Upper Hassayampa Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 787 square miles
Elevation[2]: Range: 1,896-7,971 ft; Median: 3,506 ft
Top 3 land cover types by area[3]: Shrub/Scrub (84%), Evergreen Forest (11%), Grassland Herbaceous (2.5%)
Major surface watershed(s)[4]: Hassayampa River
Groundwater subbasins[1]: None
Groundwater-derived streamflow fraction[5]:

0.40 (Moderate)

0.01 avg (0.32) 0.73

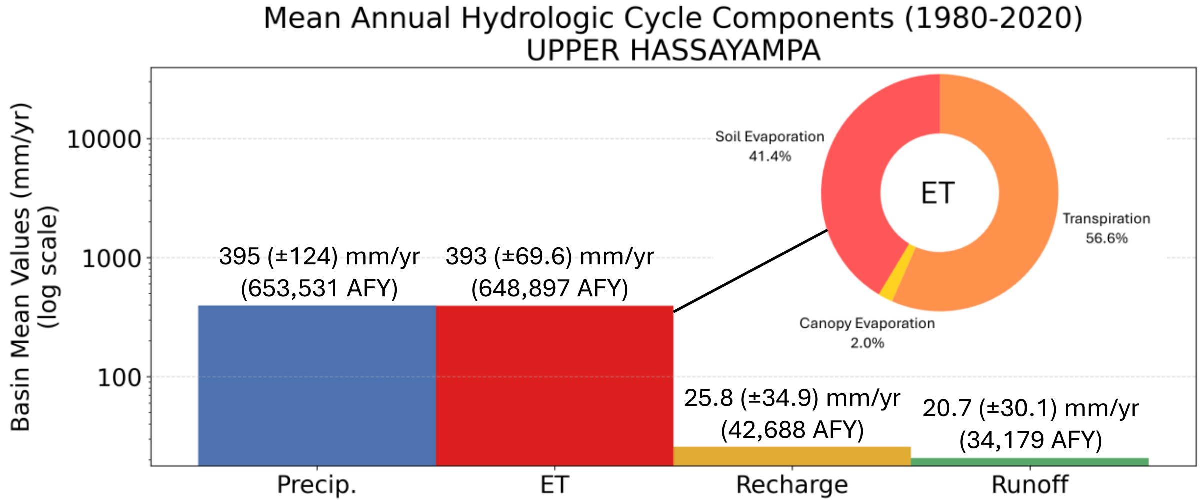

Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration.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

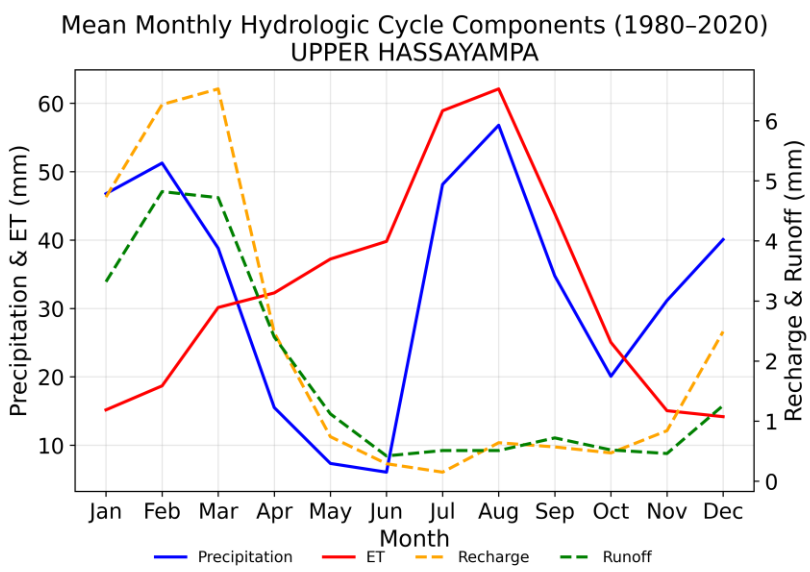

Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

Precipitation (P) in the Upper Hassayampa 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. Natural recharge (25.8 mm/yr) and runoff (20.7 mm/yr) are highest in February and March as a result of springtime snowmelt and low evaporative demand. Soil evaporation makes up 41.4% of total ET in the basin, while transpiration comprises 56.6% and canopy evaporation accounts for the remainder (2.0%). Groundwater is estimated to supply 40% of total streamflow in the basin.

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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.

