Human influences affect the predictability of streamflow droughts

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Introduction

- Precipitation based drought indicators are most commonly used in Drought Monitoring and Early Warning Systems, whereas impacts of droughts are often felt in other domains of the hydrological cycle such as streamflow (related to ecology, navigation, recreation etc.)
- Climate, catchment and human processes can completely change the precipitation signal when it propagates to streamflow.

Research questions:

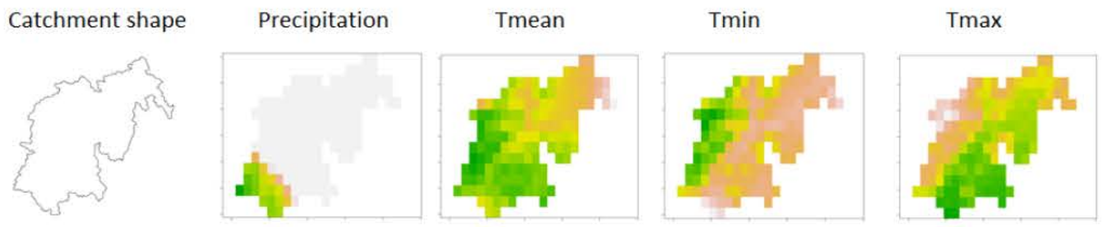
- How well can streamflow drought conditions be predicted with different meteorological drought indicators in catchments with and without human influences?
- Which meteorological drought indicator is the best predictor?
- Where and why is there a mismatch between meteorological and streamflow drought conditions?
- What are the consequences for drought monitoring systems?

Data

- Daily streamflow data (1983-2009) for ~2500 catchments from which ~500 have near-natural flow records (USGS).
- Gridded daily precipitation and temperature data for each catchment (PRISM, 4km resolution).

