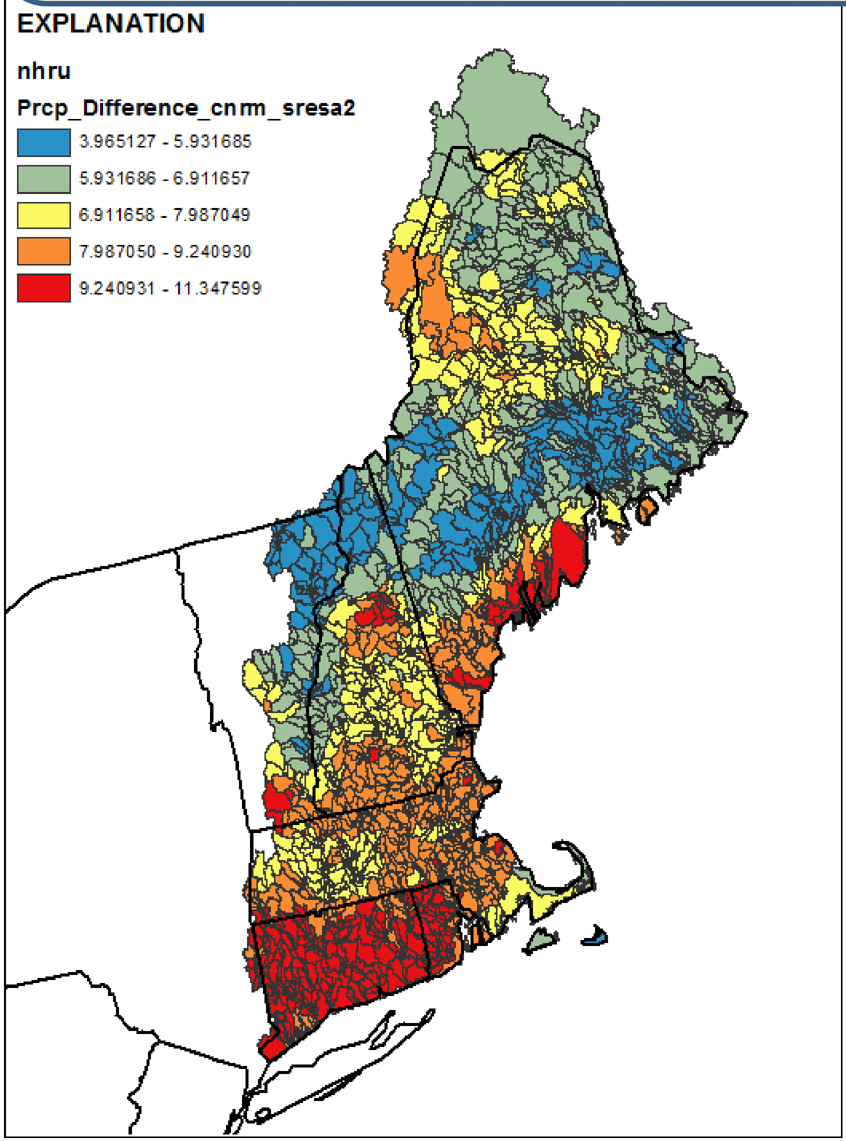
Higher emission (left) and Lower emission (right) scenarios

