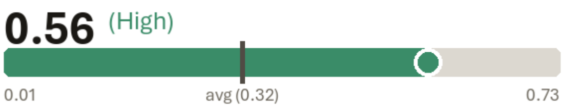
Aravaipa Canyon Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 517 square miles
Elevation[2]: Range: 2,456-8,415 ft; Median: 4,523 ft
Top 3 land cover types by area[3]: Shrub/Scrub (87%), Evergreen Forest (12%), Grassland Herbaceous (0.44%)
Major surface watershed(s)[4]: Lower San Pedro
Groundwater subbasins[1]: None
Groundwater-derived streamflow fraction[5]:



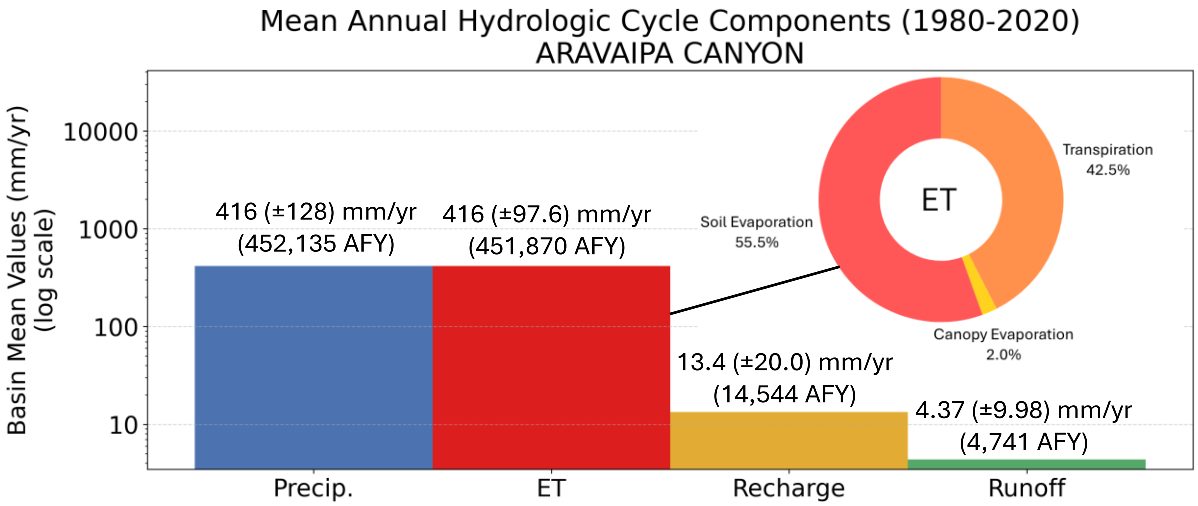


Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration. It is possible for ET to be greater than P when there are other sources such as groundwater, surface water, or water in storage.

