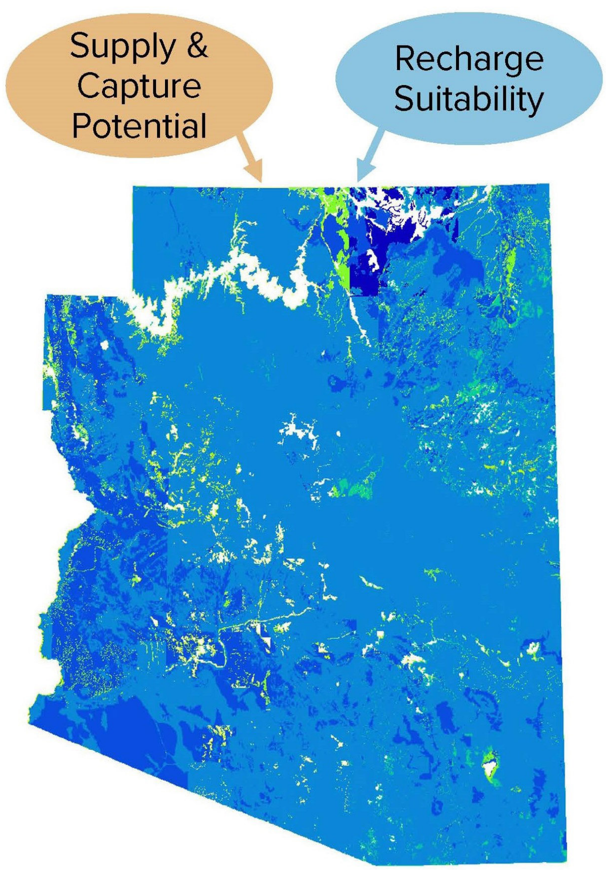
ARIZONA TRI-UNIVERSITY RECHARGE & WATER RELIABILITY PROJECT

YEAR 1

The Arizona Tri-University Recharge and Water Reliability Project (ATUR-WRP) is a research study 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 before reaching a natural or constructed channel. Studies estimate that more than 90% of the water that falls on Arizona's land surface evaporates, sublimates or transpires through plants before reaching a channel or recharging groundwater (e.g., Harshbarger et al., 1966). Capturing even a small percentage of this water could provide additional supply for Arizona's communities and ecosystems.

Using an integrated approach, the ATUR-WRP team is tackling how to capture this lost water through a series of guiding research questions: What are ways to enhance and protect water supplies by capturing precipitation that would otherwise not reach a channel before it evaporates? Where are locations where recharge can occur, and do these locations overlap with where evaporating water can be captured? What are land and vegetation practices that can enhance water availability? We hope to answer these questions and to create a framework based on our scientific analyses that helps guide future physical recharge project development by Arizona's land and water managers.

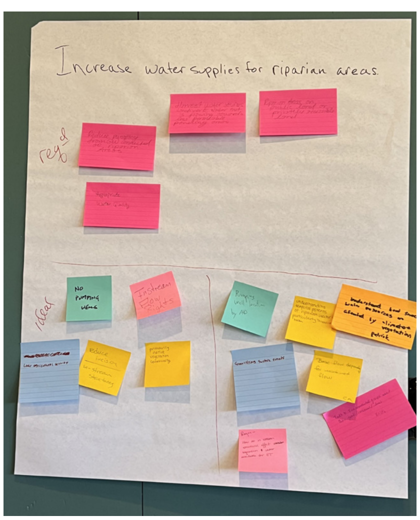
CAPTURE
Playas
Ponding after storms
Sublimation of snow
Soil evaporation
Loss from flowing streams/marshes
Losses from reservoirs and lakes
ET from riparian vegetation
ET from forests
ET from rangelands
Contribution from impervious surfaces (e.g. urban areas)



RECHARGE
Enhanced Urban Recharge
Increase retention basin & dry well coverage
Redesign impervious area network
Enhanced Streambed Recharge
Capture/manage extreme events
Capture sheet flow & direct towards streambeds, riparian areas
Enhanced Distributed Recharge
Reduce ET (e.g. thinning)
Capture sheet flow on alluvial fans
Enhanced Mountain Front Recharge
Add retention structures
Redirect sheet flow towards fractures & faults
Enhanced Focused Recharge
Infiltrate through karst features
Capture of/Reduce ET from closed basins, depression features
MAR & Constructed Options
Injection wells
Spreading basins

During Year 1 (2023), we recruited the full team of researchers, 28 members total, including post-doctoral scholars and graduate students. Spread across the University of Arizona, Northern Arizona University, and Arizona State University, the task of integrating such a large team required careful consideration of research methods and data sharing. Team members were divided into five interdisciplinary subteams that focus on subject areas within the larger project: Hydroclimate, Recharge Enhancement/Alteration, Urban Environment, Forest & Natural Environments, and Stakeholder & Partner Engagement. The subteams meet on a biweekly basis, alternating with full team meetings in which we co-develop our strategies for creating our deliverables.

