WESTERN WATER ASSESSMENT
A NOAA RISA TEAM

Anthropogenic Water Management, Climate Change, and Environmental Sustainability in the Southwestern US (ACCESS) Phase I

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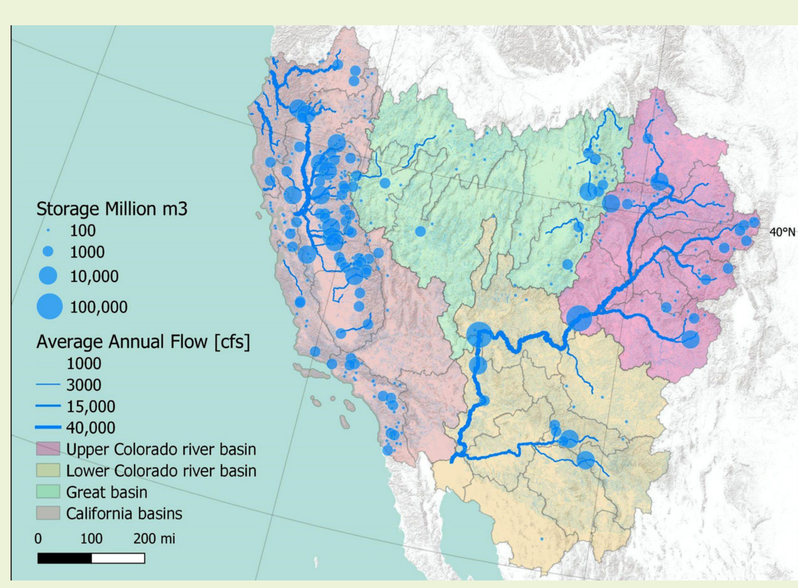
BACKGROUND

The warming and recent drying of the American Southwest have heightened concerns about future water and environmental sustainability. The ACCESS project (Anthropogenic water management, Climate Change, and Environmental Sustainability in the Southwestern US) is funded by the National Science Foundation to explore the following scientific questions:

- What are the impacts of increased aridity in the southwestern US on surface water availability?
- Can future water demands be met under current management practices?
- What are the most realistic alternative management strategies that will help mitigate the impact of future water scarcity on meeting water demands?

ACCESS is a collaborative project between researchers at Michigan State University and the University of Colorado Boulder. The project engages with Colorado River basin and California stakeholders to assess climate change impacts to streamflows and identify plausible management alternatives.



Project domain (credit: Ahmed Elkouk)

RESEARCH OBJECTIVES

1. Develop a land model to reconstruct the natural and human-induced water cycle change over the past four decades and evaluate the model's ability to resolve surface and sub-surface hydrologic processes and their spatio-temporal dynamics.
2. Quantify the future changes in water supplies and demands in the southwestern US and examine their spatio-temporal trends and variabilities, examine the changes in surface reservoir and groundwater storages, and quantify risks associated with extremes such as droughts.
3. Co-develop potential sustainability pathways with regional stakeholders. Evaluate these pathways under a range of climate change and socio-economic growth scenarios.

PHASE 1

Phase I of the project has two components, a Western Water Assessment-managed stakeholder engagement component and a Michigan State-managed basin-modeling component.

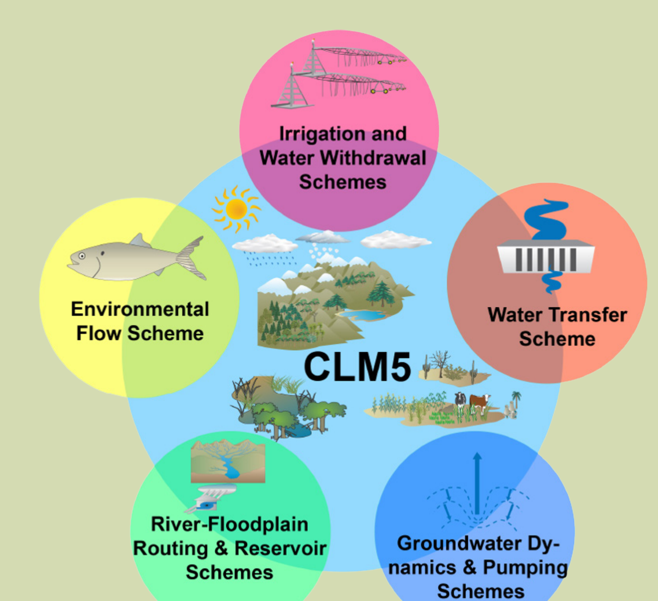
WWA hosted and facilitated a project kickoff workshop with Colorado River basin collaborators to understand their water operation systems, physical settings, and information gaps; solicit input from them on project goals; and ensure that the project scope is relevant to, and aligns with, collaborators' needs. The workshop included discussion of pilot basins that would be useful to test and validate the model. Collaborators expressed interest in a number of topics:

Upper Colorado River Commission · Six Agency Committee · Bureau of Reclamation · Office of the State Engineer NM Interstate Stream Commission · Denver Water

