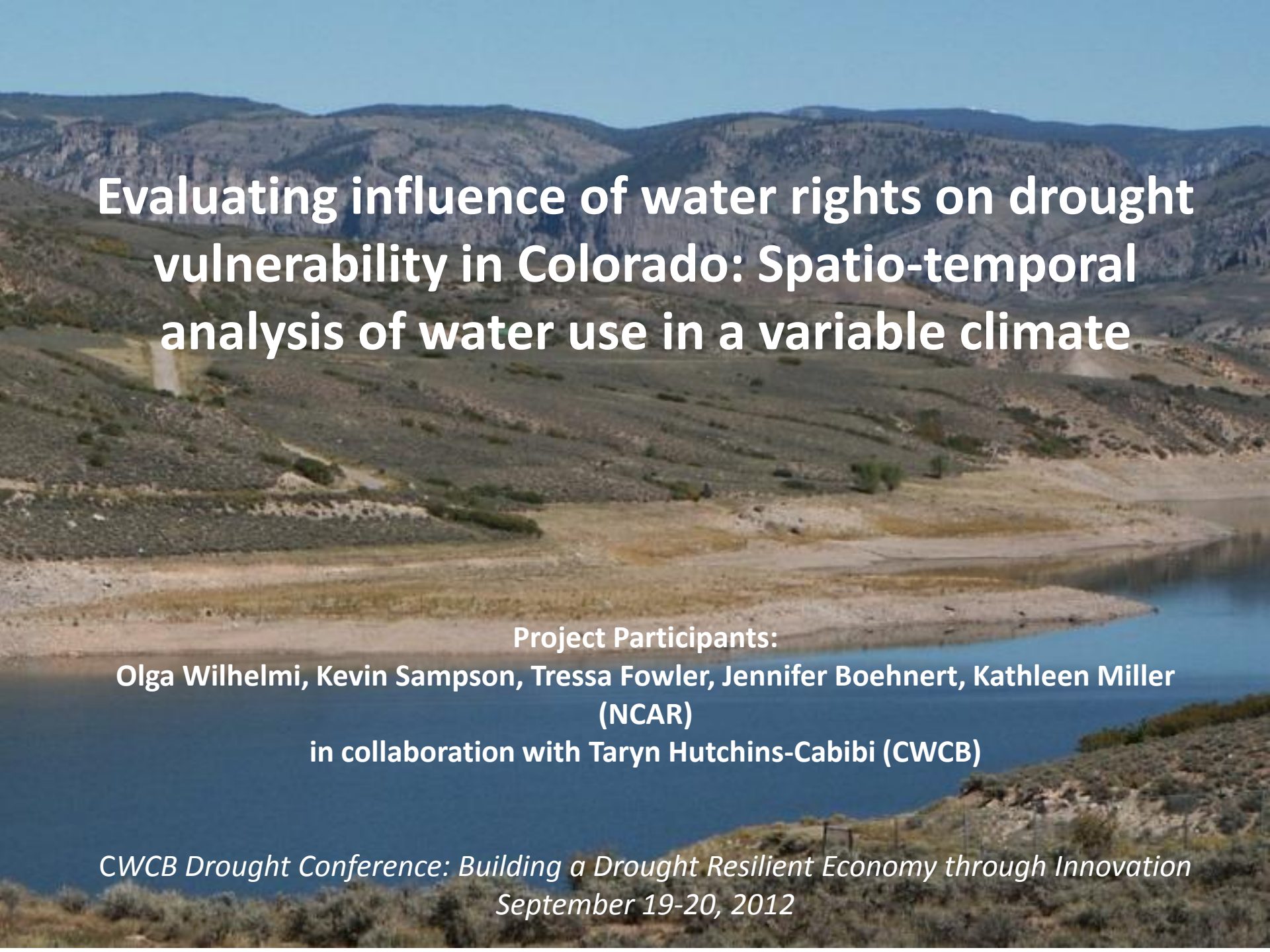

Evaluating influence of water rights on drought vulnerability in Colorado: Spatio-temporal analysis of water use in a variable climate

Project Participants:
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in collaboration with Taryn Hutchins-Cabibi (CWCB)

CWCB Drought Conference: Building a Drought Resilient Economy through Innovation
September 19-20, 2012

Motivation

"While the allocation of water supplies during dry periods via the prior appropriation system is essential to a comprehensive evaluation of drought vulnerability, the nature of individual water user's water right portfolios, general allocation of these rights, and historical water right case study is extremely complex. … It is highly recommended that future drought vulnerability studies incorporate the prior appropriation system at a level that is both feasible and sufficiently addresses drought vulnerability on a water division or district level."

Colorado Water Conservation Board, Colorado Drought Mitigation and Response Plan, 2010, page B.13

Vulnerability

- Vulnerability is the susceptibility of people or systems to damage or harm.
- Vulnerability is complex, dynamic, and spatially variable.
- Function of:
  - *Exposure* to drought - environmental and climatic conditions that position a system to be negatively affected by a drought (e.g., physical attributes of the environment, including climate, hydrology and water supply)
  - *Sensitivity* - non-climatic factors that determine the degree to which the system can be affected by a drought (e.g., attributes of the water demand, including the prior appropriation water rights system)
  - *Adaptive capacity* - the potential of a system to adjust or modify its features or actions so as to better cope with current or future drought impacts (e.g., attributes of social system, including practices, adaptive technologies and water markets)
- Better understanding and characterization of vulnerability (and the underlying factors) leads to targeted mitigation and adaptation strategies