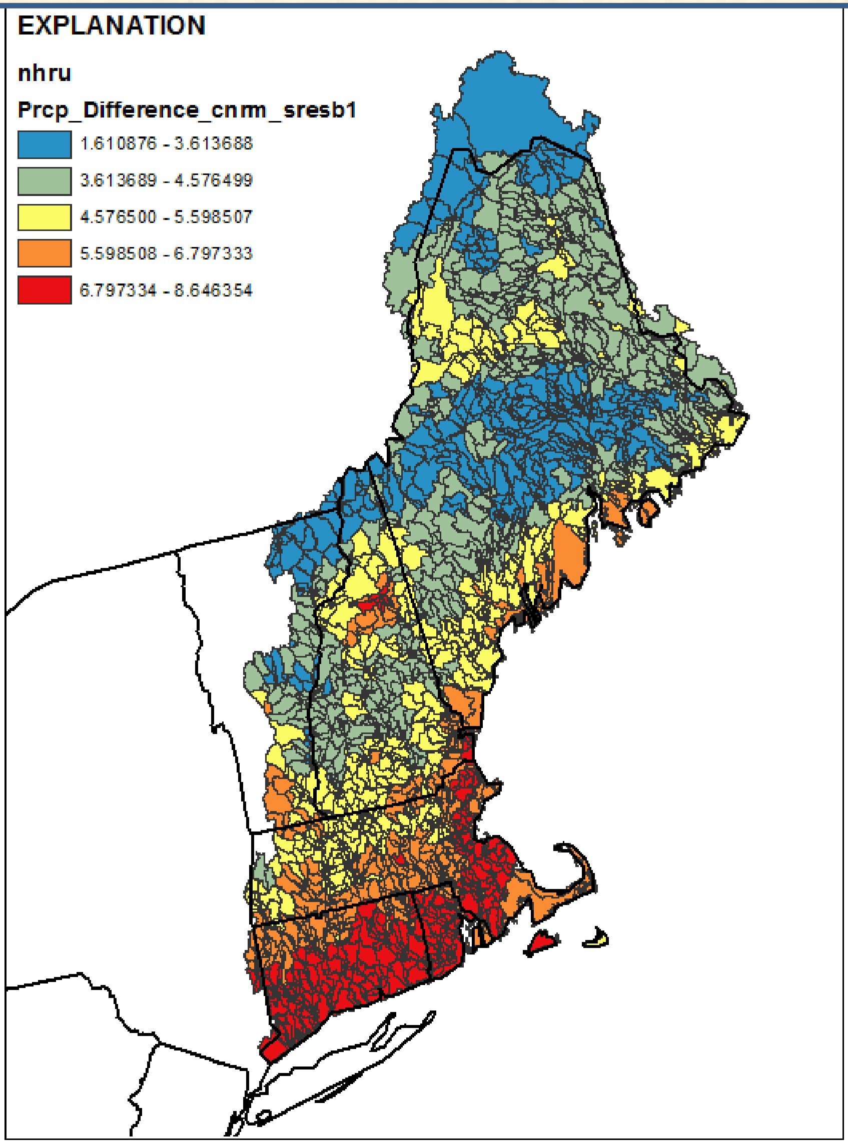




Predicted 20- year Change in Mean Precipitation

Higher emission (left) and Lower emission (right) scenarios





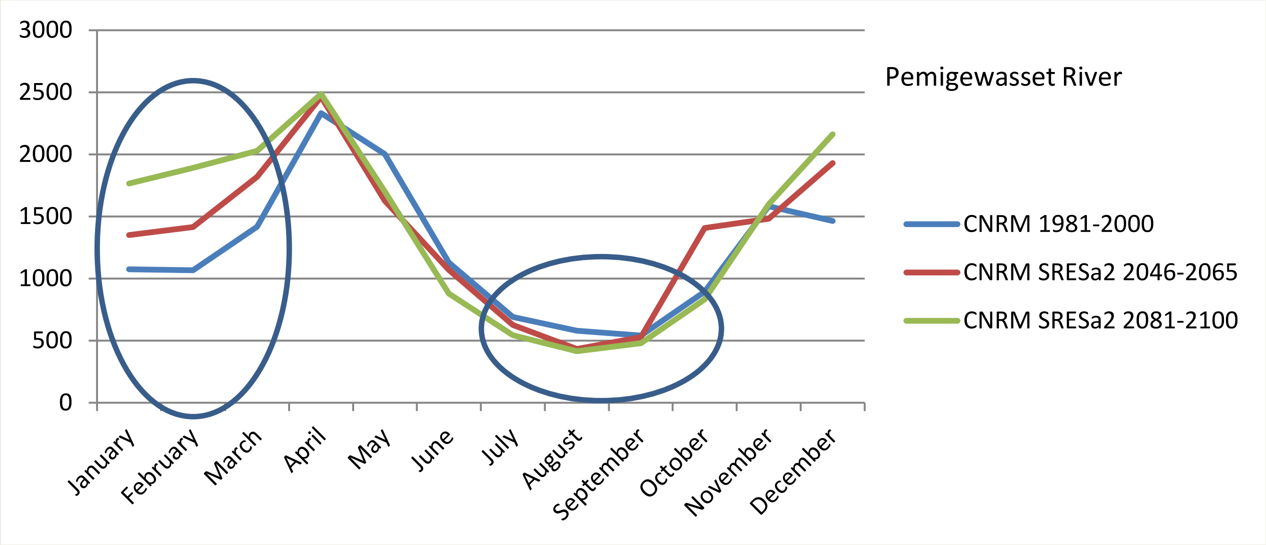
Simulated Periods of Daily Hydrologic Conditions

