Safford
Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 4,750 square miles
Elevation[2]: Range: 2,464-10,702 ft; Median: 3,959 ft
Top 3 land cover types by area[3]: Shrub/Scrub (88%), Evergreen Forest (6.0%), Grassland Herbaceous (1.9%)
Major surface watershed(s)[4]: Gila, San Carlos, and San Simon Rivers
Groundwater subbasins[1]: Gila Valley, San Carlos Valley, and San Simon Valley
Groundwater-derived streamflow fraction[5]:

0.54 (High)

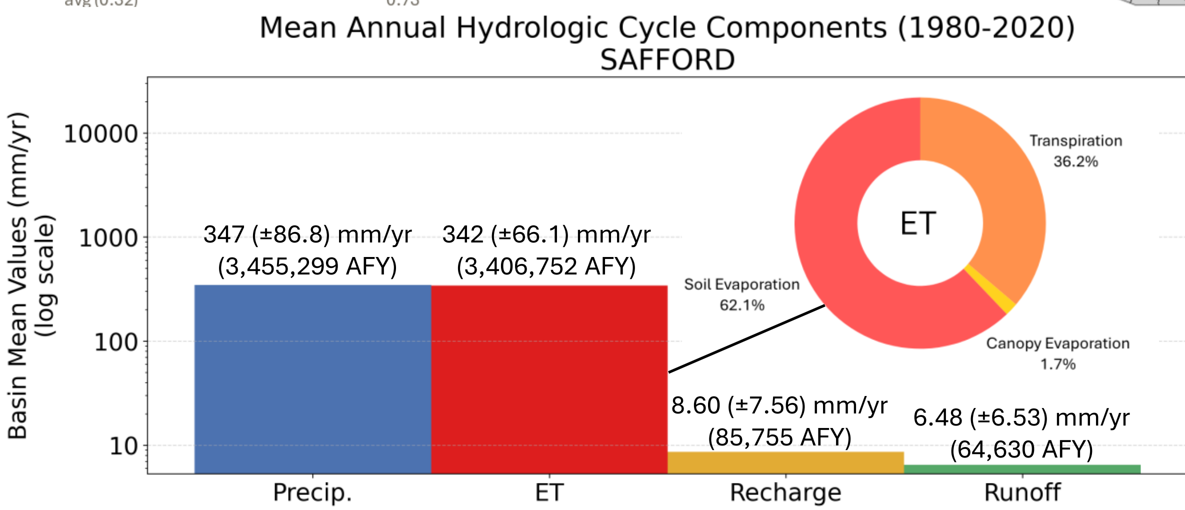

Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration.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

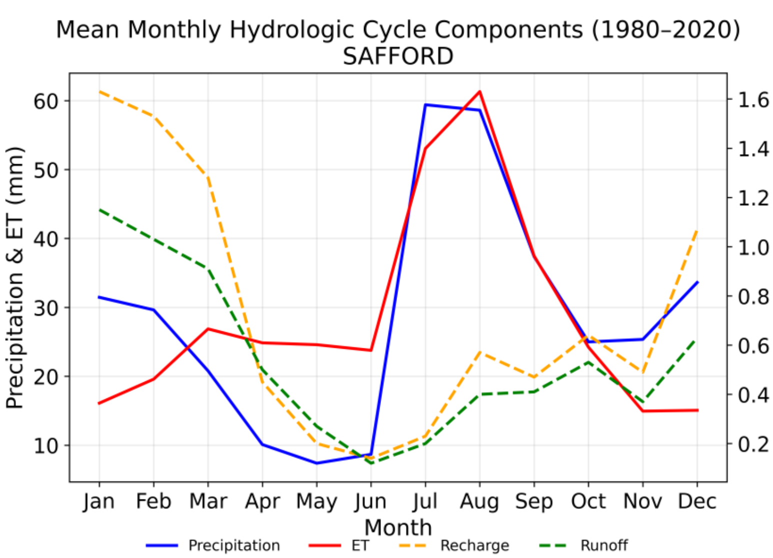

Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in relatively low basin-wide annual averages for natural recharge (8.60 mm) and runoff (6.48 mm). P in the Safford basin is affected by the North American Monsoon during the summer months. ET is approximately equal to P during these months due to enhanced water availability. ET exceeds P from mid-February through mid-June. Soil evaporation makes up 62.1% of total ET in the basin, while transpiration comprises 36.2% and canopy evaporation accounts for the remainder (1.7%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months.

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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.