The team held a multi-day retreat in February 2024 to review Year 1, share initial results, discuss methodologies, and learn how the subteams could support each other by conducting analyses across consistent spatial and temporal scales. Each subteam then developed a work plan for the next year.

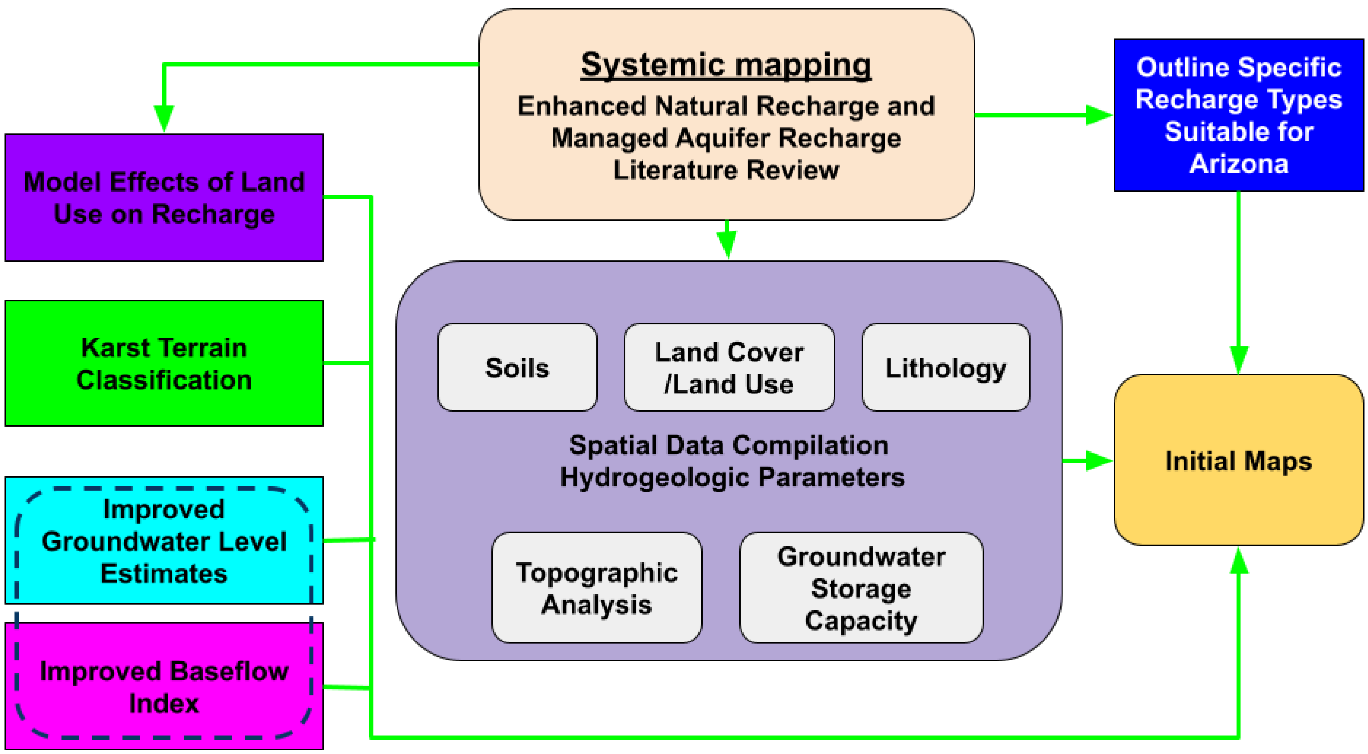


During the retreat, the team shared findings, compared approaches, and identified research questions. Evapotranspiration (ET) emerged as a topic of interest to all teams, including discussion of new sources of data from the ECOSTRESS satellite (ecostress.jpl.nasa.gov/instrument).

The team used multiple strategies to gather input and share ideas, including facilitated discussions and a world café.

RECHARGE ENHANCEMENT/ALTERATION

The Recharge Enhancement/Alteration Subteam studies locations of natural recharge and analyzes options for enhancing recharge. During Year 1, the team focused on understanding how geology influences recharge, including analyzing karst landscapes and other geologic features, such as faults, capable of facilitating rapid recharge. The subteam conducted literature reviews of Enhanced Natural Recharge techniques, for example, post-fire restoration practices, and Managed Aquifer Recharge techniques, such as constructed basins, injection wells and in-stream recharge. Ultimately, the study will create a database and maps with various parameters that can be overlayed to assess recharge suitability by location.



