

Tonto Creek Groundwater Basin Profile



Basin Summary Statistics

Size¹: 955 square miles

Elevation²: Range: 2,150-7,956 ft; Median: 4,905 ft

Top 3 land cover types by area³: Shrub/Scrub (53%), Evergreen Forest (43%), Grassland Herbaceous (1.8%)

Major surface watershed(s)⁴: Tonto Creek

Groundwater subbasins¹: None

Groundwater-derived streamflow fraction⁵:

0.47 (Moderate)



Mean Annual Hydrologic Cycle Components (1980-2020)
TONTA CREEK

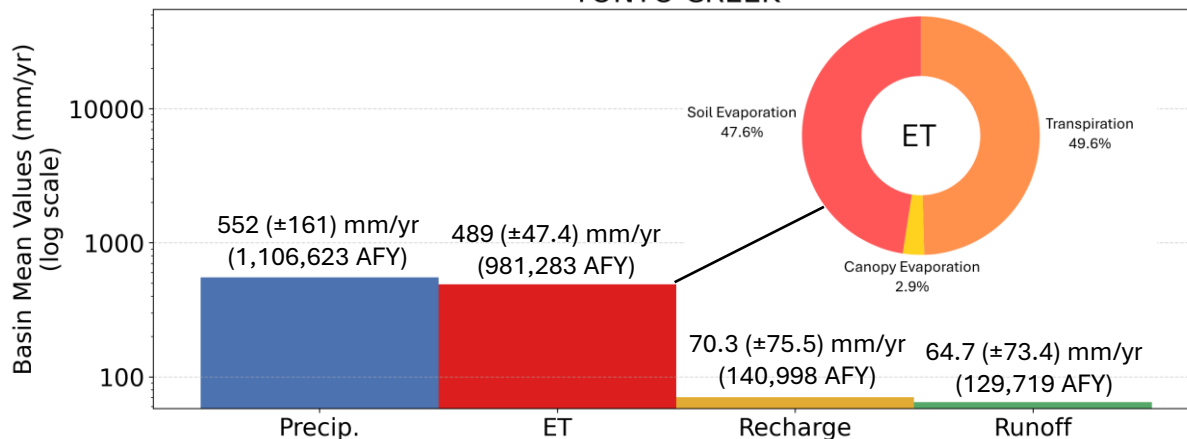


Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.⁶ ET is partitioned into soil evaporation, canopy evaporation, and transpiration. 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)
TONTA CREEK

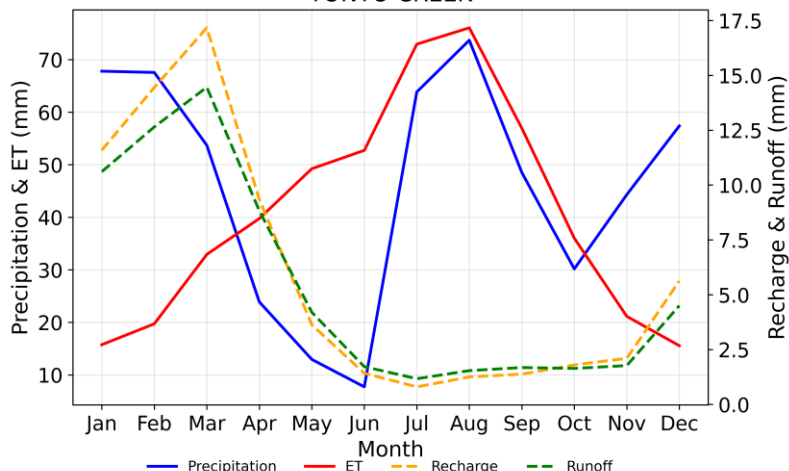


Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.⁶

Precipitation (P) in the Tonto Creek basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. The greatest atmospheric losses occur during the summer months, where evapotranspiration (ET) exceeds P from mid-March through October. The Tonto Creek basin has the highest annual natural recharge (70.3 mm/yr) and second highest runoff (64.7 mm/yr) in the state. Both recharge and runoff are highest in March due to springtime snowmelt and low evaporative demand. Soil evaporation makes up 47.6% of total ET in the basin, while transpiration comprises 49.6% and canopy evaporation accounts for the remainder (2.9%). Groundwater is estimated to supply 47% of total streamflow in the basin.

Tonto Creek



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.