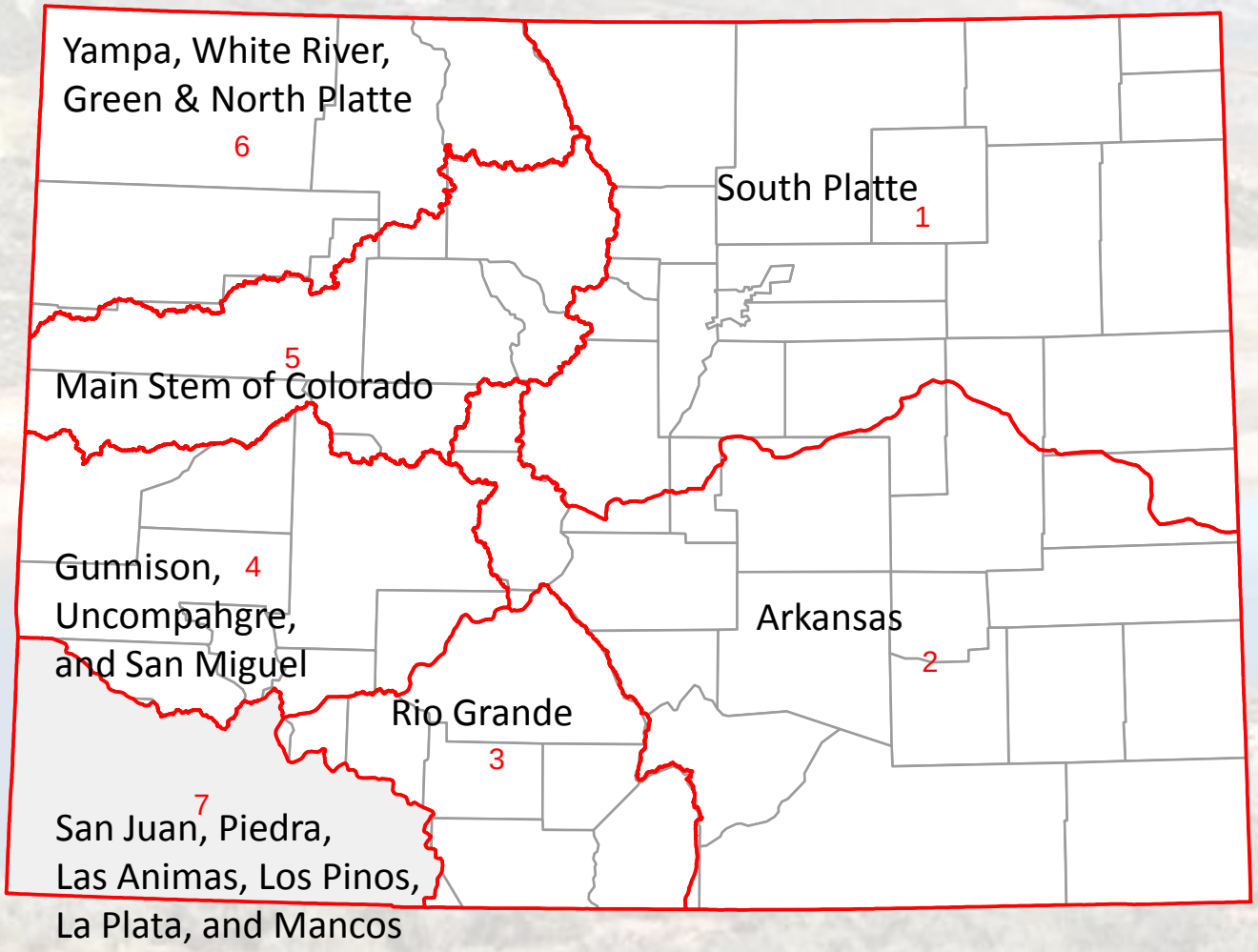
Current Research

- Are there regions or categories of Colorado water users that are more sensitive to climate variability and water shortages?
- Are there significant differences among the sectors (use type) and geographic regions?
- Can we quantify the hydro-meteorological thresholds (expressed by the drought indices) beyond which these users may experience negative drought impacts?

- Methods: spatial and statistical analysis (i.e., geoprocessing tools, extreme value statistical model)

Scale

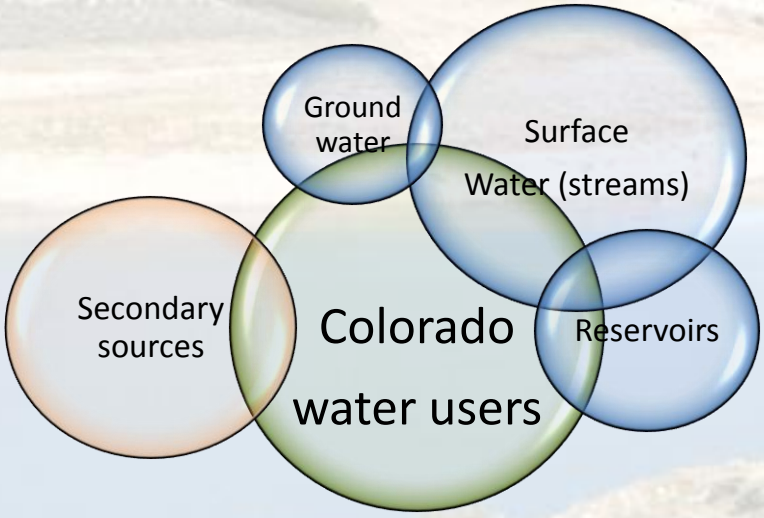
- Water Divisions and state-wide analysis



