

Verde River Groundwater Basin Profile



Basin Summary Statistics

Size¹: 5,662 square miles

Elevation²: Range: 1,731-12,621 ft; Median: 5,293 ft

Top 3 land cover types by area³: Shrub/Scrub (59%), Evergreen Forest (37%), Grassland Herbaceous (1.2%)

Major surface watershed(s)⁴: Upper and Lower Verde River

Groundwater subbasins¹: Big Chino, Verde Valley, Verde Canyon

Groundwater-derived streamflow fraction⁵:

0.45 (Moderate)



Mean Annual Hydrologic Cycle Components (1980-2020) VERDE RIVER

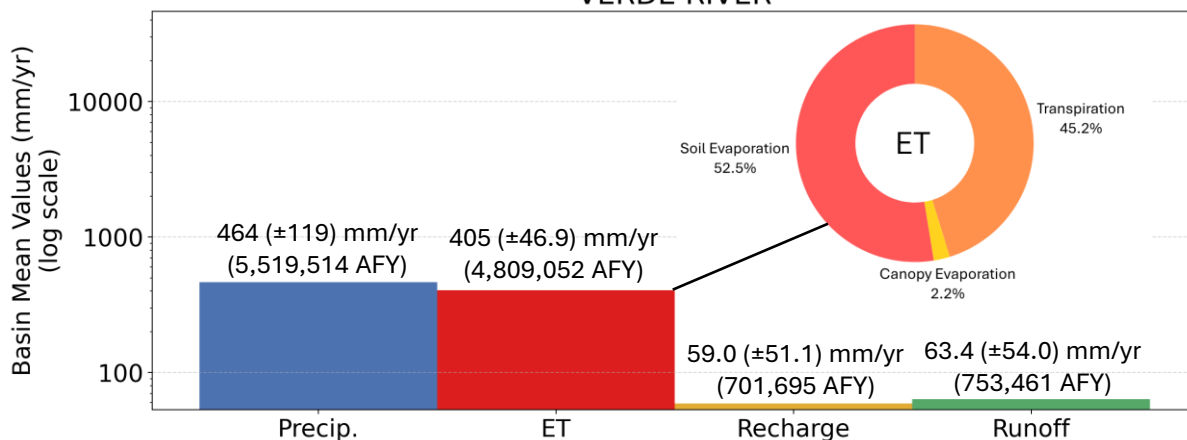


Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.⁶ ET is partitioned into soil evaporation, canopy evaporation, and transpiration. It is possible for ET to be greater than P when there are other sources such as groundwater, surface water, or water in storage.

Mean Monthly Hydrologic Cycle Components (1980-2020) VERDE RIVER

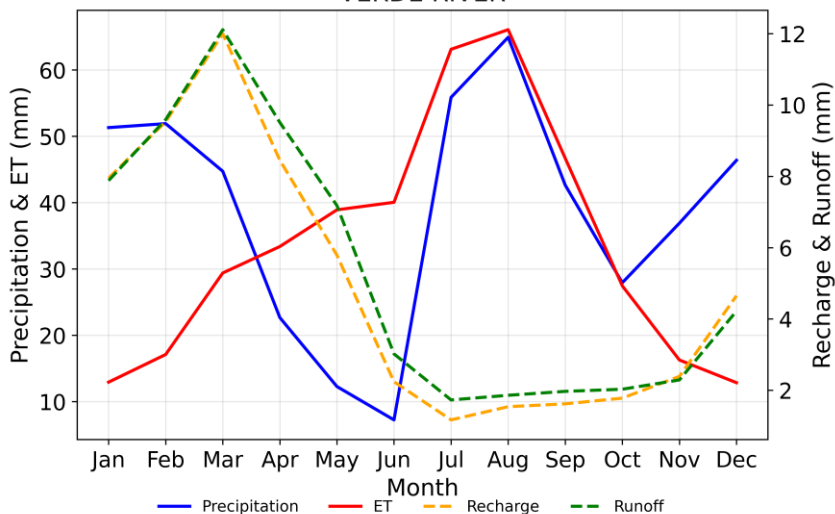


Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.⁶

Precipitation (P) in the Verde River basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. P exceeds evapotranspiration (ET) from October through mid-March, leading to higher amounts of recharge and surface runoff than other nearby basins during the cooler months. Natural recharge (59.0 mm/yr) and runoff (63.4 mm/yr) are highest in March as a result of springtime snowmelt and low evaporative demand. Soil evaporation makes up 52.5% of total ET in the basin, while transpiration comprises 45.2% and canopy evaporation accounts for the remainder (2.2%). Groundwater is estimated to supply 45% of total streamflow in the Verde River basin. 1

Verde River



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/towns⁷ and Native American Reservation boundaries⁸ are shown (as applicable) to help orient the reader.