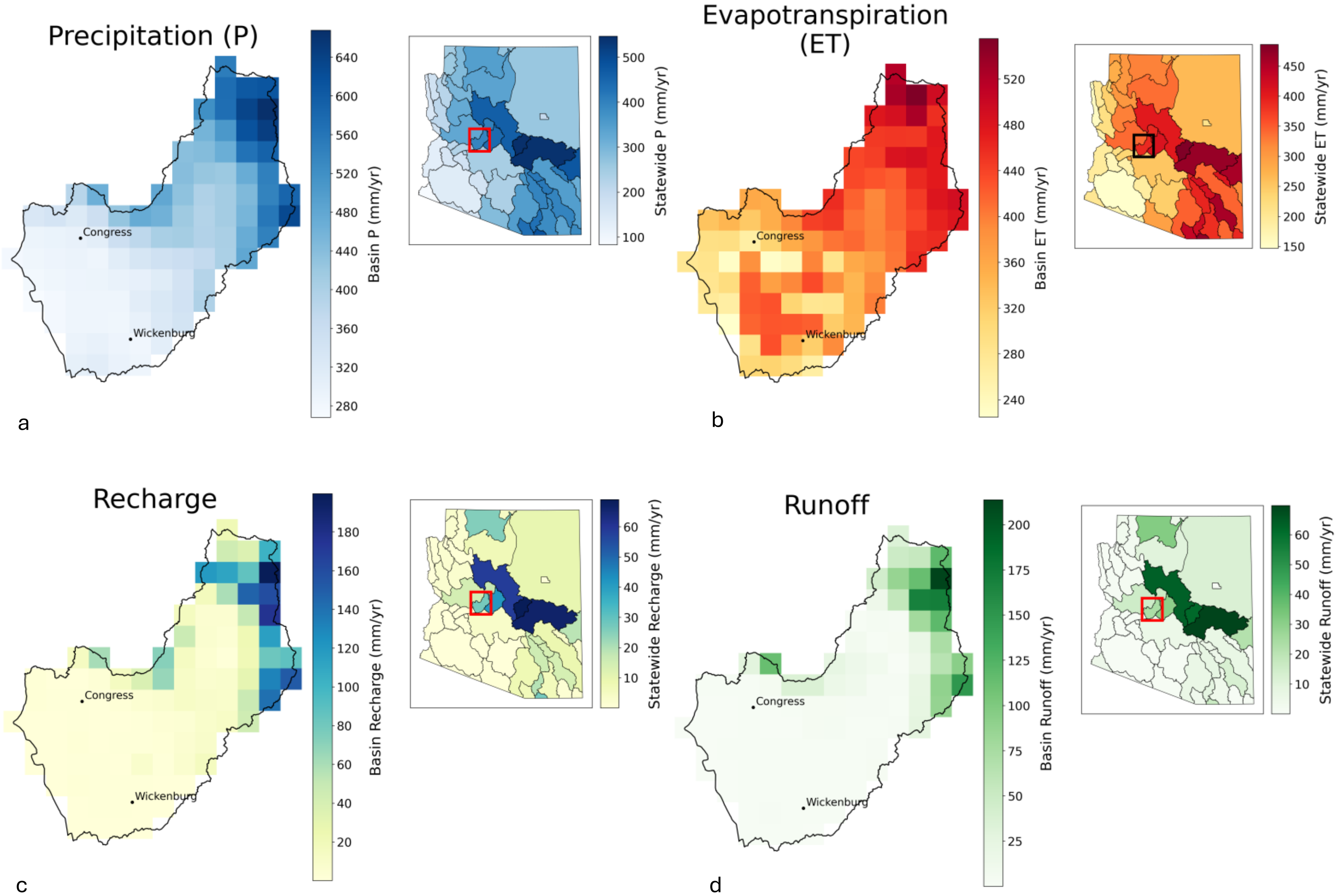
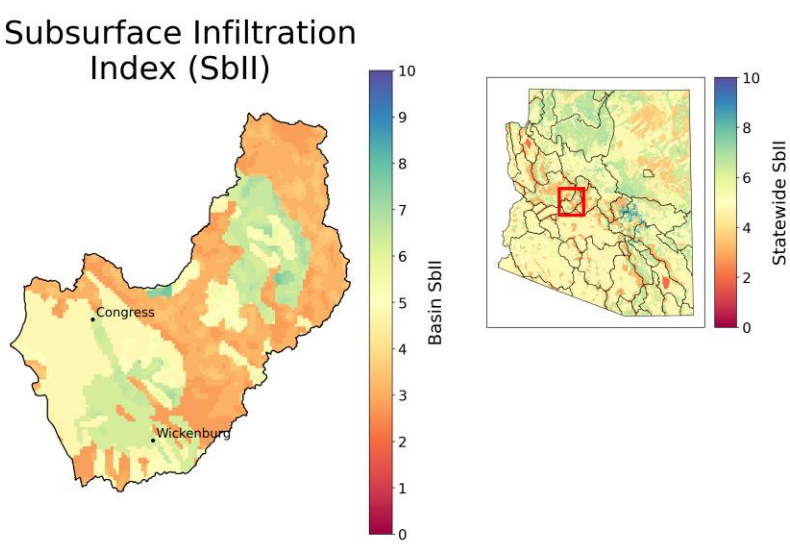


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



Precipitation (P) in the Upper Hassayampa basin is greatest in the Bradshaw Mountains in the eastern portion of the basin where it can exceed 600 mm/yr on average. Evapotranspiration (ET, ~500 mm/yr), natural recharge (150-180 mm/yr) and runoff (150-200 mm/yr) are also greatest in this region. The Agua Fria basin contains pockets of moderate infiltration potential due to moderately consolidated, limestone-containing conglomerate northwest of Wickenburg and at the mountain fronts of the Bradshaw mountains to the northeast.