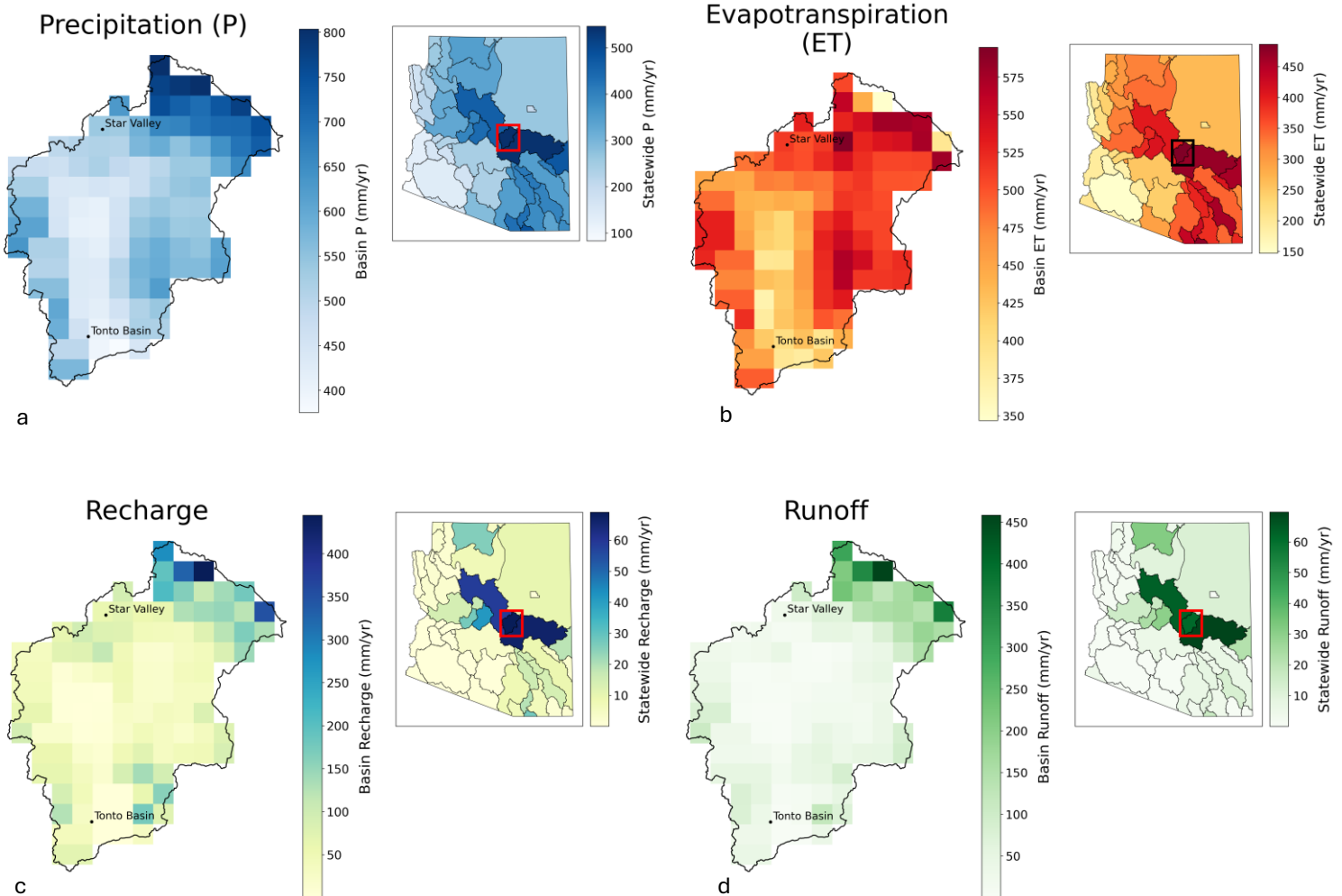
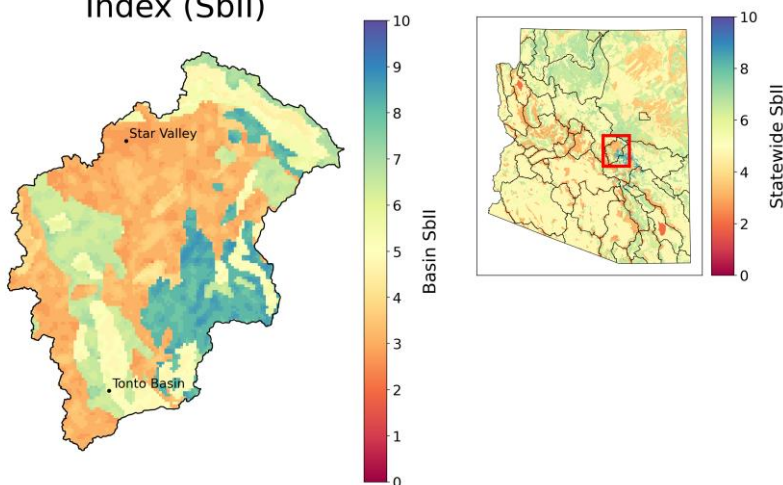


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.⁹

Subsurface Infiltration Index (SbII)



Precipitation (P) in the Tonto Creek basin is greatest on the Mogollon Rim at the northern portion of the basin, where P can exceed 800 mm/yr on average. Evapotranspiration (ET, ~570 mm/yr), natural recharge (300-400 mm/yr) and runoff (300-400 mm/yr) are also greatest in this region. The Tonto Creek basin contains pockets of high infiltration potential due to carbonate (limestone) dominated formations northeast of Tonto Basin and east of Star Valley below the Mogollon Rim.