Basin Collaborators

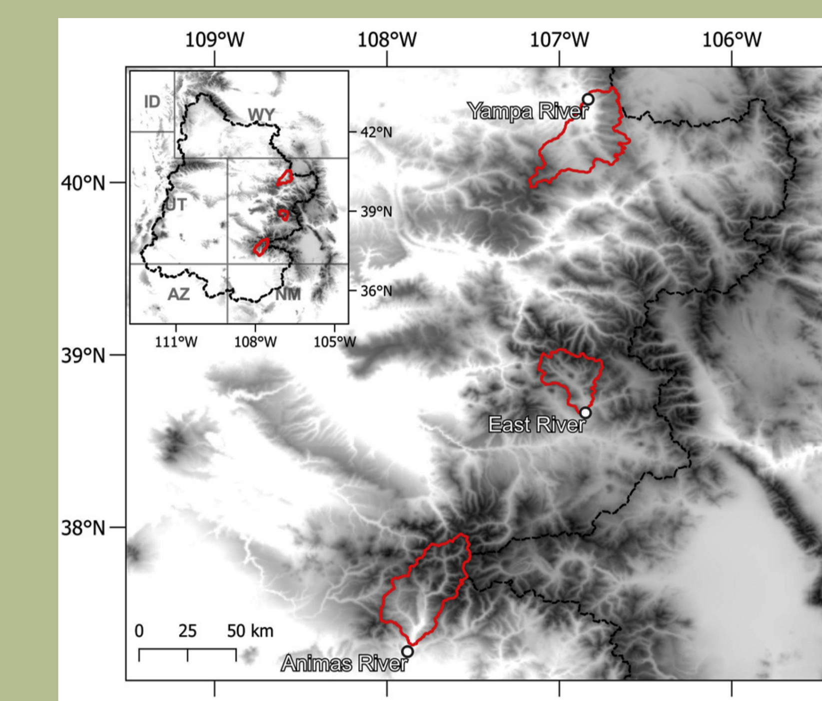
- Understanding future hydrological conditions and the threat of curtailment.
- Implementing a land surface model that could fill gaps in understanding the changes in physical processes under a warming climate and across different scenarios.
- Identifying non-negotiable and more negotiable operations of the system.
- Involving the Navajo Nation and other tribes with rights to the river.
- Understanding what aridification and increased variability in the future look like.
- Using machine learning to enhance reservoir modeling.
- Identifying infrastructure modifications that could respond to water management challenges.
- Including water quality, especially in the Lower Basin.

The modeling team is using the Community Land Model version 5 (CLM5), the terrestrial component of the Community Earth System Model (CESM), to simulate the hydrology of the southwestern US under various scenarios of climate change and water management practices.



SENSITIVITY ANALYSIS

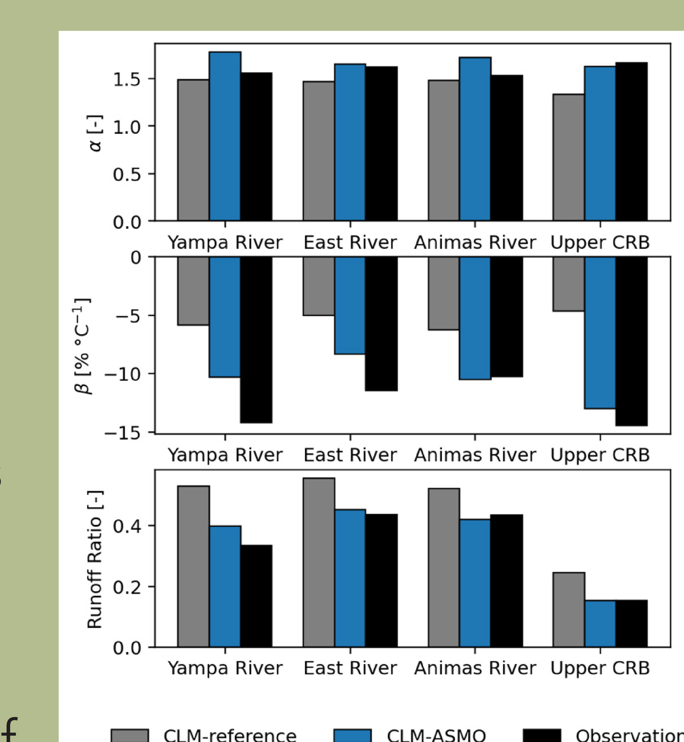
Earth System Models exhibit biases in the partitioning of precipitation between evapotranspiration and runoff and in the sensitivity of this partitioning to climate. These biases are important sources of uncertainty in projections of water availability. To tackle this bias, the team employed machine-learning techniques to analyze sensitivities to temperature and precipitation in three pilot basins (right).



Pilot basins for sensitivity analysis: the Yampa River at Steamboat Springs, the East River at Almont, and the Animas River at Durango.

This analysis involved three steps:

- Parameter Screening: Identify which parameters have the most impact on long-term runoff sensitivities.
- Sensitivity Analysis: How these parameters affect simulated fluxes and alter runoff sensitivities.
- Parameter Optimization: To what extent optimization of these parameters improves simulation of runoff sensitivities?



Pilot basin results before and after optimization (ASMO=Adaptive Surrogate Based Modeling) from Elkouk et al. (in prep.)

Results suggest that the parameters important for predictability of runoff sensitivity in CLM5 over the Upper Colorado headwaters control 1) the partitioning of moisture input into surface runoff and infiltration, 2) the minimum stomatal conductance used to determine transpiration, 3) surface resistance to evaporation from the soil, and 4) soil porosity. Optimization of the most sensitive parameters reduces the overall bias.

Phase II will focus on system modeling.

ACKNOWLEDGEMENTS

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Conducting innovative research in partnership with decision makers in the western US, helping them make the best use of science to manage for climate impacts

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