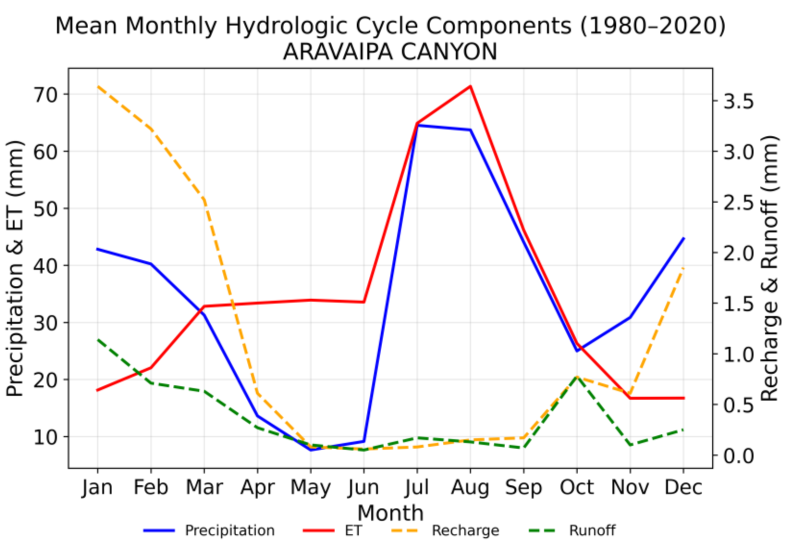


Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) on average across the basin. P in the Aravaipa Canyon basin is affected by the North American Monsoon during the summer months. ET is greater than P from March to June and tracks with P from July to October. Soil evaporation makes up 55.5% of total ET in the basin, while transpiration comprises 42.5% and canopy evaporation accounts for the remainder (2.0%). Natural recharge (13.4 mm/yr) and runoff (4.37 mm/yr) are greatest in January due to winter precipitation and relatively low evaporative demand during the cooler months. Groundwater supplies an estimated 56% of total streamflow in the basin.

Aravaipa Canyon

Figure 3 (below). Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.[6] Major cities/towns[7] and Native American Reservation boundaries[8] are shown (as applicable) to help orient the reader.

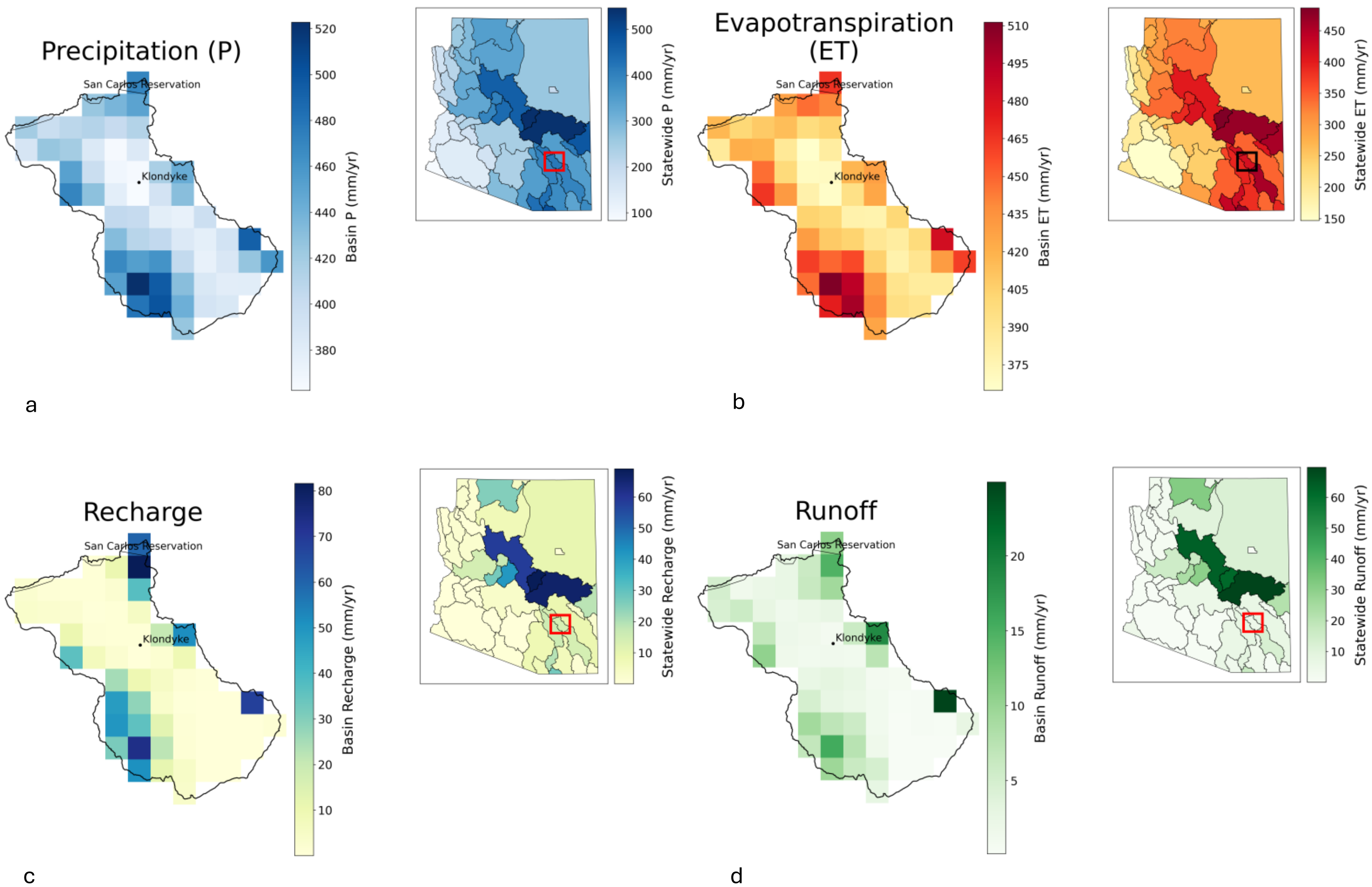
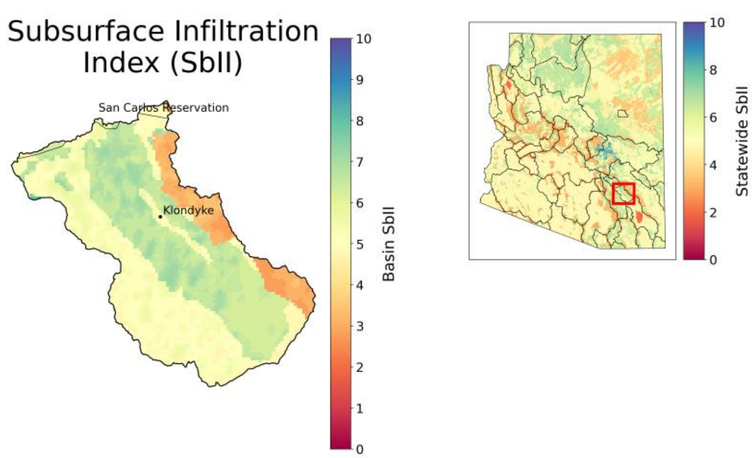


