Arizona Tri-University Recharge and Water Reliability Project

NEWSLETTER

• SUMMER 2025 •

INTRODUCTION

Here in Arizona, we are entering the summer in the hopes of a strong monsoon season, emerging from an exceptionally dry winter. Across our landscapes, soil moisture is low, vegetation is stressed, and fire danger is high. Against this backdrop, it is clear that new and innovative solutions are needed to solve our water issues, and more information is needed to support interest in recharge across the state.

The Arizona Tri-University Recharge and Water Reliability Project (ATUR) is working to identify possible new supplies of water across Arizona and to provide screening tools to support recharge planning. ATUR is a research project funded by the Arizona Board of Regents at the request of the Arizona Department of Water Resources. The project is focused on identifying opportunities to enhance water supplies through capture of precipitation that would otherwise evaporate. Our work has reinforced prior studies that estimated that more than 95% of the water that falls on Arizona's land surface evaporates, sublimates[1] or transpires[2] through plants before reaching a channel or recharging groundwater. Capturing even a small percentage of this water for groundwater aquifer recharge or direct use could provide additional supplies for Arizona's communities and ecosystems.

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[1] Sublimation is direct loss of snowpack to the atmosphere without melting – the water passes directly from a solid state to water vapor. This occurs more frequently at higher air temperatures.

[2] Transpiration is the process through which water is lost as vapor through plants' leaves, stem, and flowers.

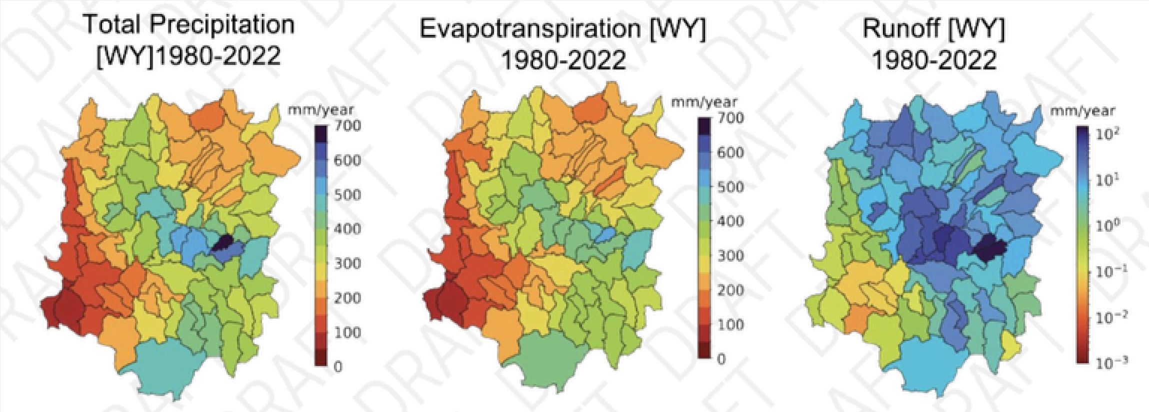

Figure 1. Maps of hydroclimate fluxes across the State of Arizona from 1980-2022 developed using the Noah-MP land surface model and the National Water Model validated with observational datasets from across the state of Arizona. From Moiz and Mascaro (in review)

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Highlights from Years 1-3 of the ATUR Project

Using a multi-disciplinary approach, the ATUR team is tackling how to capture this “lost” water and studying Arizona’s hydrologic fluxes[3], noting the large volumes of water lost through evaporation and transpiration, opportunities for urban stormwater capture, and best practices for producing usable science.

Our Recharge Enhancement & Alteration Subteam (Recharge Team) has been focusing on **understanding how surface and subsurface geology influences recharge**, including analyzing karst (limestone) landscapes and other geologic features, such as faults, capable of facilitating rapid recharge. We researched an array of recharge techniques and completed a study on the role of groundwater in supporting streamflow across the state. In addition, we developed a **baseflow index that illustrates where streams are gaining versus losing water to underlying aquifer systems**. This research resulted in maps of annual baseflow-derived recharge estimates for each basin, and identification of stream reaches where additional flow could lead to enhanced recharge (see Figure 2).