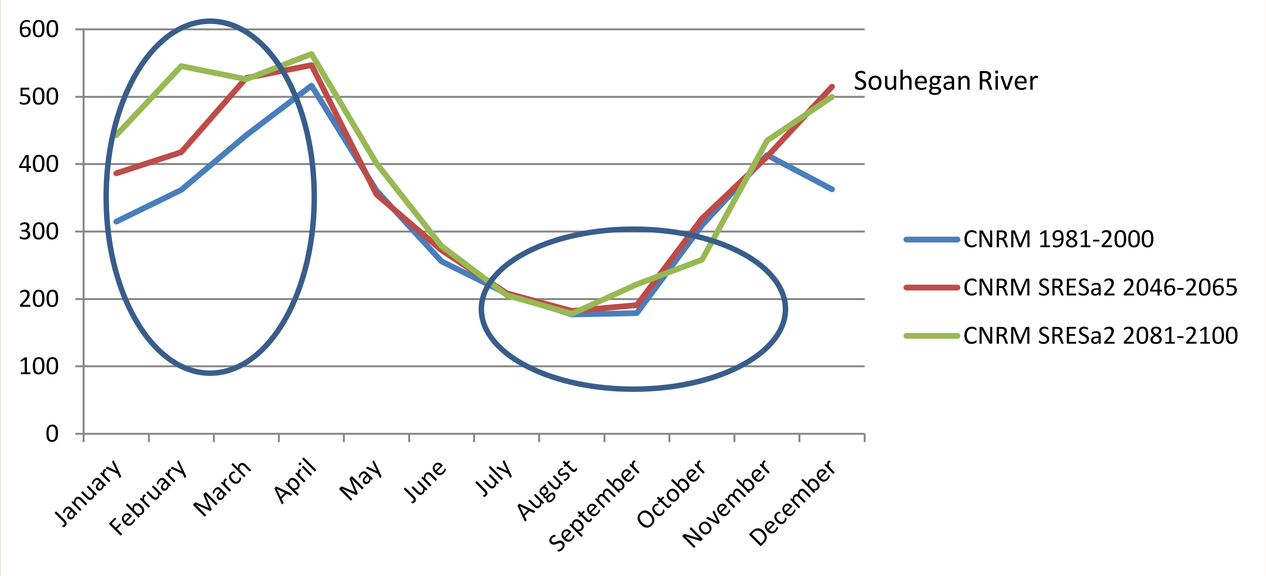
Simulation Periods:

