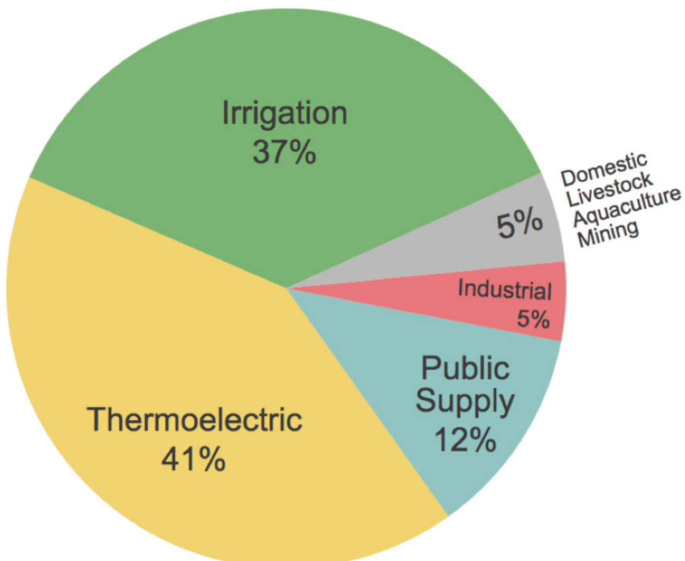
FOCUS AREA

QUANTIFYING WATER DEMAND IN A CHANGING CLIMATE



How the United States uses water (2015). Source: USGS

Drought assessments are complicated by shifts, or potential shifts, in water demand from physical processes and human demands on water. This highlights the urgency for quantification of water demand across various sectors and cross-sector interactions (e.g., municipal water demands being met by transfers of agricultural water). In a warming climate, evapotranspiration is expected to increase, which leads to increased consumptive use of water. For instance, to satisfy crop needs under warmer conditions will require increased demand for both ground and surface water supplies. Quantifying these changes in evapotranspiration is complex and not accurately measured. Additionally, the seasonality of precipitation and intermittent dry periods—especially during the growing season—can create stress on plants as evaporation rates often outweigh observed precipitation. Crop choices, soil health and water management all contribute to changes in consumptive water use. For forest, shrubland, and grassland systems, water demand dynamics of the landscape and evapotranspiration rates are also impacted by precipitation patterns and increased heat, which can also increase wildfire risk. In addition, there are questions about the potential role of landscape and vegetation changes on water demand, such as rates of growth (Mankin et al., 2019; Ficklin et al., 2009) and transpiration and leaf-level stomatal closure (Grossiord et al., 2020; Yang et al., 2018; Eckhardt & Ulbrich, 2002).

Societal changes also impact water demand. For instance, new water-intensive industries, tourism, and population shifts have impacts on water availability (seasonal and sub-seasonal) and total demand. Understanding and monitoring changes in water supply availability and shifts in demand across sectors is fundamental to improving water management in a changing climate.

Priority Actions:

1. Accurately quantify water demand (anthropogenic and environmental) and how it is changing, including (1) monitoring of potential evapotranspiration and actual evapotranspiration, both nationally and locally, (2) developing evapotranspiration climatologies and trend analyses, (3) improving soil moisture monitoring, and (4) developing soil moisture climatologies.
2. Utilize water budgets across sectors to improve drought resilience for communities experiencing aridification and humidification in a changing climate.
3. Improve representation of atmospheric water demand in drought models and projections to more accurately account for potential evapotranspiration (PET) and actual evapotranspiration (AET) given the importance of land-atmosphere interactions for some drought events, and the impacts of land processes for sub-seasonal to seasonal forecasts and climate models.

Research Questions:

1. How can drought assessments incorporate quantified changes in water demand across sectors and natural demands (e.g., changes in evapotranspiration, land use, human behavior)? How can uncertainty that arises from human activities be quantified in drought assessment (e.g., people see conditions getting dry and then ramp up water use, thereby exacerbating drought)?
2. How are climate change-related phase changes in precipitation or terrestrial water sources impacting water availability (e.g., rain/snow, frozen/thawed permafrost, melting glaciers)?
3. What drives changes in water demand across different timescales for different sectors (e.g., agriculture, industry, tourism), and how can drought assessment and future planning consider times of highest demand?
4. How will evapotranspiration change with warming temperatures and changing climate, as this could place increased demand on water supply to satisfy crop needs and feed people? Should these changes be incorporated into drought assessment and response and how?
5. How can evapotranspiration and potential evapotranspiration (PET) be incorporated to improve assessment of current soil moisture conditions to understand how different plants (e.g., crops, rangelands, and forests) might experience stress?