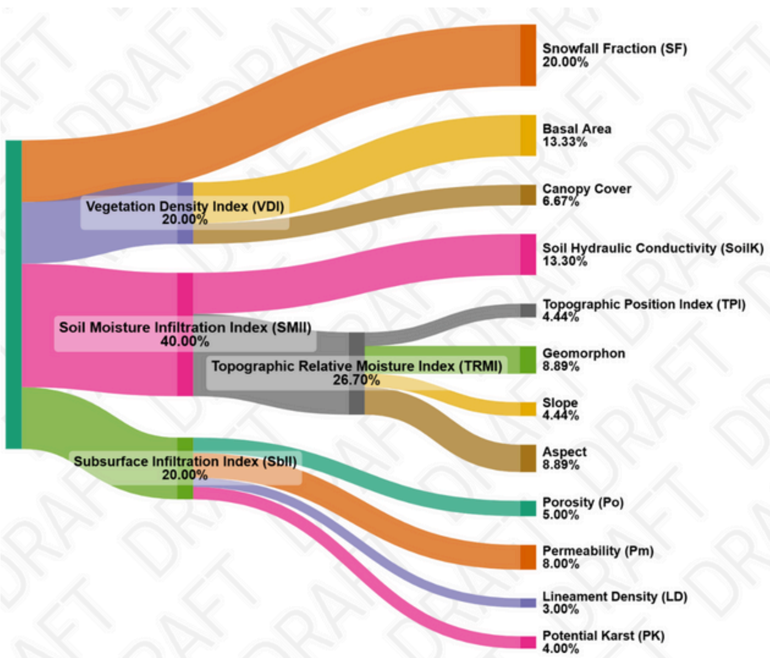


Figure 2. Recharge suitability mapping schematic diagram for forest thinning recharge suitability. From Lima et al. (in review)

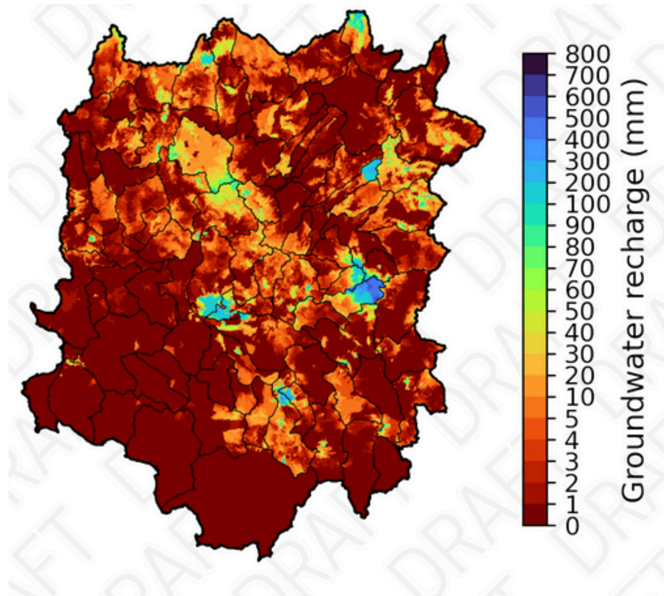
In a publication currently under review, members of our Forest & Natural Environments Subteam (Landscape Team) along with our Recharge Team conducted an analysis of ponderosa pine forests in northeastern Arizona to **assess where tree thinning may enhance recharge**. A long list of factors is relevant to the suitability of forest thinning to enhance recharge, including annual and winter precipitation estimates, the slope and aspect of the land surface, the density of trees, the presence or absence of fractures and fissures at the land surface, and many others. Overlaying these factors revealed **areas of high and low suitability across the forests** that were studied. More than 1.9 million acres of forest was deemed suitable for thinning to enhance recharge. Similar suitability analyses can be conducted for other land management practices across the state to understand where to focus recharge efforts.

The Landscape Team has also been focused on finding ways to **support natural habitat in the context of maximizing the capture and recharge of water** that is currently lost to our water cycle. An emerging topic is clarifying the benefits of enhancing infiltration in some areas even if there is no net gain to the aquifer itself.

[3] Hydrologic fluxes are the ways that water moves between phases of the hydrologic cycle, such as evaporation, precipitation, transpiration, surface water discharge or recharge.

Our Hydroclimate Subteam (Hydroclimate Team) is using highly calibrated versions of two computer modeling softwares – the National Water Model (NWM) and the Noah Multi-Parameterization (Noah-MP) land surface model – to **examine Arizona's hydrologic system under past, current and alternative future climates**. We have simulated the key components of the water budget – precipitation, evapotranspiration, surface runoff, and recharge – during the last 40 years and produced geospatial maps of seasonal and annual climatological averages of the water balance components in a gridded format and aggregated over the surface and groundwater basins. The modeling shows that, on average across the state, less than 4% of annual precipitation is converted to recharge. The figure to the right (Figure 3), in which the majority of the state is shown in red, illustrates that **according to the models, very little natural recharge is occurring across the state**.

Figure 3. Long-term mean (1981-2020) annual groundwater recharge. From Moiz and Mascaro (in review)



Maps and data depicting the water balance components will be accessible by stakeholders and practitioners, who can use them to **support water resources planning and management studies**. We are currently exploring how the water balance components will change in a future warmer climate. These basin water balance estimates will be used by the other teams in their analyses of recharge potential across the state.