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



Precipitation in the Aravaipa Canyon basin is highest in the high-elevation areas of the basin, including the Galiuro Mountains to the southwest, the Santa Teresa Wilderness to the northeast, and Mount Graham to the southeast. These regions receive over 500 mm/yr of precipitation on average. Evapotranspiration (ET, ~500 mm/yr), natural recharge (~60 mm/yr) and runoff (~15 mm/yr) are greatest in these regions. Subsurface infiltration potential is moderate to high across the basin due to the presence of conglomerates containing limestone along Aravaipa Creek.

Aravaipa Canyon

Climate Change Projections:
Changes in Temperature, Precipitation, ET, Recharge, and Runoff
(2060-2099 vs. 1981-2020)

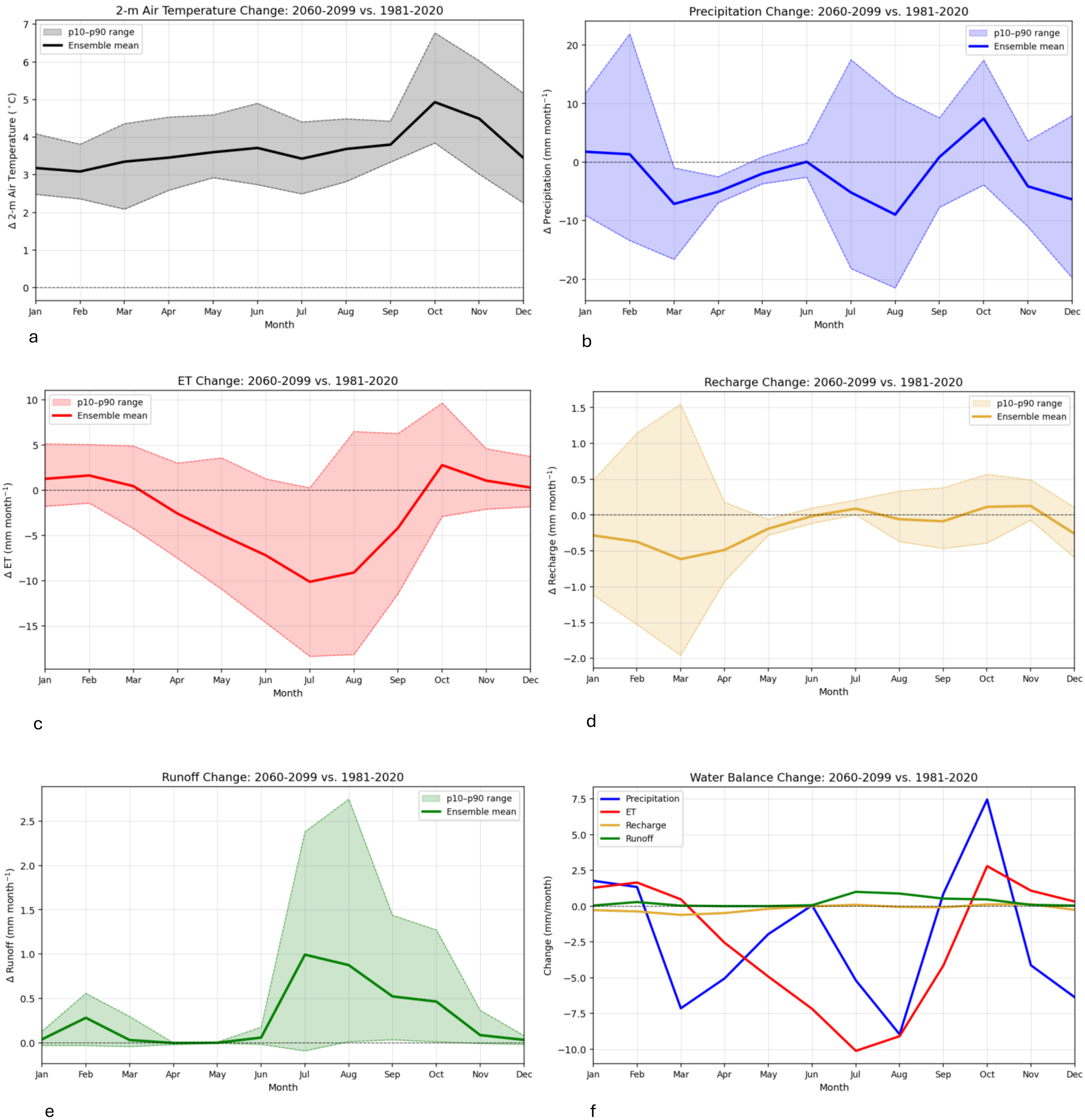


Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change in the water balance components (P, ET, recharge, and runoff) on a single graph for direct comparison. The analysis uses 14 dynamically downscaled global climate models (GCM) at 9-km resolution and the Noah-MP land surface model. The ensemble mean of the 14 GCMs is shown in bold for each component of the hydrologic cycle, with the 10-90th percentile shaded to show model projection uncertainty.

Aravaipa Canyon

Climate change projections across the Aravaipa Canyon basin show less precipitation throughout much of the year, with the exception of January-February (3-4% or 1.3-1.6 mm/month increase) and October, which shows a 30% (7.4 mm) increase in precipitation. The greatest declines in precipitation are projected for March-May (21-40% drier), July-August (8-14%), and November-December (14%). Declines in recharge ranging from 18-24% (-0.34 to -0.62 mm/month) are projected for highest recharge months from January to March. Recharge is projected to be slightly negative in June and July (-0.05 to -0.07 mm/month).* While remaining below 1.3 mm/month, runoff is projected to increase by 0.47-1.0 mm/month from July to October by the end of the century. Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Less water availability from April to August leads to projected declines (7-16% or -2.6 to -10 mm/month) in evapotranspiration (ET) during the warmer months, while higher temperatures and greater precipitation are consistent with a projected 10% (2.7 mm) increase in ET in October compared to the baseline period.

*Projected negative recharge values are attributed to increased capillary rise from the aquifer through the vadose zone due to climate factors, resulting in water loss from the system. Because the Noah-MP model does not include groundwater pumping, this indicates that climate-driven factors play a significant role in groundwater storage decline in Arizona.

References

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