Current:	1981 - 2000
Mid-Century:	2046 - 2065
End of Century:	2081 – 2100

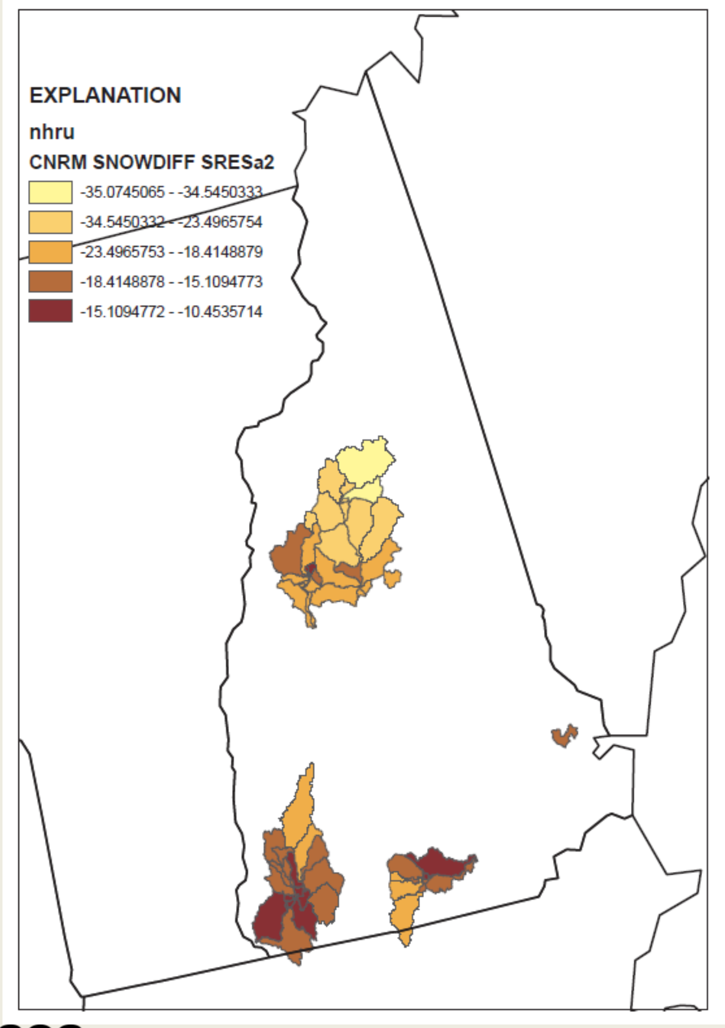
…but any time period could be simulated

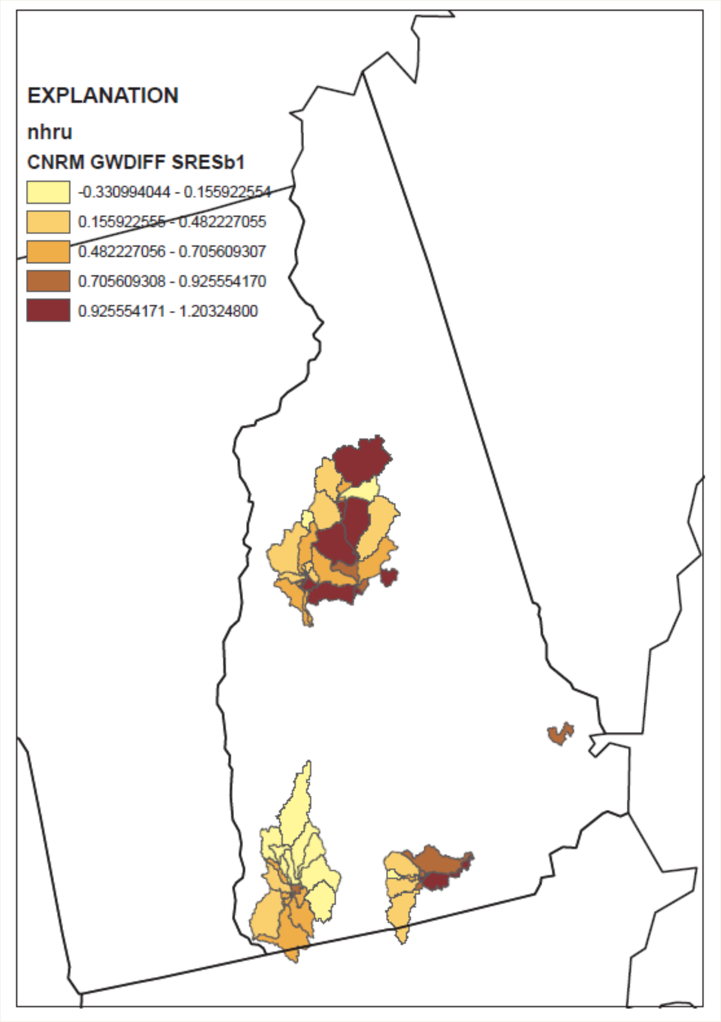
Monthly mean simulations for current (1981-2000), mid-century (2046-2065), and end of century (2081-2100)





Change in Snowmelt and Groundwater





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Summary of Findings and Potential Implications

- More frequent high and low flow events (daily):
  - Effects on channel erosion, culvert/road maintenance and design, effects on flood control and damage
  - Effects on instream habitat.
- Seasonal changes in flow timing and magnitude:
  - Effects on water availability
  - Effects on water quality.
- Less reliable snow and more winter high flow events:
  - Effects on winter recreation and maintenance of roads.
- More groundwater on average but wider range of fluctuation in shallow groundwater:
  - Effects on availability of water to wells
  - Effects on groundwater quality.

