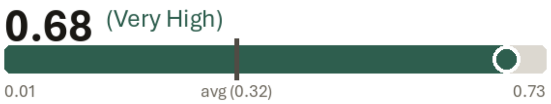
McMullen Valley Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 649 square miles
Elevation[2]: Range: 1,657-5,601 ft; Median: 2,239 ft
Top 3 land cover types by area[3]: Shrub/Scrub (91%), Cultivated Crops (6.5%), Developed – Open Space (0.96%)
Major surface watershed(s)[4]: Centennial Wash
Groundwater subbasins[1]: None
Groundwater-derived streamflow fraction[5]:



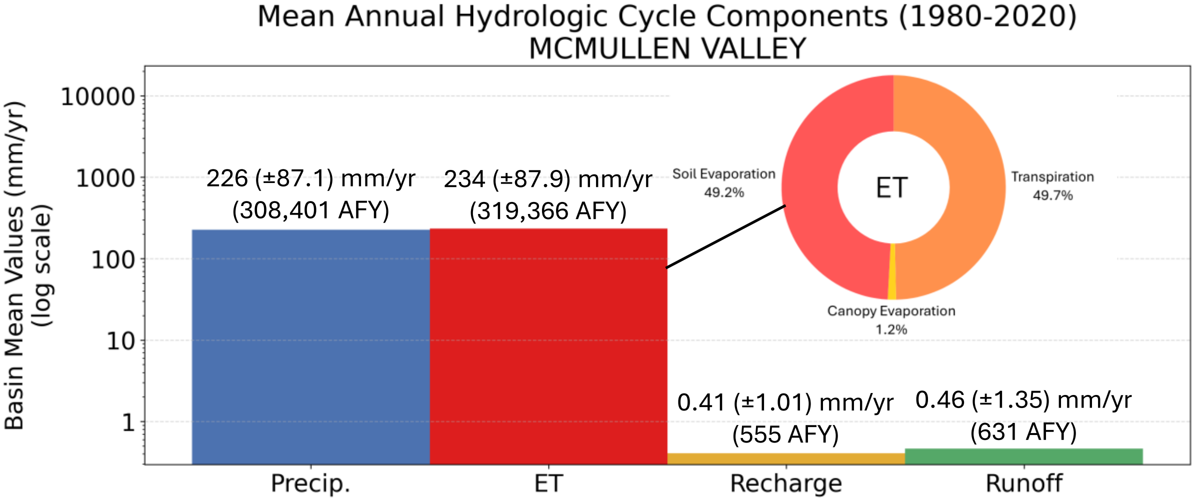


Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration.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

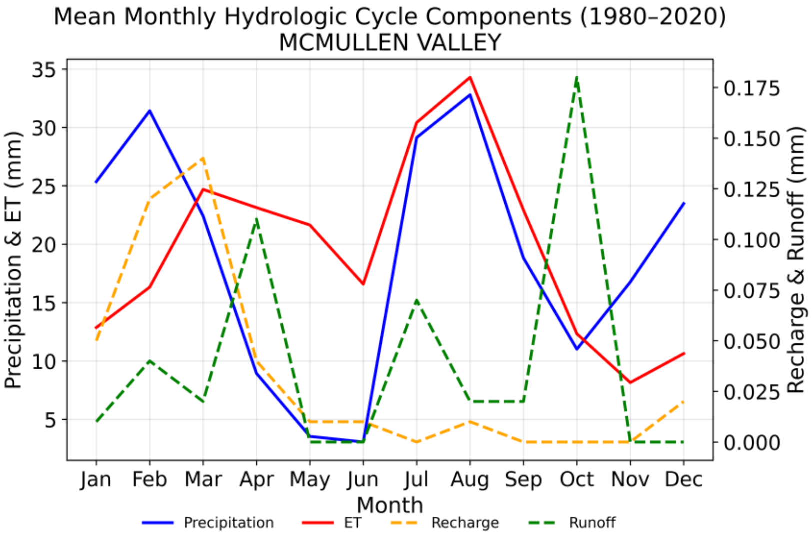


Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the McMullen Valley basin. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P during the warmer months from March to October. Soil evaporation makes up 49.2% of total ET, while transpiration comprises 49.7% and canopy evaporation accounts for the remainder (1.2%).

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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.