Data and key variables

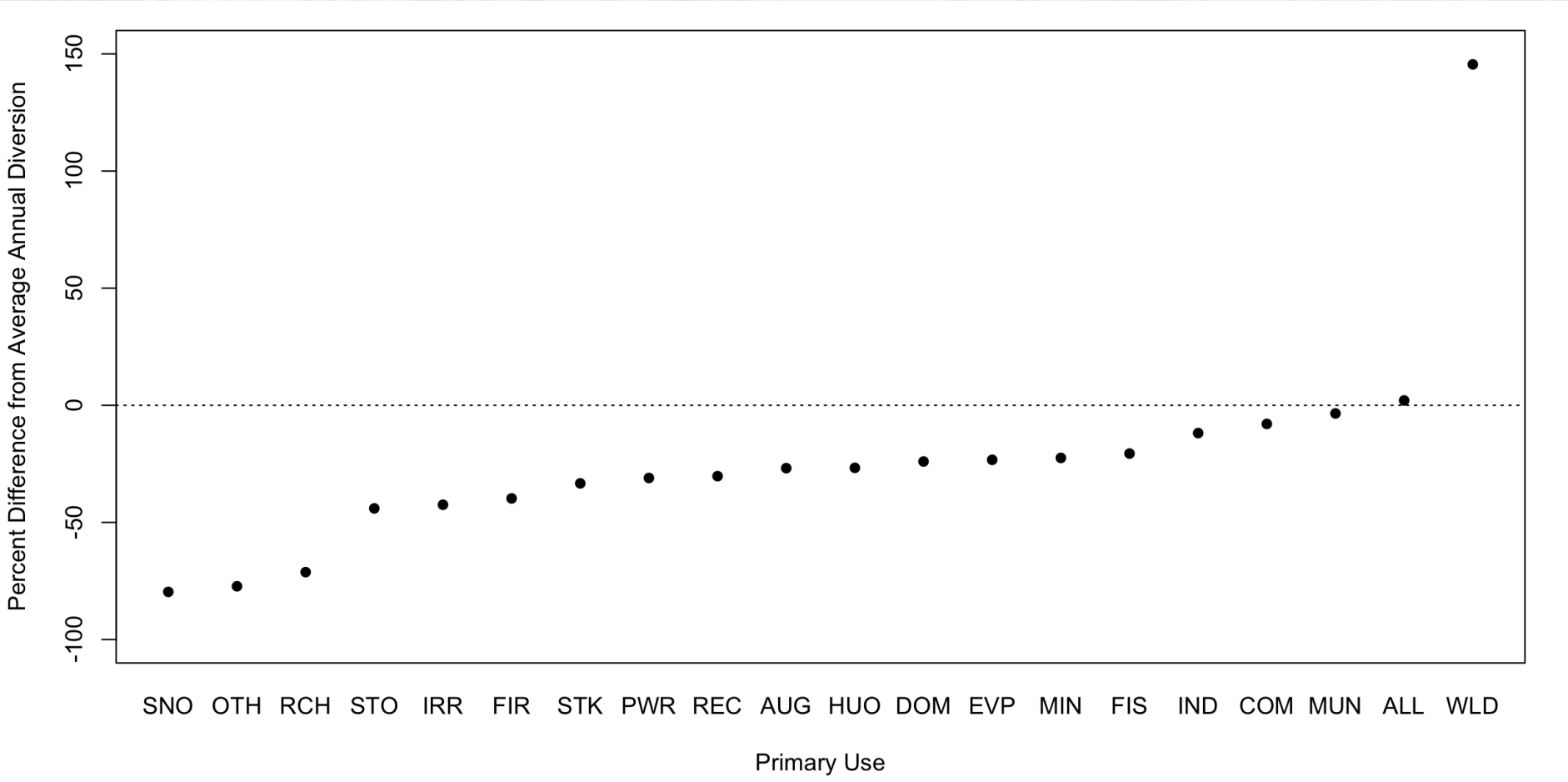
- HydroBase surface water diversion records for 1980-2010
  - at least 1 water right associated
  - At least 1 diversion record between 1980-2010
  - 15,502 structures resulting
  - Average of 16.2 years of diversion records per structure

- Reductions in water diversions
  - Percent below annual average
- "Attributes" of water users
  - use type, seniority, elevation, timing of use
- Drought indices
  - SPI *(new SWSI forthcoming)*



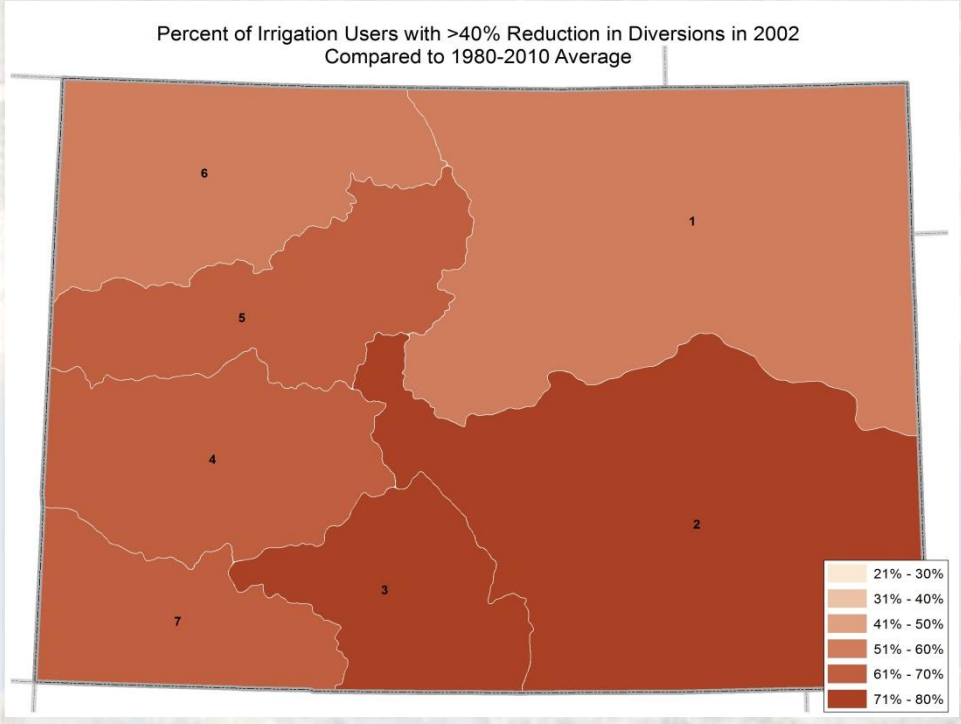
Accounting for surface and ground water volumes in a HydroBase records

State-wide water diversions in 2002

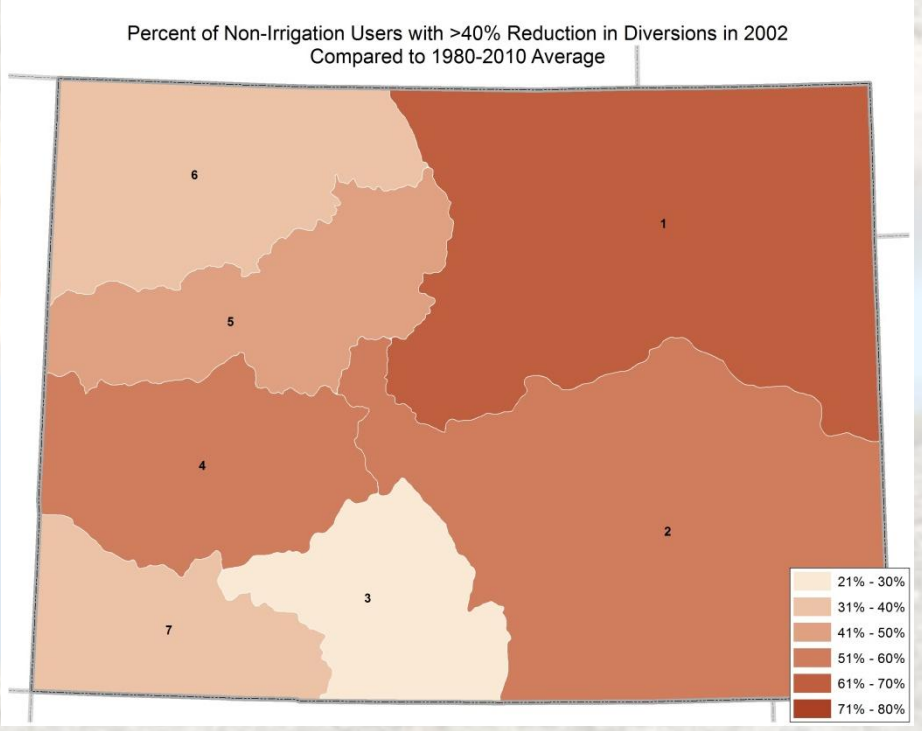


Reductions in water diversions in 2002

- In the non-drought years, there are 20-25% of users that use less than 40% of average annual diversions (consistent across use and division).