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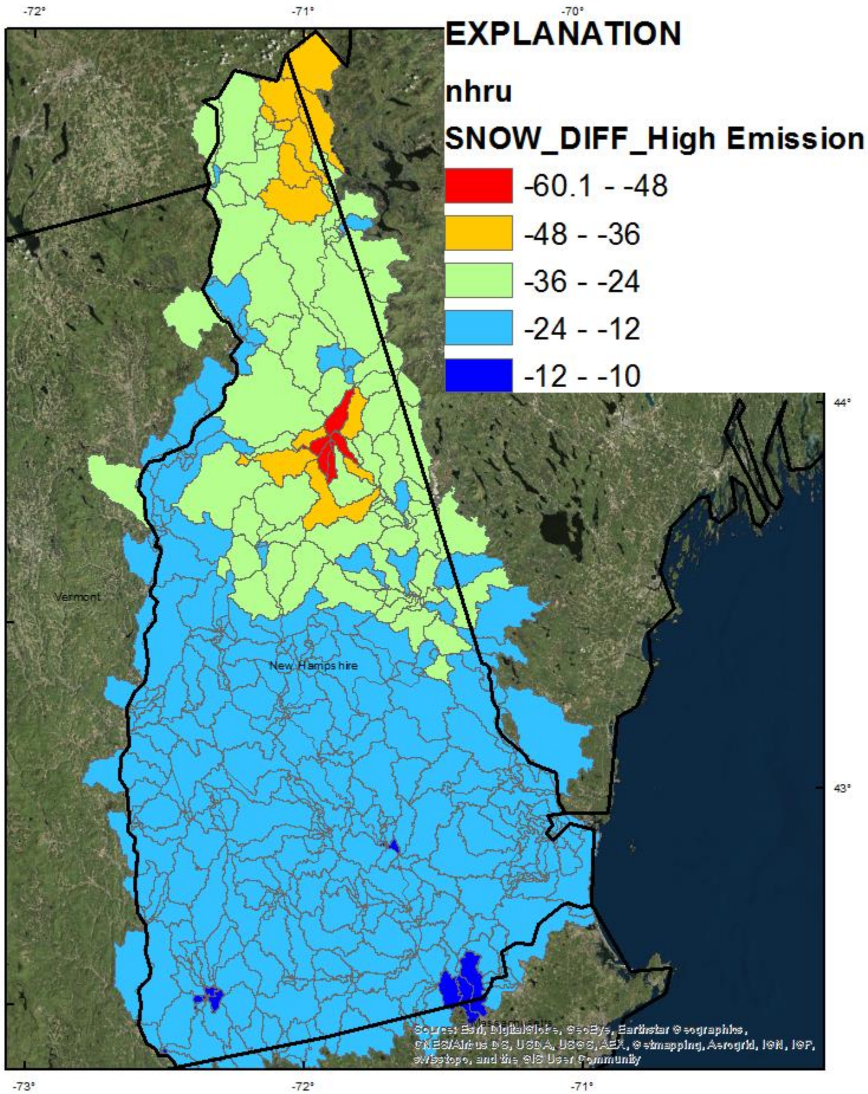
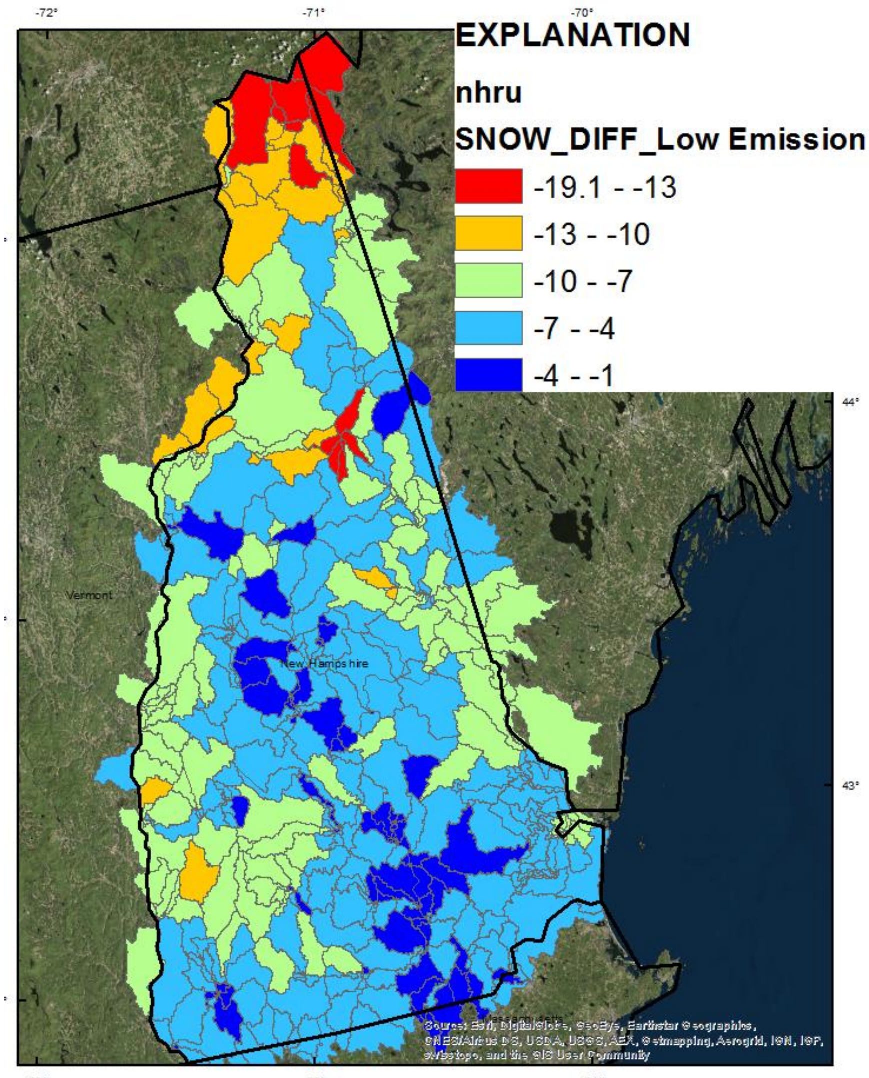
Evaluation of results is complex