Streamflow data

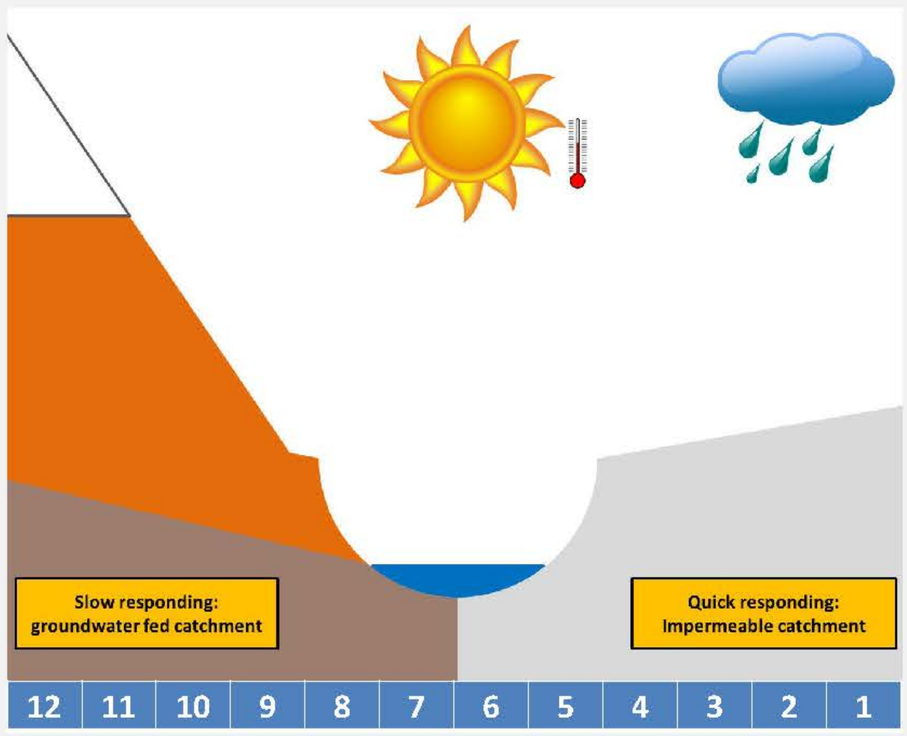
Meteorological data



The natural influences and predictors

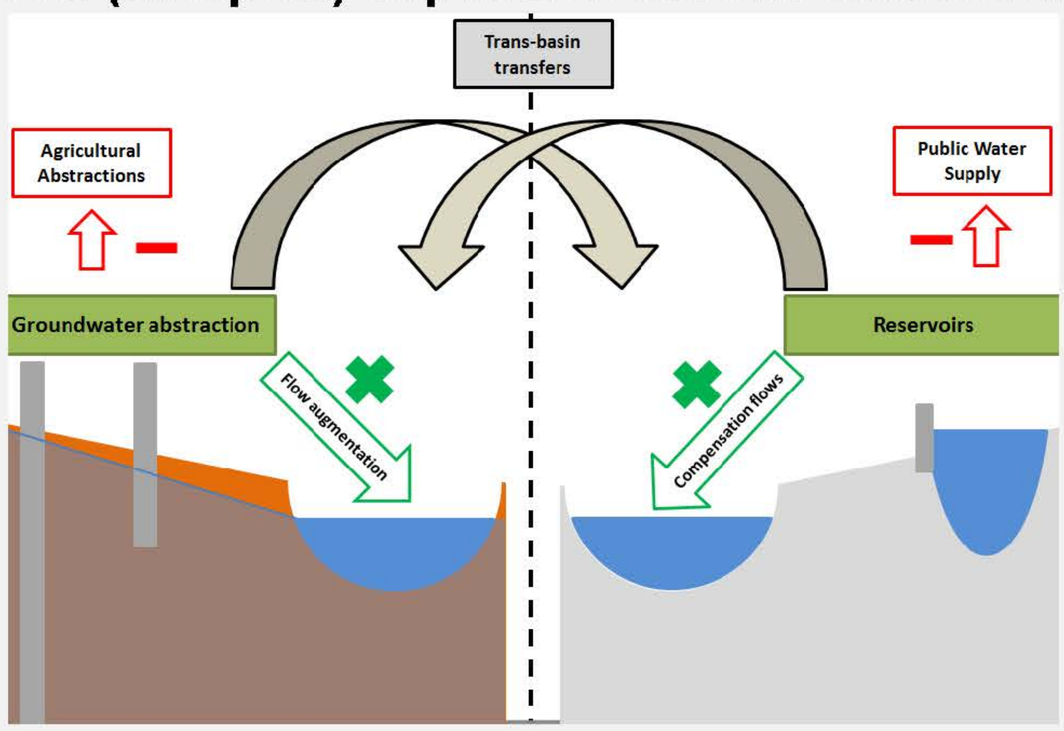
3 different types of indicators to reflect different meteorological processes that are important for the water balance.

Precipitation + Snow melt - Snow accumulation	Precipitation – Evaporation	Precipitation



12 different aggregation periods (1-12 months) to distinguish between quickly and slowly responding catchments

The (complex) impacts of human influences

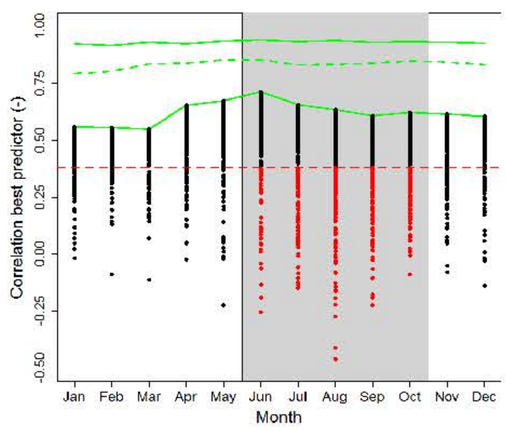


Also Related to (changing) policies - uncertain for the future

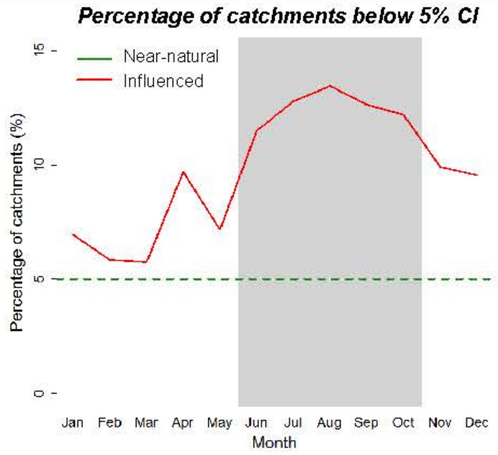
Donald Trump about the California drought (May, 2016):