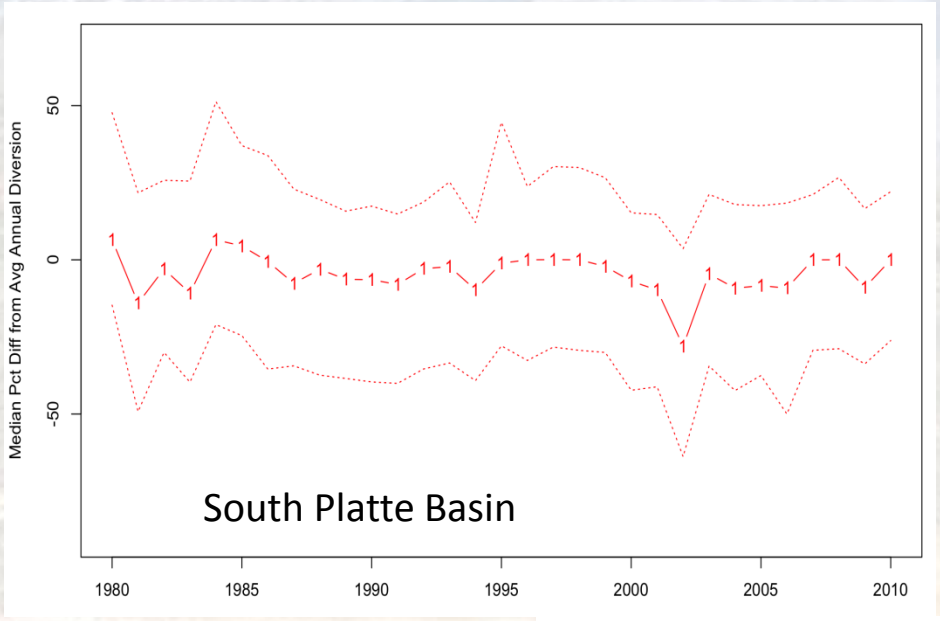


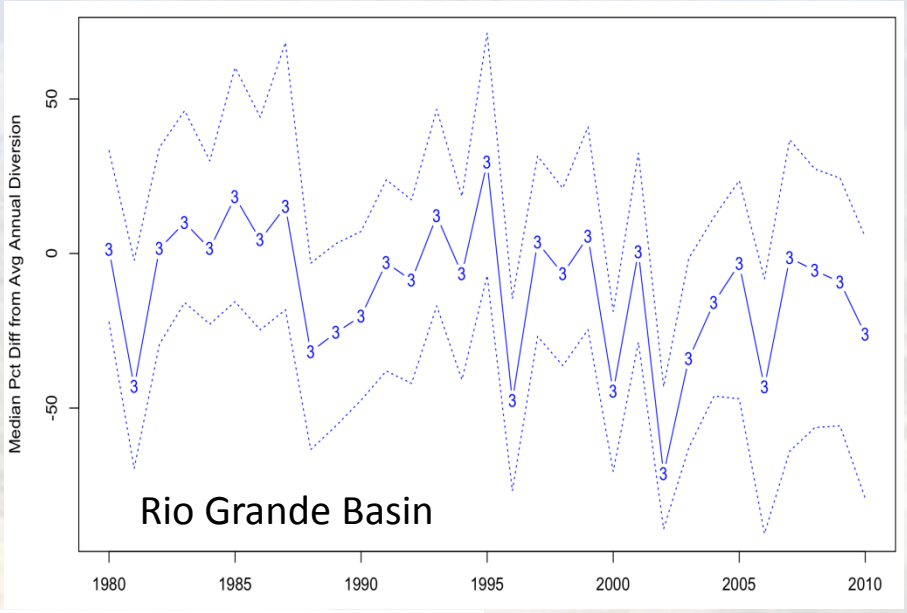
Irrigation

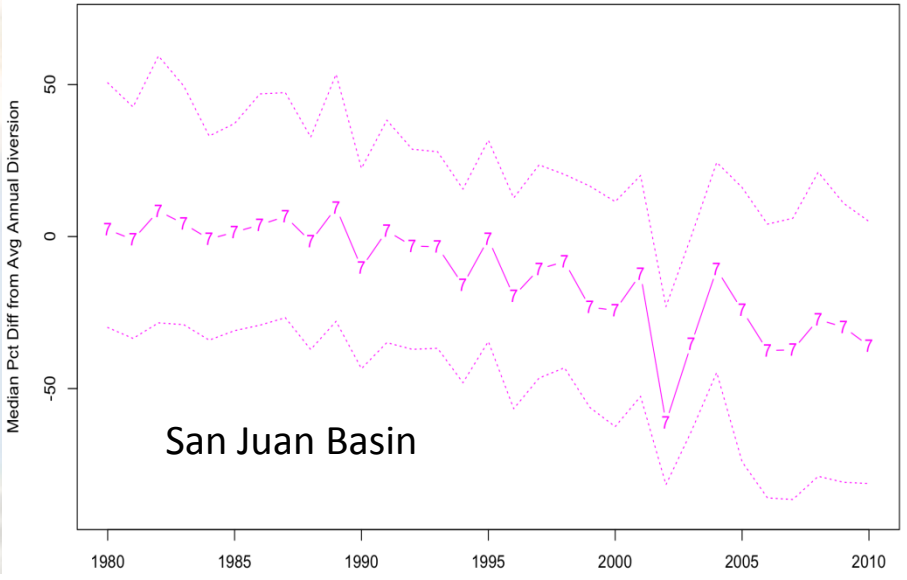