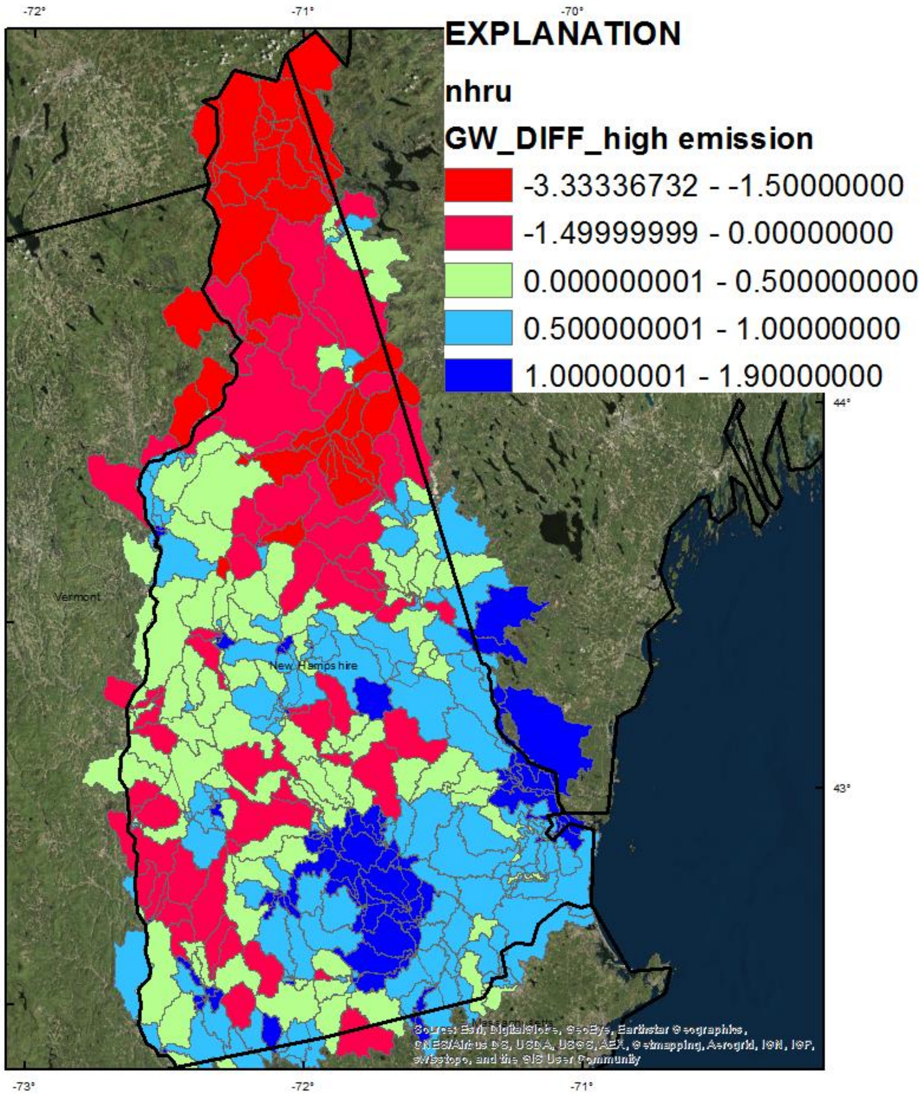
- **Biggest impacts may not be related to biggest change** – small changes could have larger impact in low-lying areas or where development is projected to increase.
- **Need for statewide model** – assess vulnerability and develop adaptation plans (bridges, culverts, well construction, water sources, seasonal lows and highs) in regulatory context.