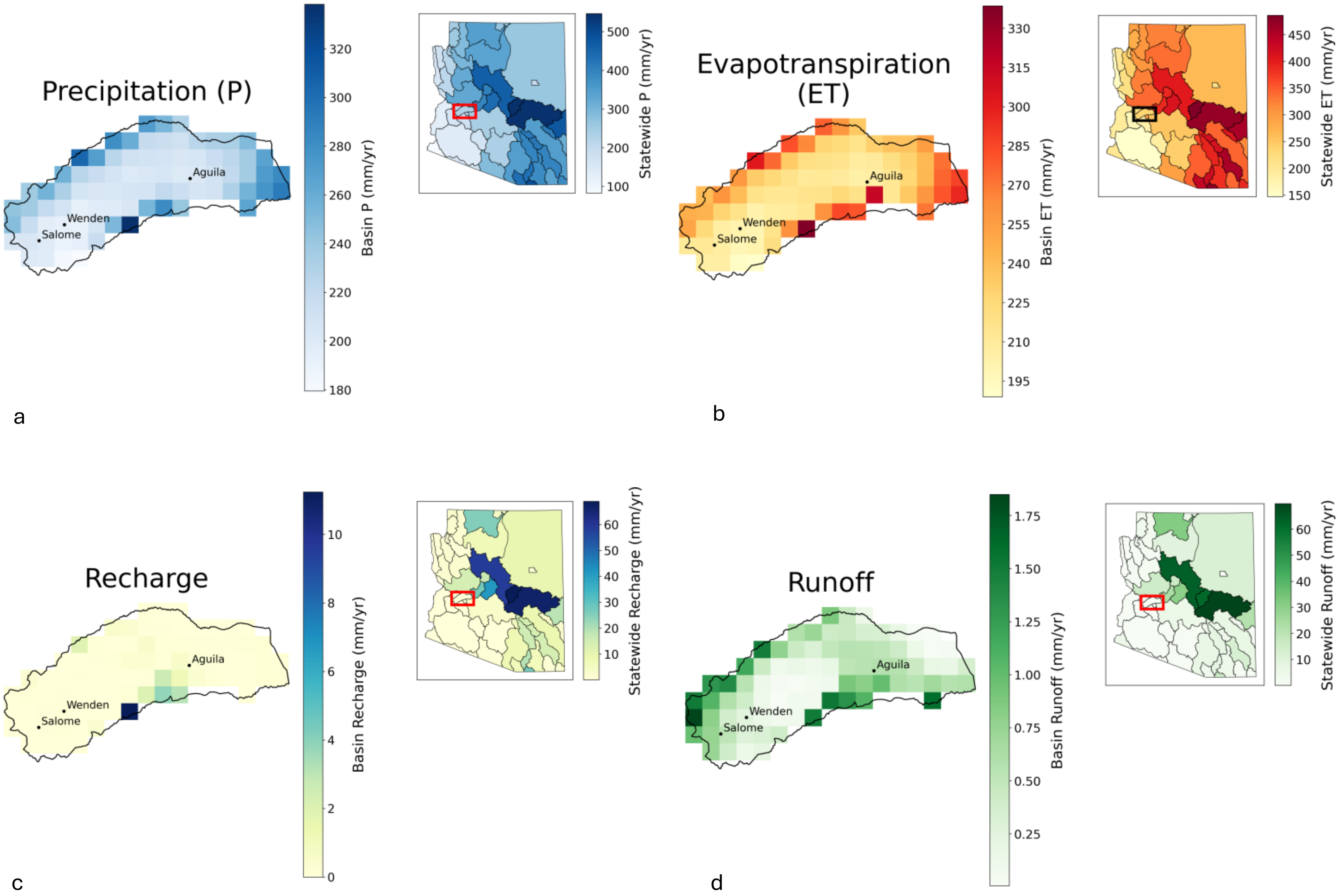
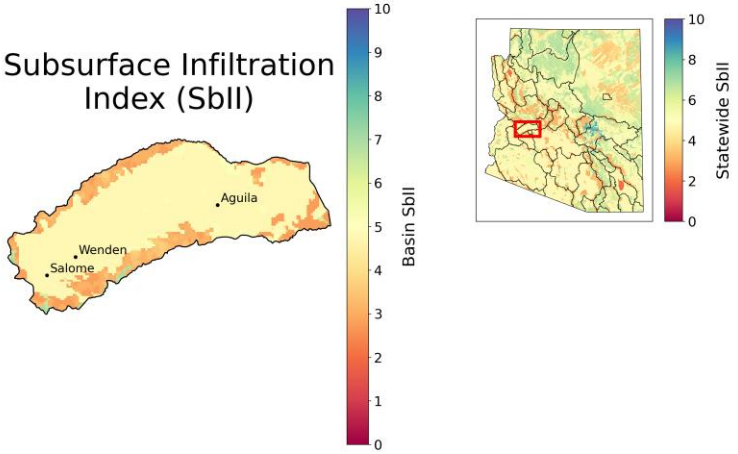


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



Precipitation (P) in the McMullen Valley basin is greatest in the Harcuvar Mountains Wilderness to the north and the Harquahala Mountains Wilderness to the south. Both P and evapotranspiration (ET) can exceed 300 mm/yr on average in these regions. Natural recharge and runoff are minimal (less than 2.0 mm) across the basin; however, modeling shows recharge can exceed 10 mm on average in a section of the Harquahala Mountains. The McMullen Valley basin generally has low to moderate infiltration potential; however, areas of higher infiltration potential are present in small pockets of limestone geology in the Harquahala Mountains.