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

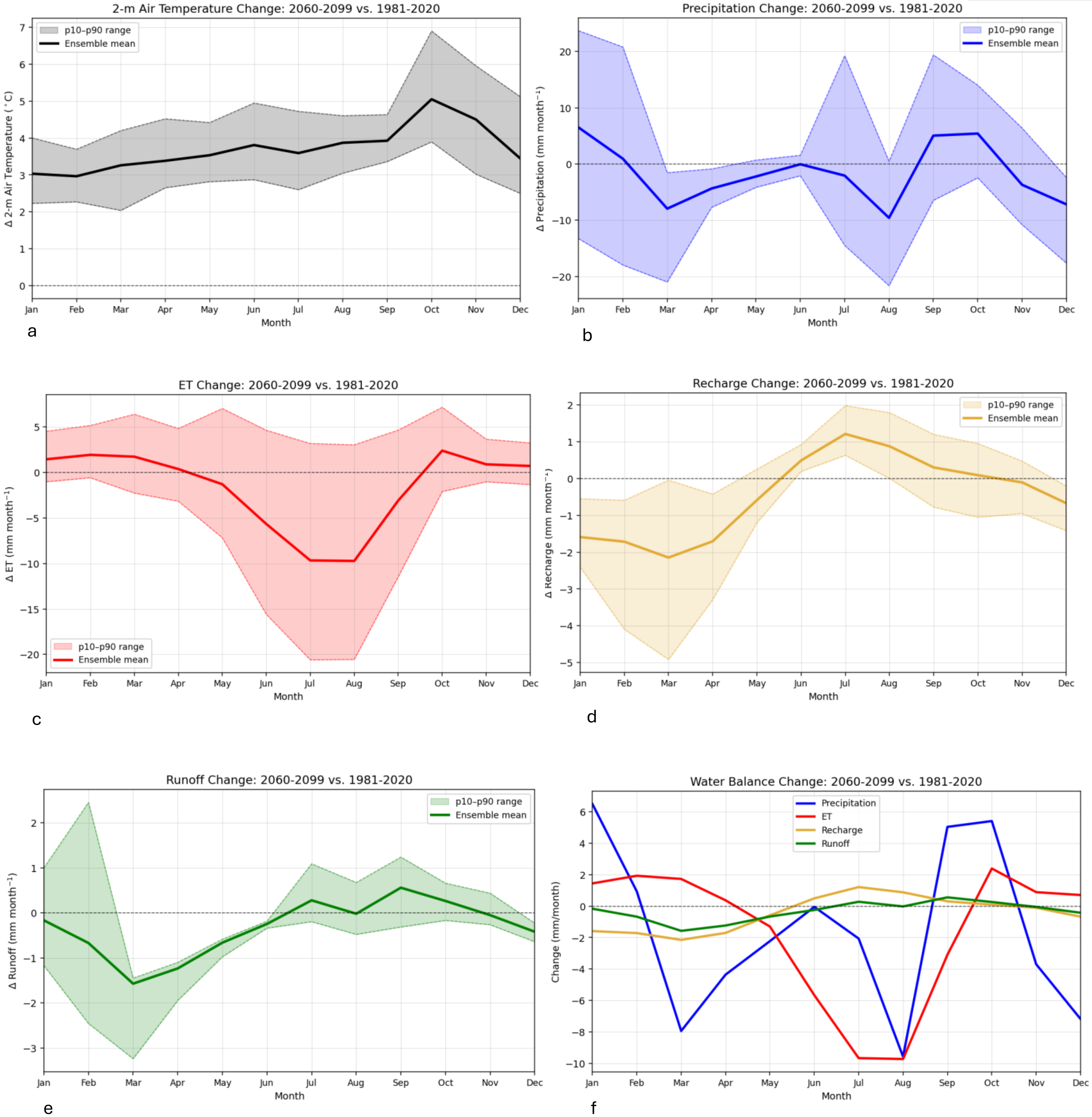

Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change 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 Upper Hassayampa basin show drier springs (19-33% drier March through May) and a drier July (4%), August (16%), November (14%), and December (18%). September and October are projected to be 14-24% (4.9-5.5 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 45-56% (-1.7 to -2.2 mm/month) are projected for the highest recharge months (February-April). Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections are slightly negative for June-December (-0.27 to -1.1 mm/month).* Runoff is projected to decrease during the highest runoff months from February to April (38-76%, or -0.70 to -1.6 mm/month), while increasing in July (0.27 mm), September (0.56 mm), and October (0.28 mm). Projected increases in temperature range from approximately 3.0 °C in February to 5.1 °C in October. Less precipitation in August leads to a projected 15% (-9.7 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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