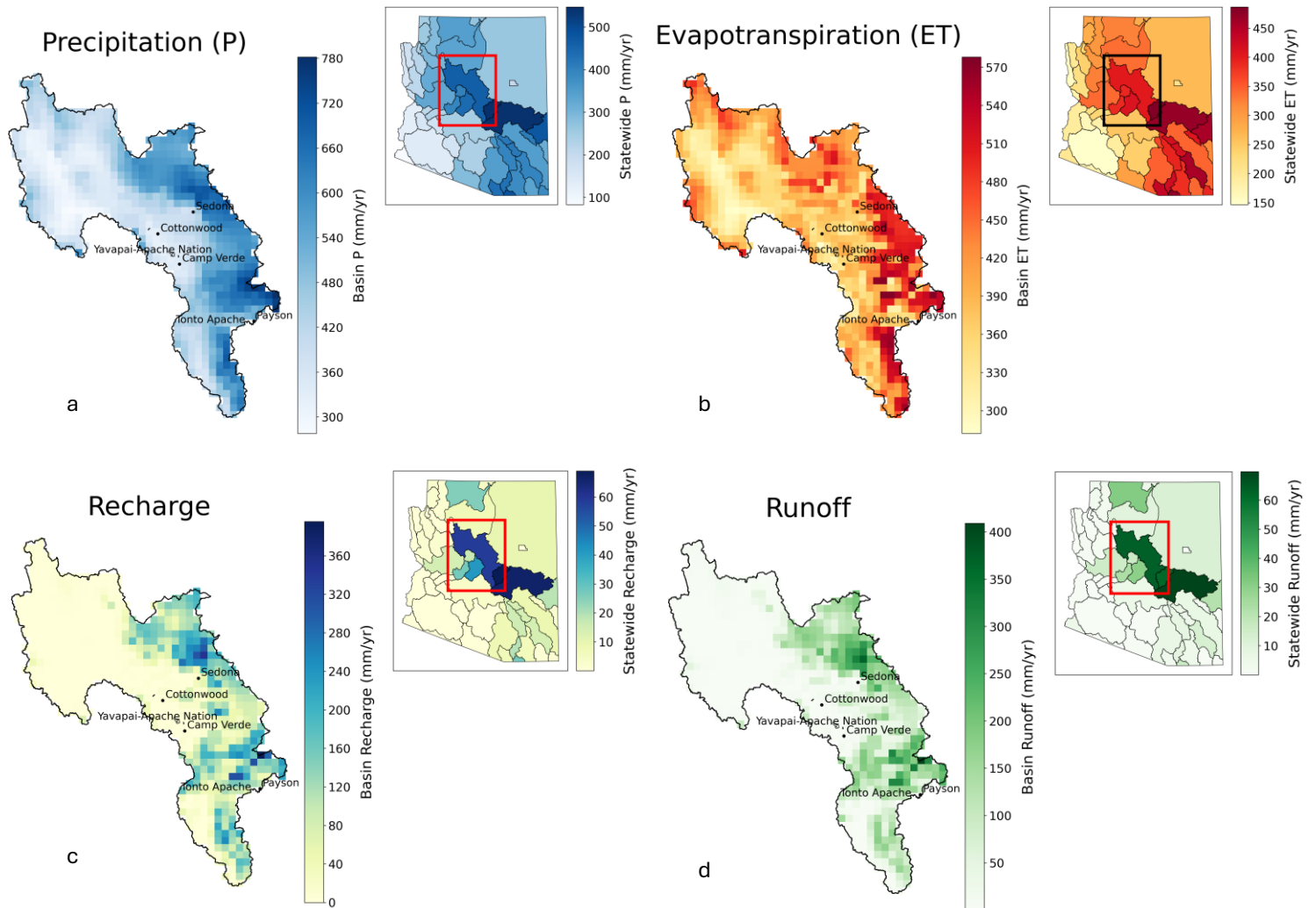
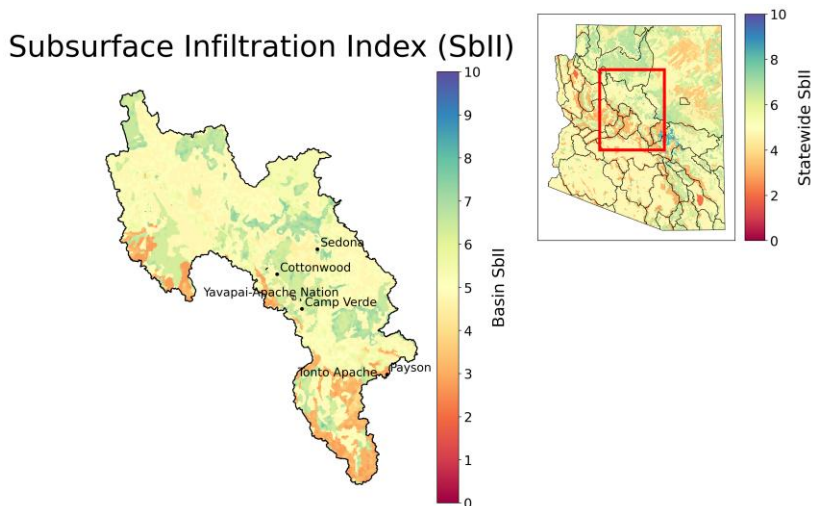


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.⁹



Precipitation (P) in the Verde River basin is greatest at the higher elevations along the Mogollon Rim, where P can exceed 700 mm/yr on average. ET (>520 mm/yr), natural recharge (>300 mm/yr), and runoff (>300 mm/yr) are also highest in along the Rim and the Mazatzal Mountains. Overall, the basin has moderate infiltration potential with pockets of higher potential. Areas with higher potential result from presence of faults and karst-type geology as well as alluvial deposits along the Verde River.