Tonto Creek



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

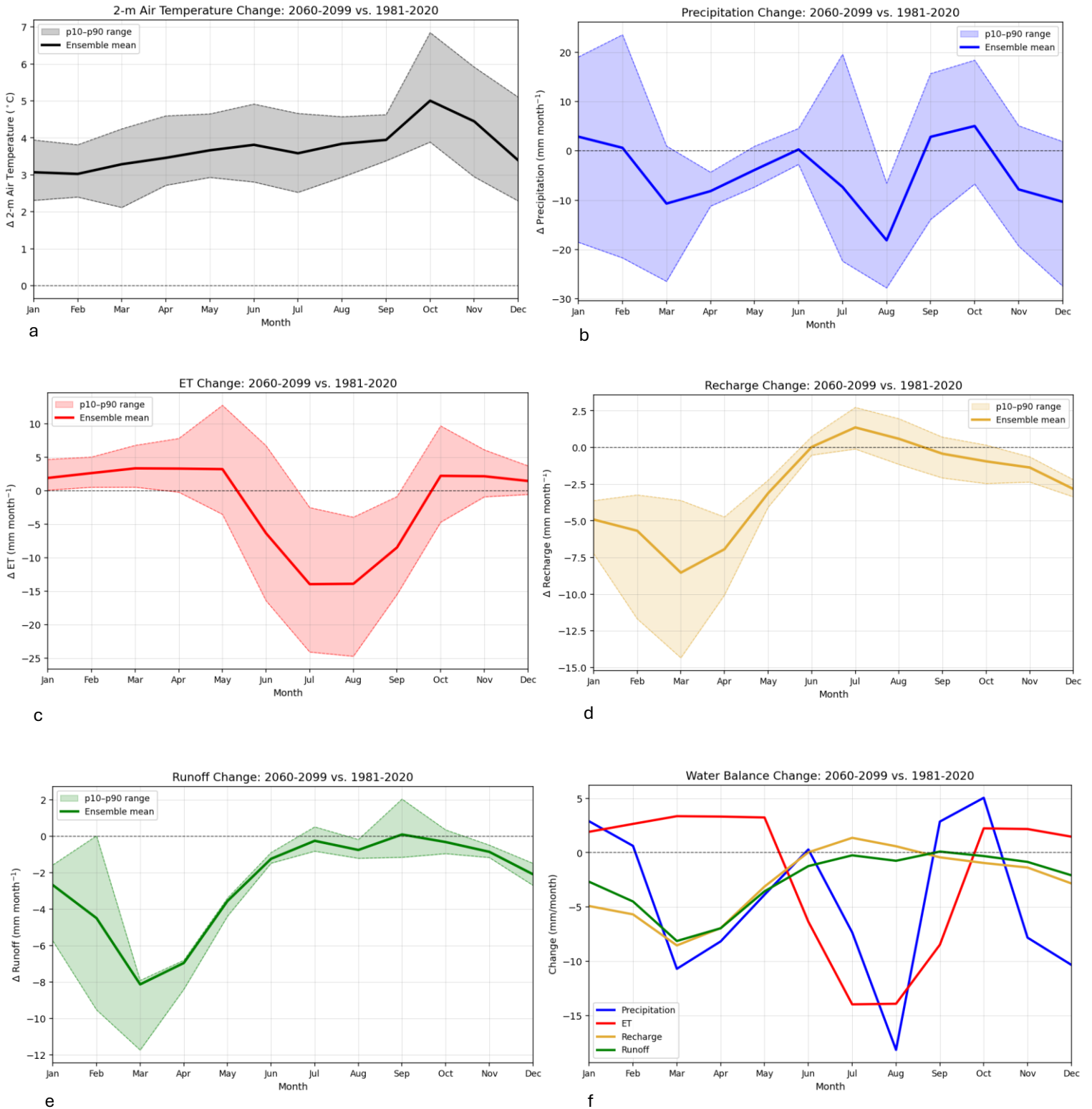


Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.¹⁰ Plot (f) shows the change in 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 Tonto Creek basin show drier springs (18-38% drier March through May) and a drier July (11%), August (23%), November (19%), and December (18%). September and October are projected to be 5-15% (2.6-5.2 mm/month) wetter on average by the end of the century, which is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Declines in natural recharge of 52-59% (-5.9 to -8.6 mm/month) are projected for the highest recharge months (February-April), while projections for June-December show negative recharge (-0.45 to -2.5 mm/month)*. Negative recharge is projected despite less water loss in the system from June through August (shown as an increase from the baseline in Figure 8(d)). Runoff is projected to decrease during most months of the year, with declines of 55-77% (-4.7 to -8.2 mm/month) during the highest runoff months (February-April). Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Less precipitation in August leads to a projected 17% (-14 mm) decrease in evapotranspiration (ET) during that month.

*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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