"You have a water problem that is so insane. It is so ridiculous, where they're taking the water and shoving it out to sea … they're trying to protect a certain kind of three-inch fish … Believe me, we're going to start opening up the water, so that you can have your farmers survive."

How good are these indicators?



Percentage of catchments below 5% CI

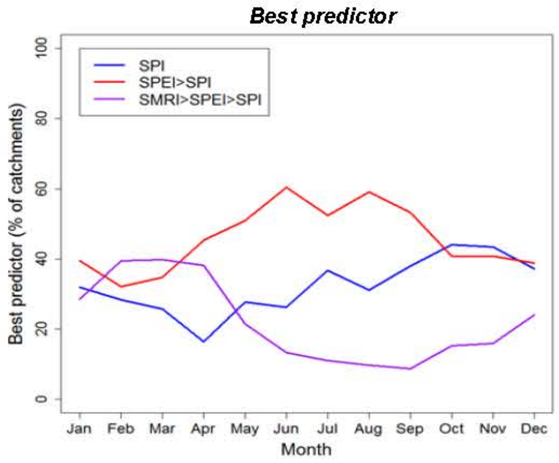


Legend	Near-natural	Influenced
	Median	Below 5th percentile
	90% CI	No significant (summer)

- Significant correlations between streamflow in catchments with near-natural flow and best meteorological predictor.
- Correlations for some catchments with human influences are lower or even non-significant, esp. in the summer months (red dots).

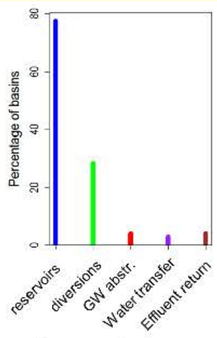
Which indicator is best?

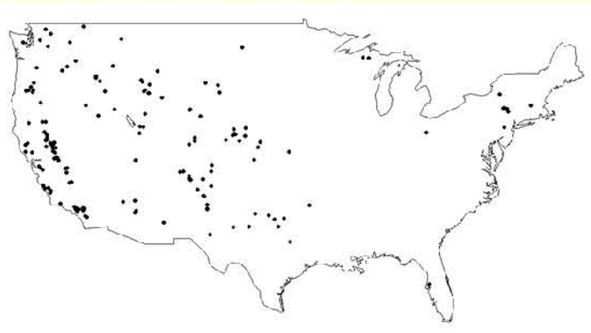
Best predictor



- Although most commonly used, indicators based solely on precipitation are not always best.
- Improvement for a large percentage of catchments when considering: snow melt and accumulation in winter and when considering evaporation in the summer.

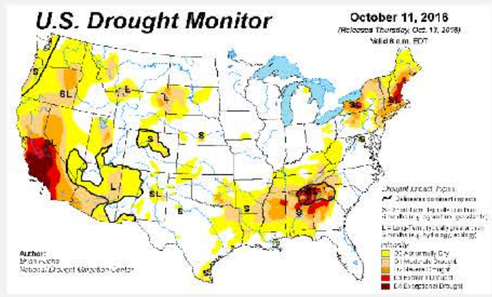
Why and where is there a mismatch?





Based on non-significant correlations in summer months

Improve drought Monitoring and Early Warning Systems



http://droughtmonitor.unl.edu/

Application

Knowing which indicator is the best predictor of streamflow droughts and knowing the locations of basins where there is a mismatch between both improves large scale drought monitoring systems such as the US drought monitor. Future research should investigate how to monitor droughts at locations with a mismatch between hydrology and meteorology.

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