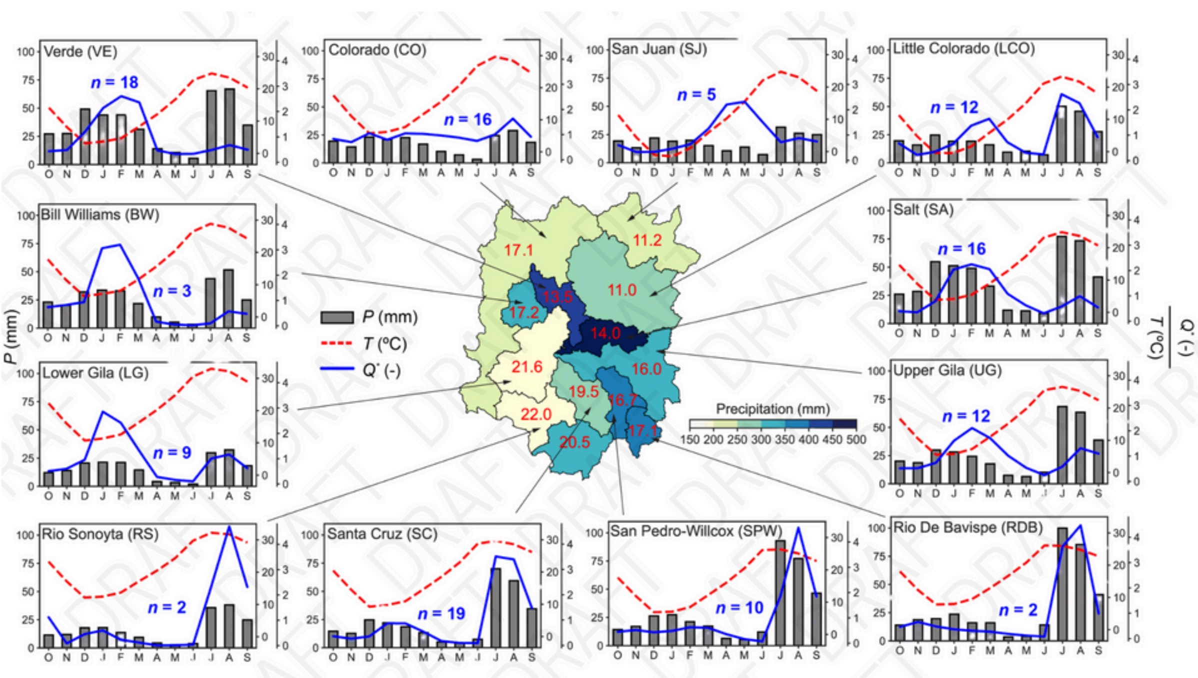


Figure 4. The monthly hydrologic fluxes of precipitation (P), temperature (T), and runoff (Q) for 12 main watershed basins in Arizona. The central map reports the values of the mean annual P and T. From Moiz and Mascaro (in review)