Non-irrigation

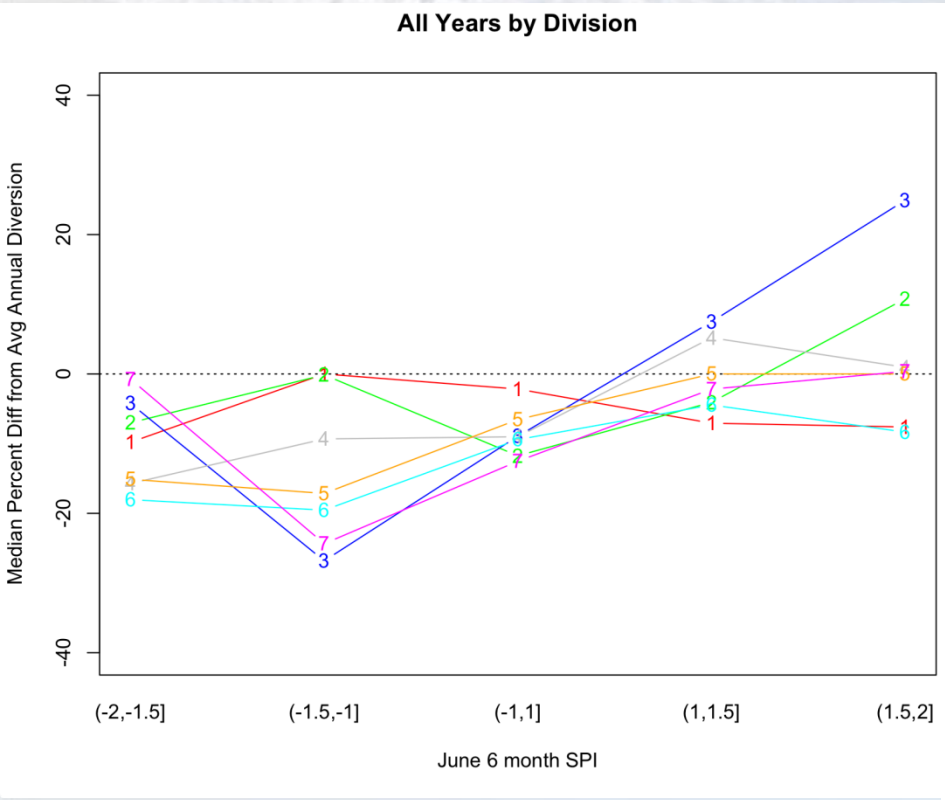
Interannual variability

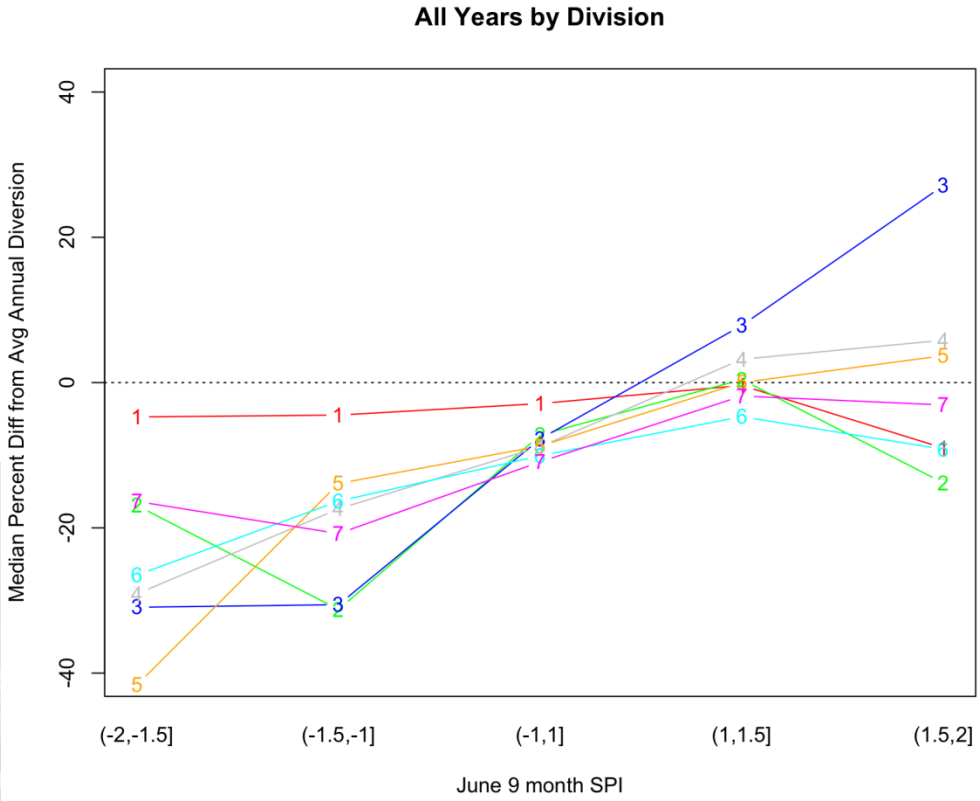