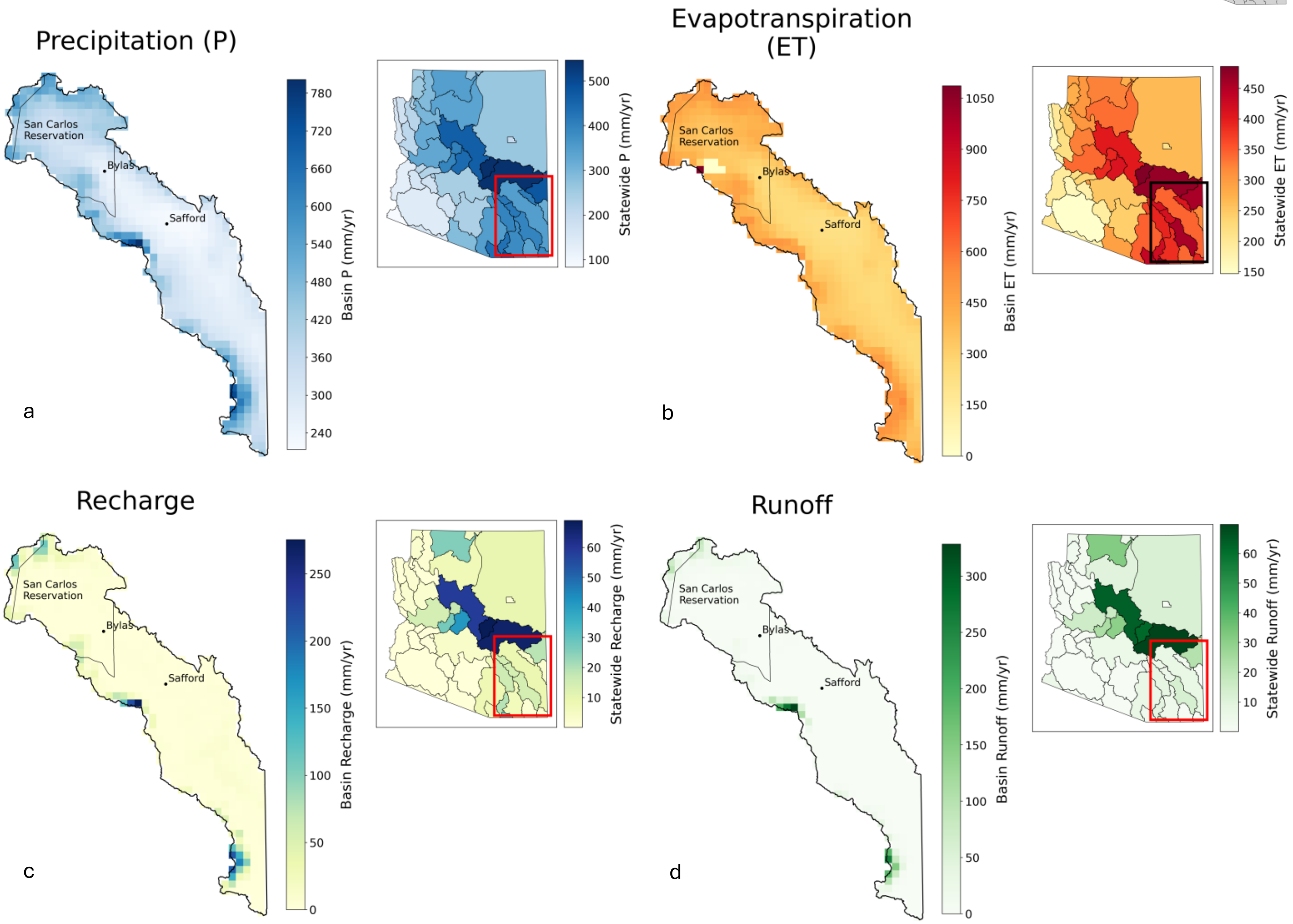
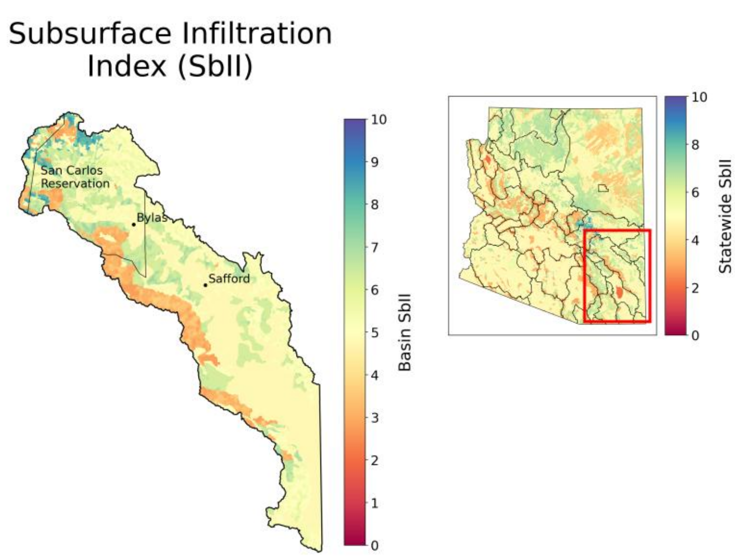


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



The Sky Island regions of Mt. Graham and the Chiricahua Mountains account for the highest precipitation in the Safford basin, each receiving over 750 mm/year. These high elevation forests also account for the highest evapotranspiration in the basin, particularly during the summer months. Natural recharge and runoff are higher near these regions than elsewhere in the basin (over 200 mm/year and 300 mm/year at Mt. Graham, respectively). Infiltration potential is greatest in the northwestern portion of the Safford basin due to high permeability soils in that area.