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

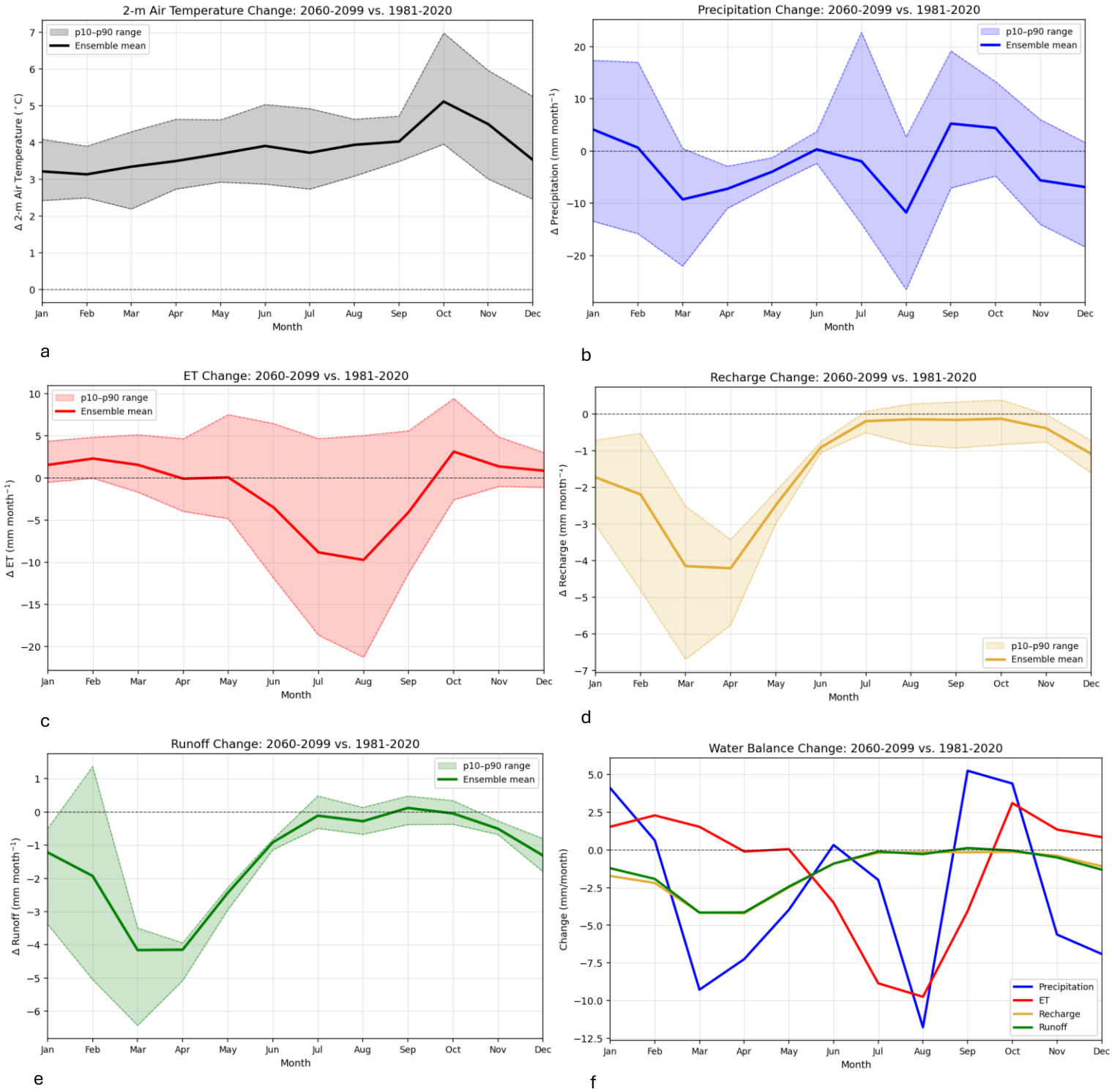


Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.¹⁰ Plot (f) shows the change in 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.



Climate change projections across the Verde River basin show drier springs (19-34% drier March through May) and a drier August (17%), November (16%), and December (14%). September and October are projected to be 12-14% (4.3-5.1 mm/month) wetter on average, which is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity by the end of the century. Declines in natural recharge are projected for most months of the year, with the highest recharge months (February-April) showing declines of 44-64% (-2.3 to -4.3 mm/month), and June-November showing negative recharge (-0.11 to -0.82 mm/month)*. Similarly, runoff is also projected to decrease throughout most months of the year, particularly during the highest runoff months (February-April, -2.0 to -4.2 mm/month). Projected increases in temperature range from approximately 3.2 °C in February to 5.2 °C in October. Less precipitation in August leads to a projected 13% (-9.8 mm) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 10% (3.1 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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