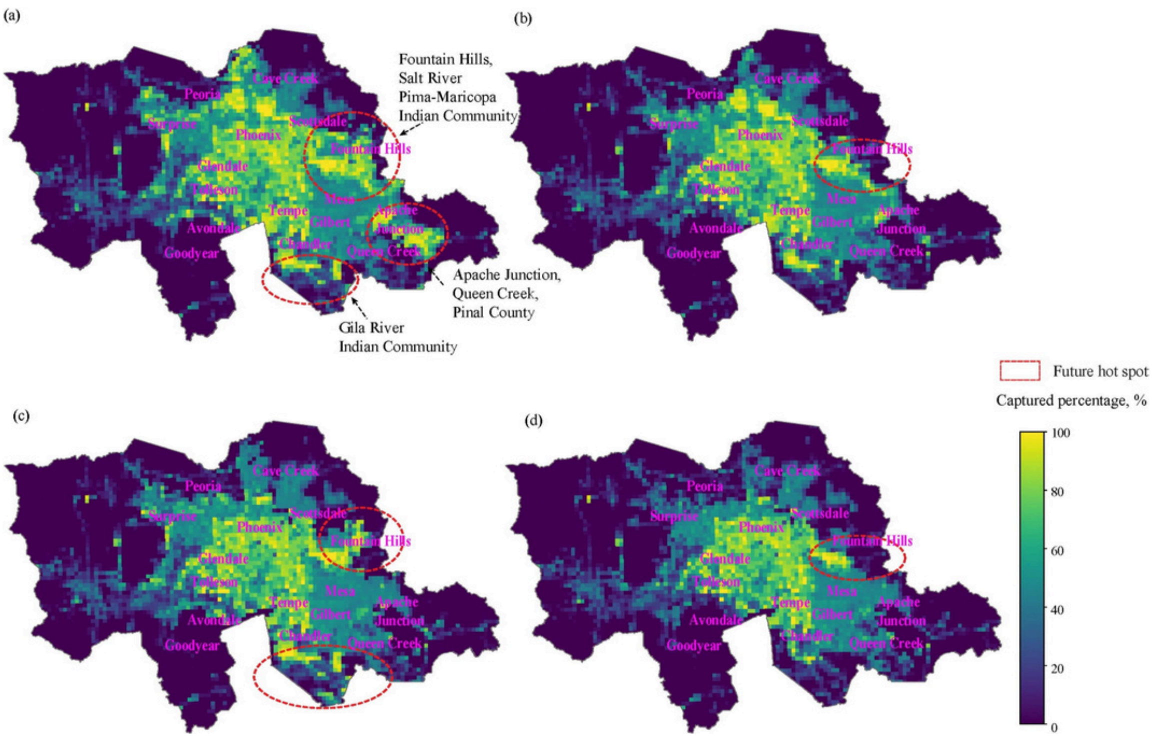


Figure 5. Example of stormwater capture potential of retention ponds and drywells in the Phoenix Active Management Area using a novel curve number-based method, retention and detention pond detection algorithm, and future land cover and climate change scenarios. From Su et al., 2025 published in City and Environment Interactions.

Another area of focus for the ATUR project is understanding and quantifying the **opportunities that exist within urban systems to capture stormwater runoff and augment water supplies.** Our Urban Environments Subteam (Urban team) is developing estimates of future stormwater generation in both current and projected future climates in areas projected to urbanize over the next century. The team is also assessing areas in which flooding and recharge potential align across the state through a GIS-based suitability analysis. Using precipitation and land use data, the subteam is quantifying urban runoff that could be captured and potentially recharged through using stormwater management features that include retention/detention basins and drywells. **The publication detailing this work can be read here.**

Evapotranspiration (ET) has emerged as a major focal point in our research. ET is responsible for the largest loss of water to the atmosphere in Arizona's hydrologic cycle, but it is the hardest component to measure. When so much water is lost to ET, even a small reduction in ET may have a significant impact on recharge potential. Without direct ET measurements, researchers must rely on models and estimates, which can vary widely. A major focus for our researchers - across subteams - has been to understand the various methods of estimating this elusive value on a statewide scale. The team has made great strides in this research, most notably by **developing and comparing multiple methods of estimating ET across Arizona**- including model-based ET and satellite-based ET- and **generating several statewide maps of these estimates**. The team is now in the process of developing a review paper of different methods for estimating ET in Arizona with analysis and results specific to AZ, work that will surely help to advance future research in capture and recharge.

Stakeholder Engagement

Stakeholder and community engagement is critical to ATUR's efforts to ensure that the project produces useful and credible information. The ATUR team meets regularly with ADWR staff to update them on our progress and answer their questions, and we also engage with an external technical advisory committee on a regular basis. To engage more broadly with stakeholders, our team has held more than 60 meetings and workshops with 30+ organizations to date. In March 2024, we met with practitioners from Flood Control Districts (FCD) across the state to discuss barriers and opportunities at the intersection of flood control and groundwater recharge. Regulatory, funding, and data availability constraints were highlighted as major barriers, while opportunities discussed included collaboration with multi-stakeholder coalitions, articulating community and ecosystem benefits, and more. A white paper was developed to share these findings and can be accessed here.

In December 2024, we partnered with The Nature Conservancy to co-host a Grasslands Hydrology workshop with a panel of experts across Arizona to discuss the state of knowledge of grasslands hydrology. While grasslands in Arizona are not known for their high recharge potential, several site-specific conditions and land management strategies may help mitigate grassland degradation and contribute to enhanced infiltration and recharge potential. Additional findings from this workshop are documented in a white paper that can be found here.

Working with bridging organizations including University of Arizona Cooperative Extension and Federally Recognized Tribes Extension Program (FRTEP) as well as the Indigenous Resilience Center (IRes) at the U of A, the engagement team is focused in particular on working with Indigenous communities. Engagement efforts thus far have included individual meetings with Tribal environmental professionals to discuss how ATUR findings and project deliverables can help support their priorities, as well as Tribal youth engagement events focused on hydrologic science. We are planning to co-host a workshop for Tribal environmental professionals in Fall 2025.

Looking Ahead

The ATUR project continues through the first half of 2026. In the interim, we will be producing multiple products to support the AZ Department of Water Resources and others as they manage Arizona's water supplies. Products include: a summary report, a series of maps and data sets, story maps, research publications, and more. Visit our newly designed website at ccass.arizona.edu/atur to find a range of draft products and data!

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