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

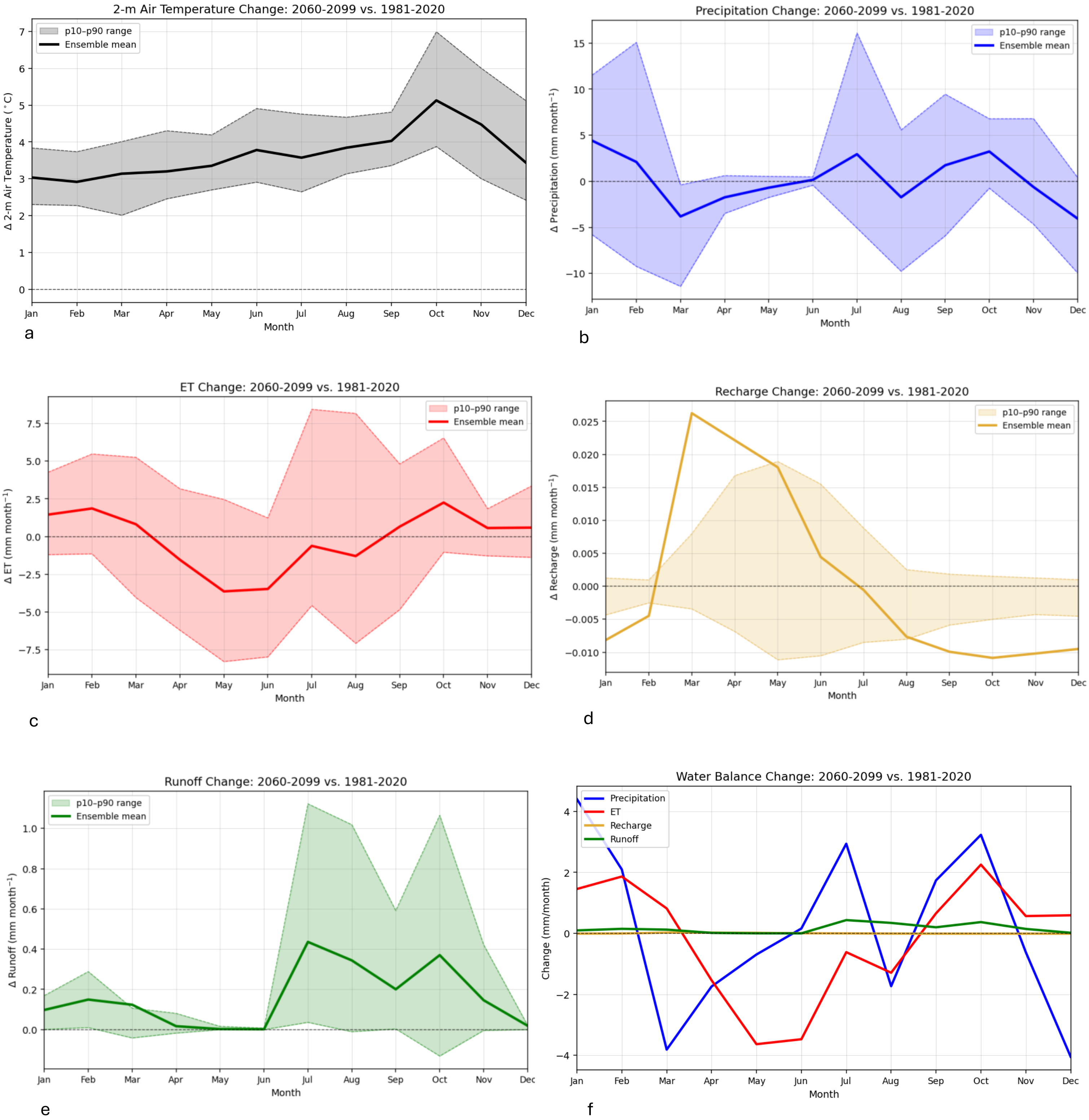

Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change 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.

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Climate change projections across the McMullen Valley basin show drier springs (16-25% drier March through May) and a drier August (5%), November (5%), and December (18%). January (19%), June-July (11-17%), and September-October (9-25%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (1.6-3.3 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (approximately -0.01 mm/month) in January-February and from July through December.* While runoff is projected to remain below 0.5 mm/month, minor increases of 0.15-0.44 mm/month are projected for July-November. Projected increases in temperature range from approximately 3.0 °C in February to 5.2 °C in October. Less precipitation in April and May leads to a projected 7-18% (-1.6 to -3.7 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 17% (2.2 mm) increase in ET in October, a 13% (1.5 mm) increase in January, and a 11% (1.8 mm) increase in February 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.

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