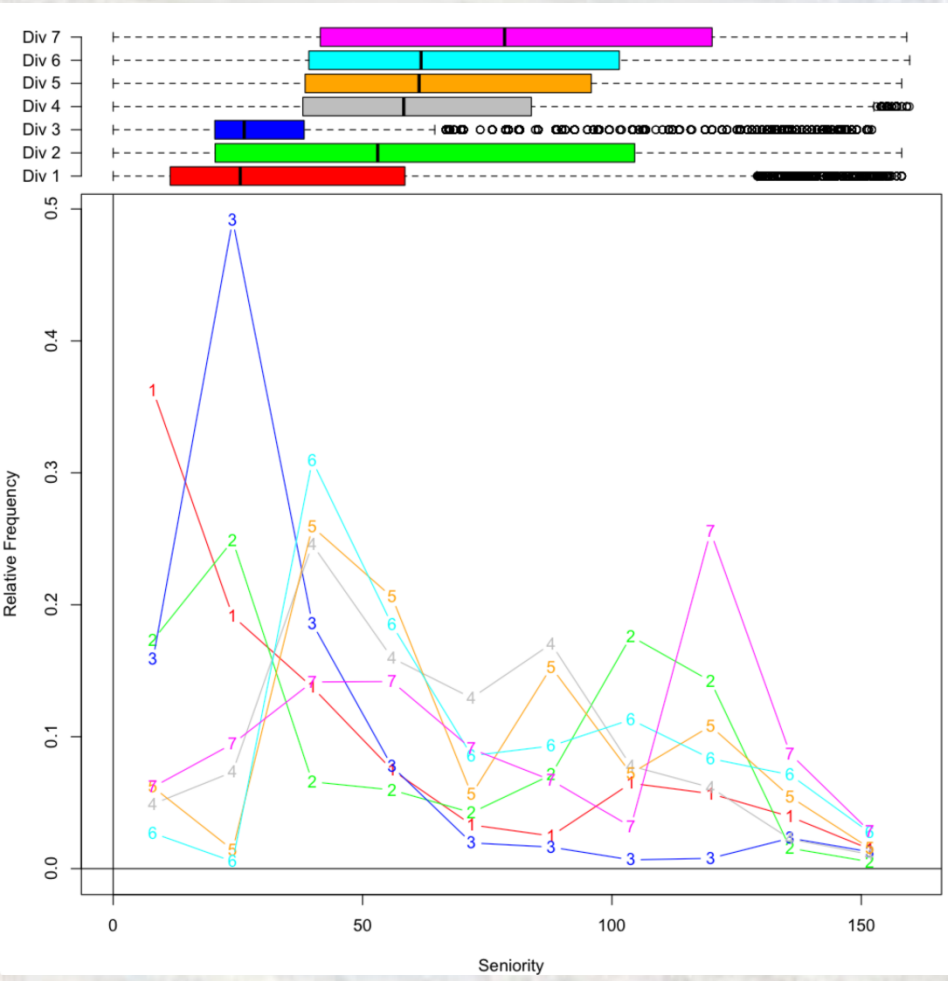


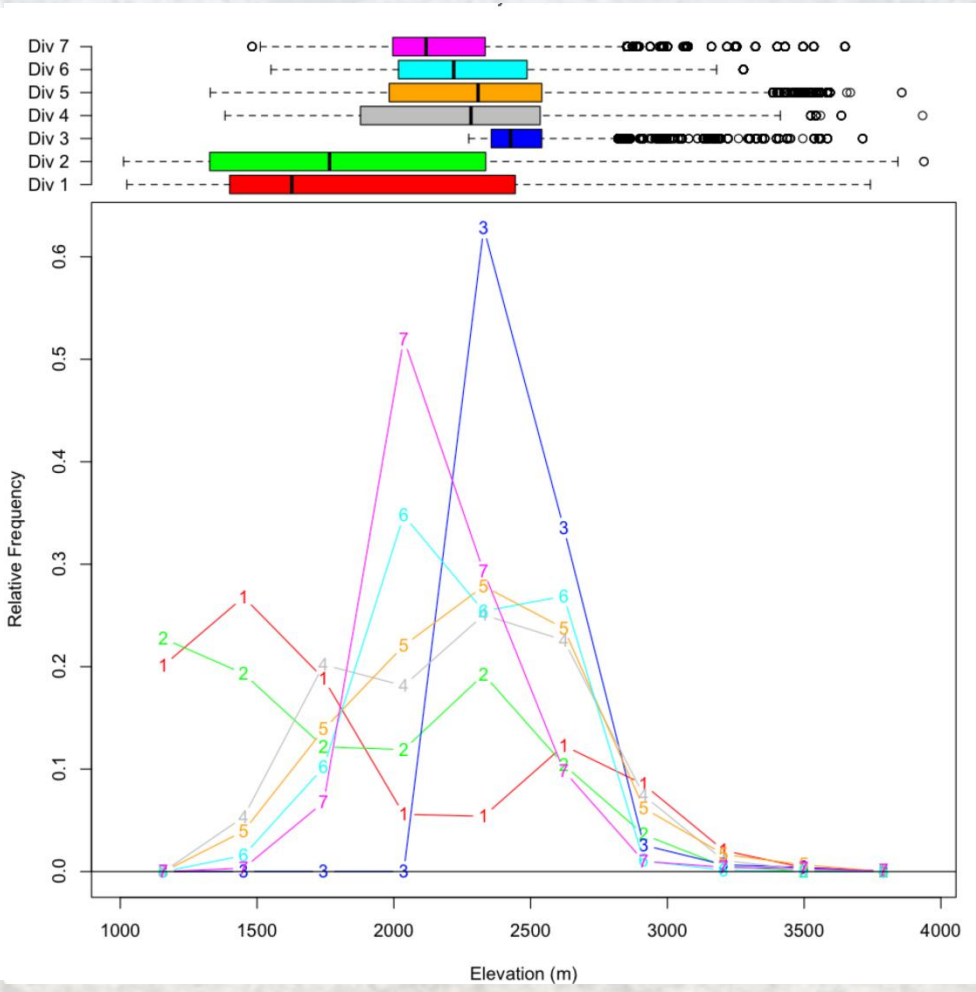
Drought thresholds (6 and 9 months SPI)