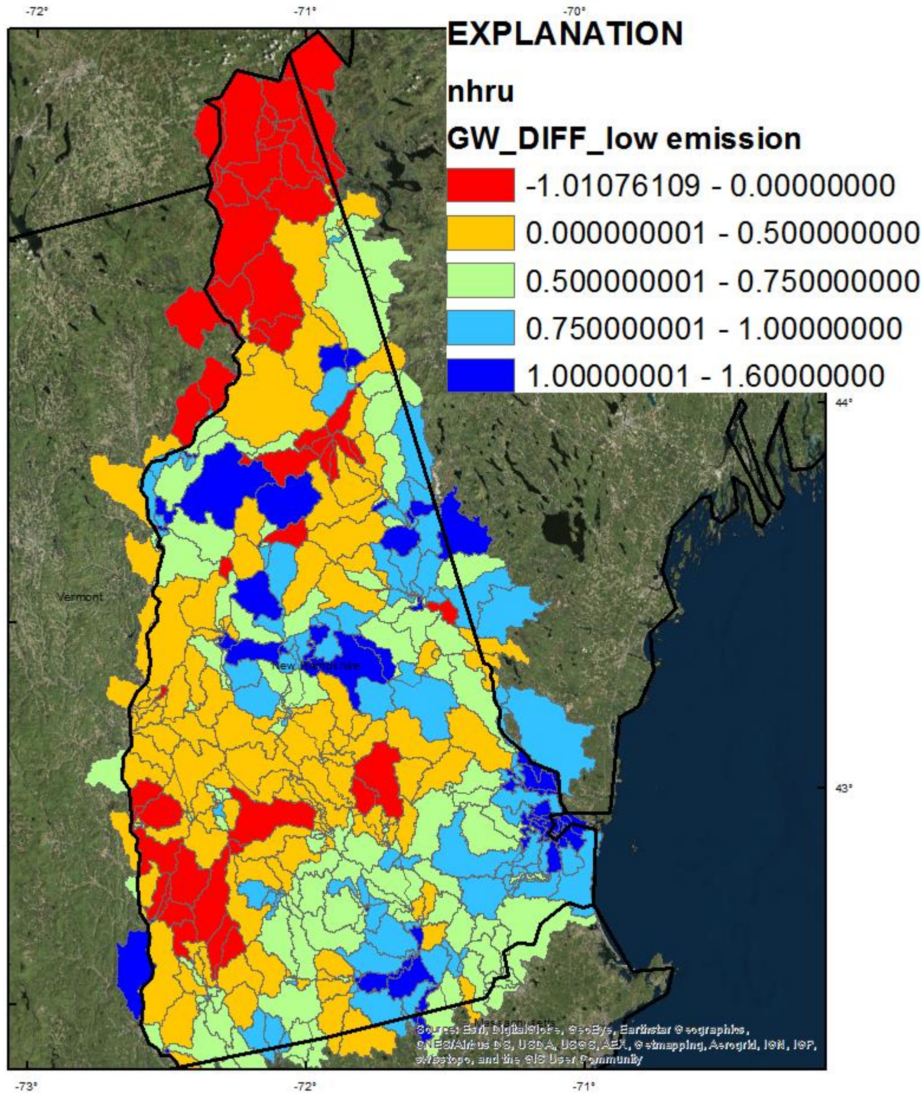
Next Step: State-wide study – Example change in snowfall





State-wide study - changes in groundwater recharge





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