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

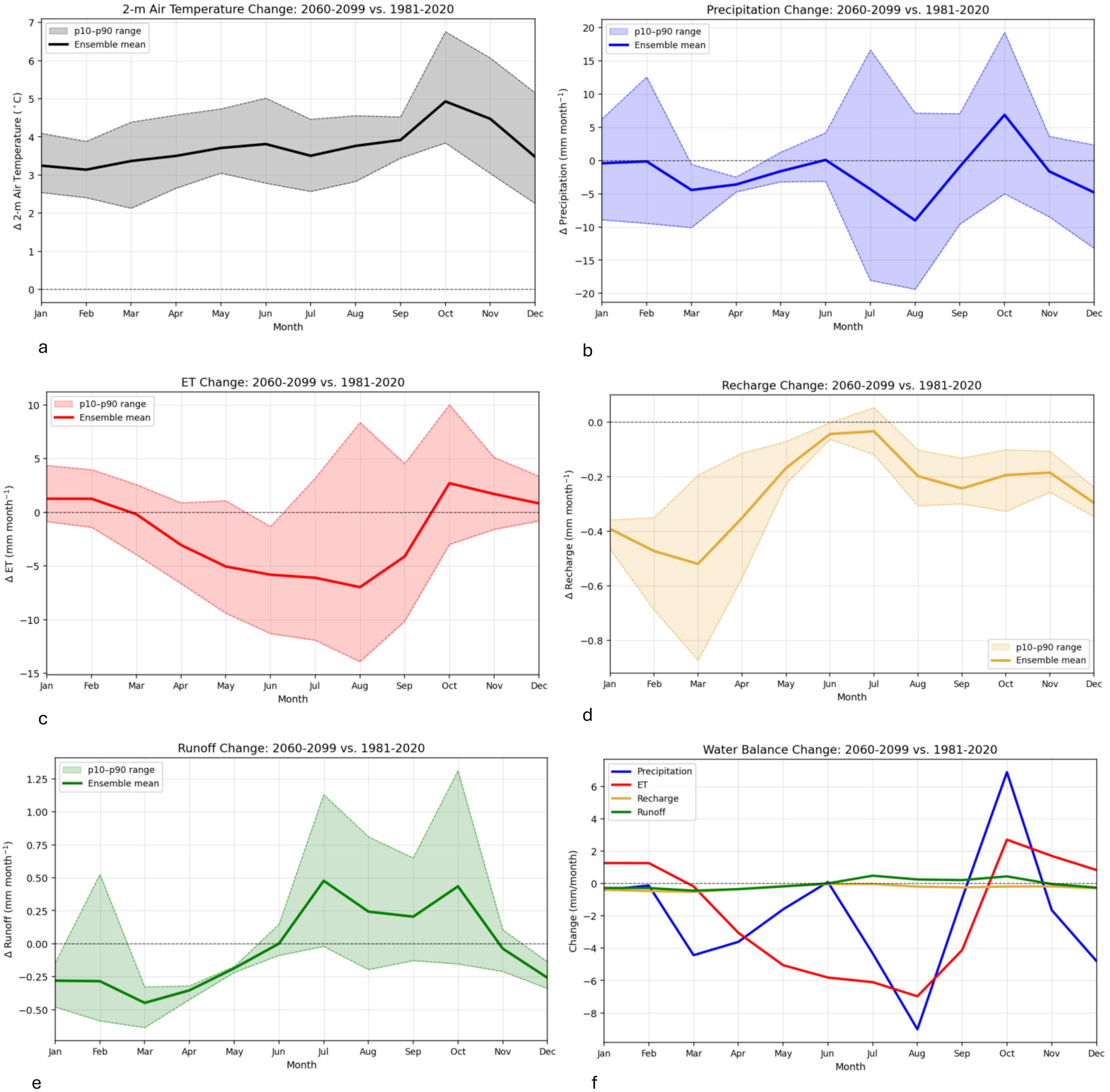

Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change 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 Safford basin show drier springs (20-39% drier March through May), a drier July-August (7-15%), and a drier November-December (7-13%). October is projected to be 26% (6.9 mm) 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 all months of the year, with projections in the highest recharge months (January-April) showing declines of 55-76% (-0.35 to -0.52 mm/month). Recharge projections are slightly negative (-0.02 to -0.14 mm/month) from June to November.* Runoff is projected to decline 45-77% in January-April (-0.28 to -0.45 mm/month) and 13-71% in November-December (-0.03 to -0.26 mm/month). From July through October, runoff is projected to increase by 0.21 to 0.48 mm/month. Projected increases in temperature range from approximately 3.2 °C in February to 5.0 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 11% (2.6 mm) increase in evapotranspiration (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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