Using a combination of machine learning, remote sensing, and recorded groundwater level measurements, the subteam constructed a depth-to-groundwater map covering the state during Year 1. In addition, the subteam developed a baseflow index in preparation for publication that indicates how much groundwater baseflow supports rivers in Arizona and where streams are gaining versus losing water to underlying aquifer systems. This research will result in maps of annual baseflow-derived recharge estimates for each basin.

HYDROCLIMATE

The Hydroclimate Subteam focuses on modeling climate and hydrology in order to put estimate the inputs and outputs to the water balance for each basin in Arizona. The subteam is using the National Water Model (NWM) (https://water.noaa.gov/about/nwm) and the Noah-MP Model (https://ral.ucar.edu/model/noah-multiparameterization-land-surface-model-noah-mp-lsm) to examine Arizona's hydrologic system under past, current and alternative future climates. During Year 1, the subteam focused on collection and quality control of ground and gridded (spatial data) observations, including stream flow, precipitation and snow measurements, soil moisture, and satellite-measured evapotranspiration and gravity data. Using these points, the team assessed the performance of NWM outputs (by comparing to historical observations) and began developing bias correction tools. The results of Year 1 will seed targeted modeling in Year 2, particularly over regions producing higher levels of surface runoff and evapotranspiration. Comparing these locations with surface elevation maps may identify depressions where runoff is lost to the atmosphere before entering a channel. The estimates of water amounts moving through each watershed's hydrologic cycle will be used by the Recharge Enhancement/Alteration and Forest & Natural Landscapes teams in their analyses.

URBAN ENVIRONMENTS

The Urban Environments team focuses on excess stormwater produced by the expansion of impervious surfaces during urban development, water that is not appropriated by downstream users and is available for recharge. The team is modeling the overall contribution to groundwater recharge of water originating in urban environments in both current and projected future climate, and under different land use scenarios. Using precipitation and land use data, the subteam is quantifying urban runoff that could be recharged through green stormwater infrastructure, retention/detention basins, injection wells, and managed aquifer recharge techniques. By pairing urban recharge techniques with physical parameters, such as soil characteristics and vegetation, the team will determine appropriate urban recharge methods given location conditions. Recharging water in the urban environment as rapidly as possible can reduce the amount lost to evaporation and assist with flood control.

STAKEHOLDER & PARTNER ENGAGEMENT

During Year 1 of the project, the Stakeholder & Partner Engagement subteam developed a phased engagement strategy to reach stakeholders working in land and water management sectors, including Federal, State, Tribal, environmental, agricultural, and policy organizations. The goals of the engagement strategy are to introduce the project to key members of water-related sectors and gather feedback regarding project areas of focus and methods, identify data and reports to incorporate into the study, and identify potential future partners for recharge projects. In Year 1, the ATUR-WRP team held over 25 meetings with stakeholders throughout the year, presenting project goals, methods, and areas of focus, and gathering feedback. This feedback was then incorporated into research team discussions of how potential analyses could answer stakeholder questions. The project assembled a Technical Advisory Committee with representatives from stakeholder organizations. Committee members bring a wealth of expertise and experience in Arizona water to the project. For Year 2, There are four workshops planned that focus on different stakeholder sectors and we will continue to meet with individual organizations.

FOREST & NATURAL ENVIRONMENTS

The Forest & Natural Environments subteam studies land management practices to enhance runoff and recharge, including forest and grassland management, wildfire-related opportunities, and snow hydrology. During Year 1, the team conducted literature reviews of how vegetation and land management practices affect runoff and recharge in lowland areas, and how management of riparian areas affects channel-bed recharge. Using integrated modeling and satellite-based evapotranspiration monitoring, the team is investigating water budgets in lowland ecosystems. Team members are using mapping and modeling to look at how forest thinning and fires affect how snow accumulates and sublimates (direct loss of snowpack to the atmosphere), impacting runoff and recharge processes. Locations experiencing high sublimation may be locations of potential management to increase runoff and recharge. Modeling of evapotranspiration, water budgets and snow hydrology, including ways to affect the timing and magnitude of snowmelt, will continue into Year 2.

During Year 1, the Forest & Natural Environments subteam's research focused on if and how post-fire and flood mitigation restoration structures, such as rock dams, affect water budgets. Team members at Northern Arizona University are using the Rio De Flag watershed as a case study to look at the effects of fire on water budgets and evapotranspiration rates. The Rio De Flag watershed experienced multiple fires in recent years, the Shultz Fire in 2010, the Museum Fire in 2019, and the Pipeline Fire (pictured left) in 2022. Restoration structures built since the fires, for example the structure pictured right in Schultz Creek, slow runoff and may change the volume of water that evapotranspires and/or recharges.

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