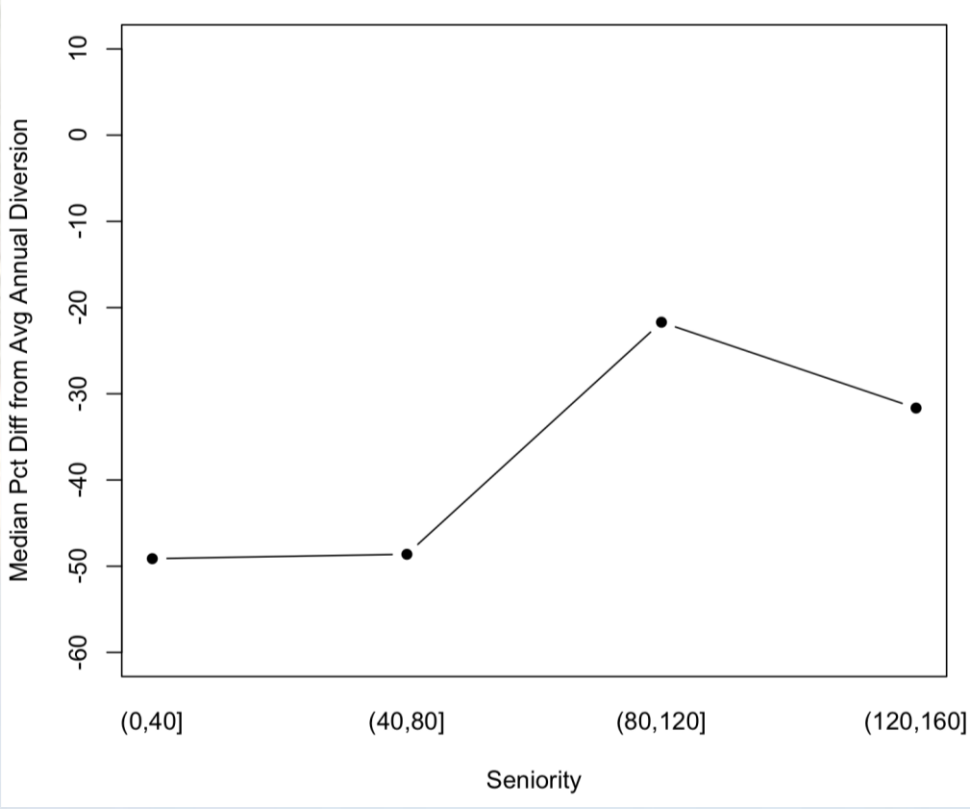


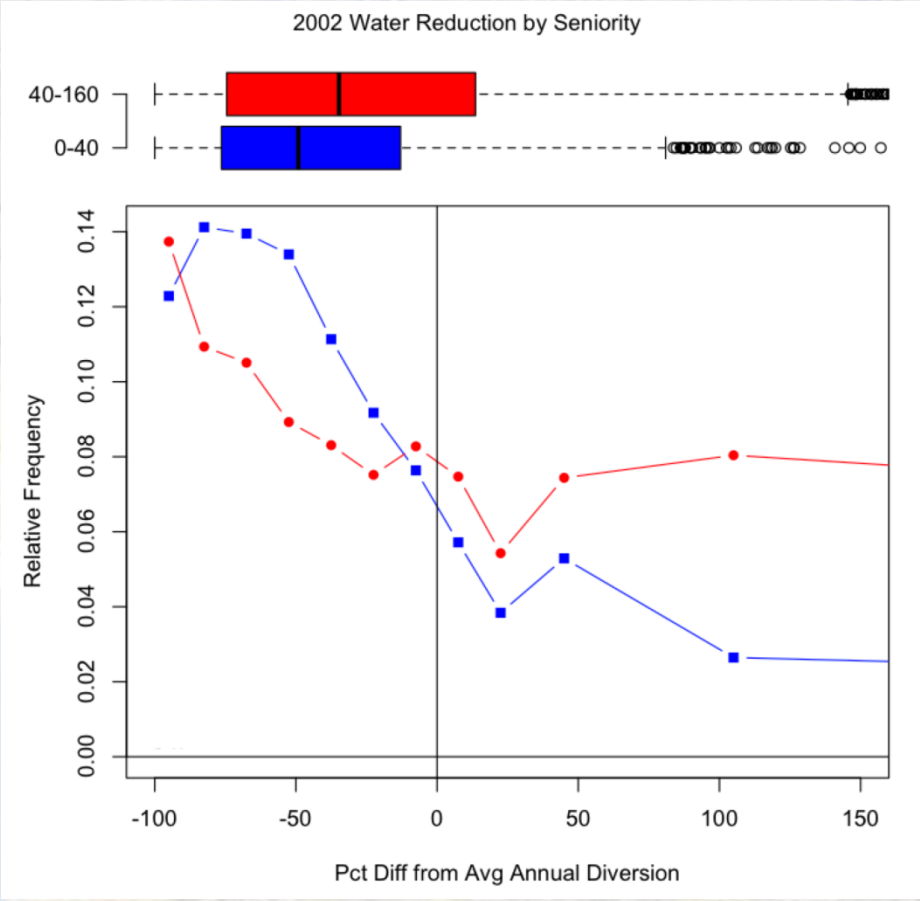
Characteristics of the water divisions



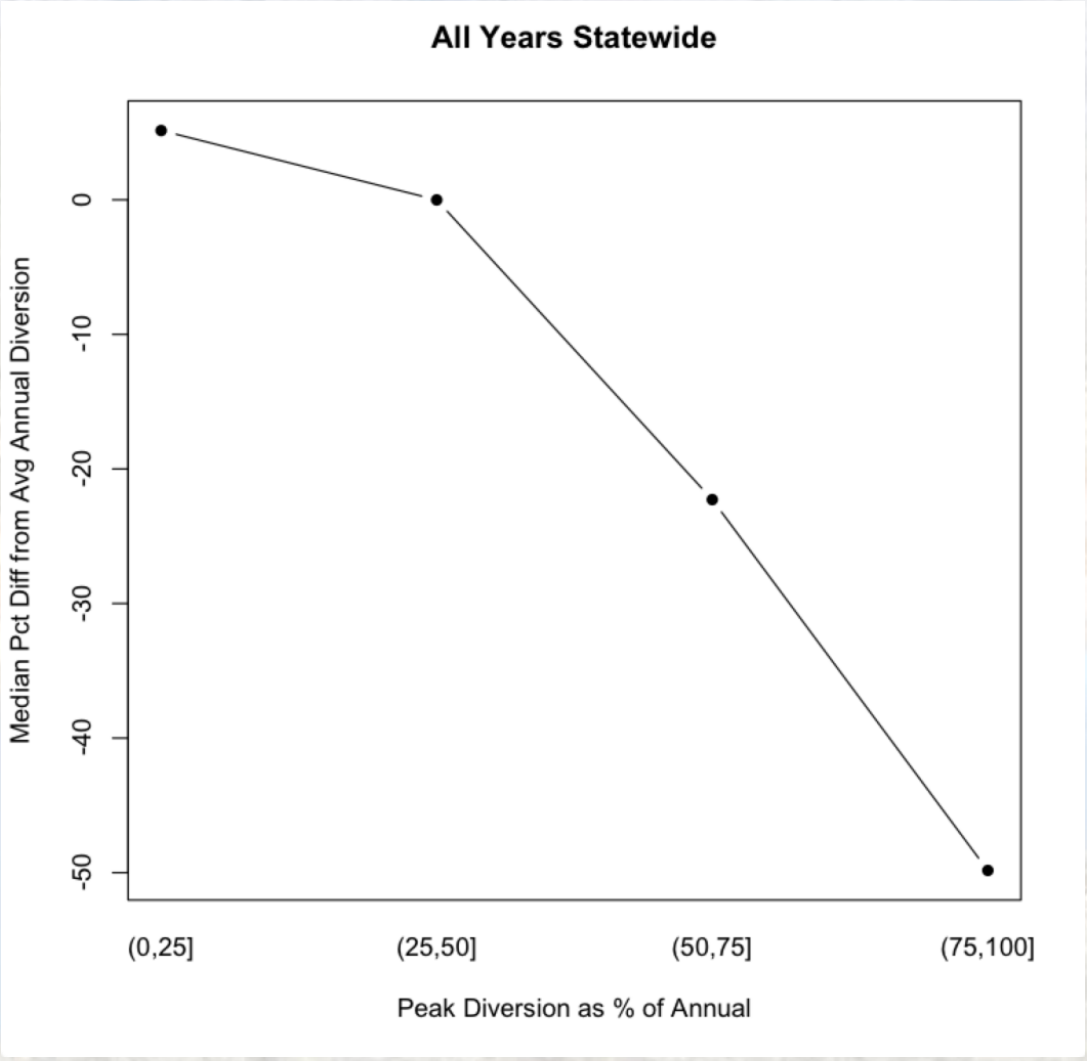


State-wide 2002 water use by seniority

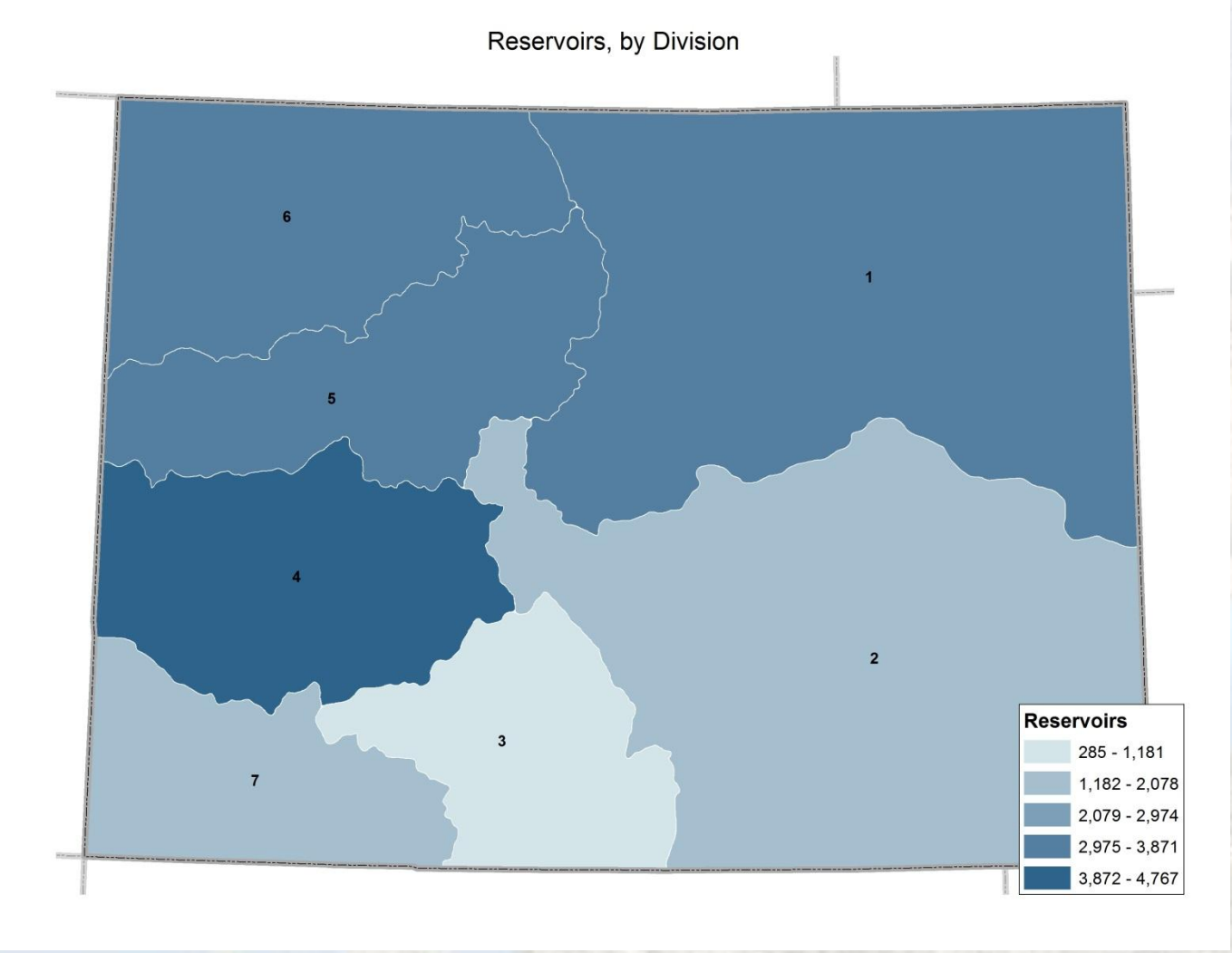




Annual distribution and timing of water use



Reservoirs and water storage



Conclusions

- Are there regions or categories of Colorado water users that are more sensitive to climate variability and water shortages?
  - We found trends and drought sensitivity patterns across Colorado Water divisions, using 1980-2010 records and 2002 drought.
- Are there significant differences among the sectors (use type) and geographic regions?
  - In 2002 divisions 2,3 and 7 had a greater proportion of users with water reductions, especially in irrigation. In Division 1 the proportion of users with water reductions was greater for non-irrigation users.
  - Water rights seniority alone do not explain drought sensitivities; the complex interplay of seniority, geography, timing of water use and access to secondary water sources affect drought impacts.
  - Analysis on a sub-division scale (including topological networks and local conditions) may better explain these interactions.
- Can we quantify the hydro-meteorological thresholds (expressed by the drought indices) beyond which these users may experience negative drought impacts?
  - In extreme drought conditions both senior and junior water right holders experience water shortages.
  - Drought exposure thresholds vary by division and depend on the complex relationships between physical and social characteristics of the region.

Future research

- Diversion = Use? Better characterization of where the water is used can improve spatial analysis of water demand and supply.
- Integrative analysis of surface and ground water supplies in the context of drought impacts, vulnerabilities and responses.
- Exposure: analysis with new SWSI index
- Adaptive capacity: How can the new areas of innovation in Colorado water law, policy and water management reduce drought vulnerability and impacts?

Thank you!

- Funding: NOAA

- Questions?

- Contact: olgaw@ucar.edu