Douglas AMA
Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 949 square miles
Elevation[2]: Range: 3,894-7,364 ft; Median: 4,338 ft
Top 3 land cover types by area[3]: Shrub/Scrub (91%), Cultivated Crops (4.5%), Evergreen Forest (2.0%)
Major surface watershed(s)[4]: Whitewater Draw, Willcox Playa
Groundwater subbasins[1]: None
Groundwater-derived streamflow fraction[5]:

0.73 (Very High)

0.01 avg (0.32) 0.73

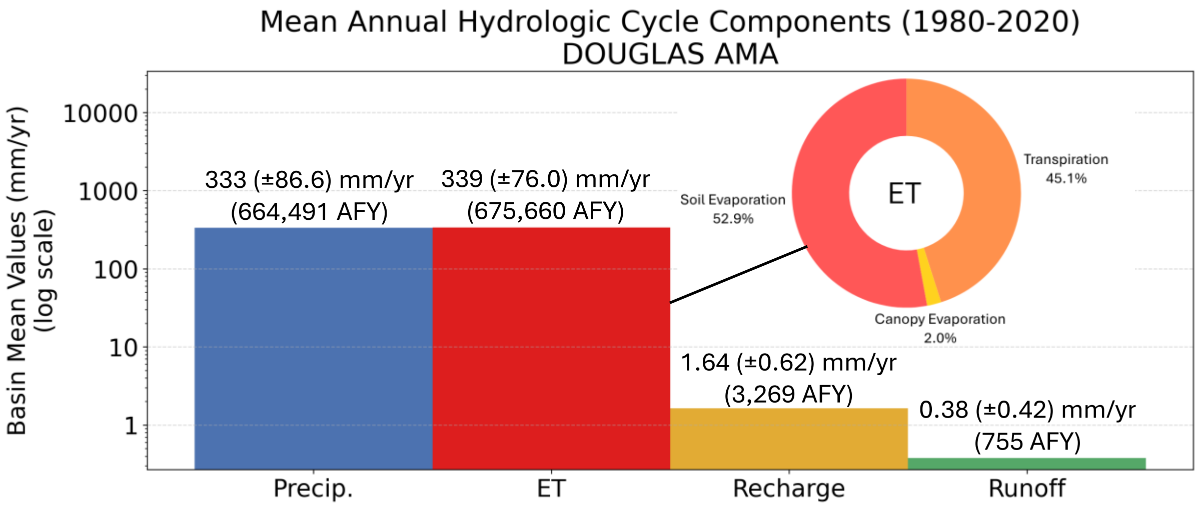

Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration.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

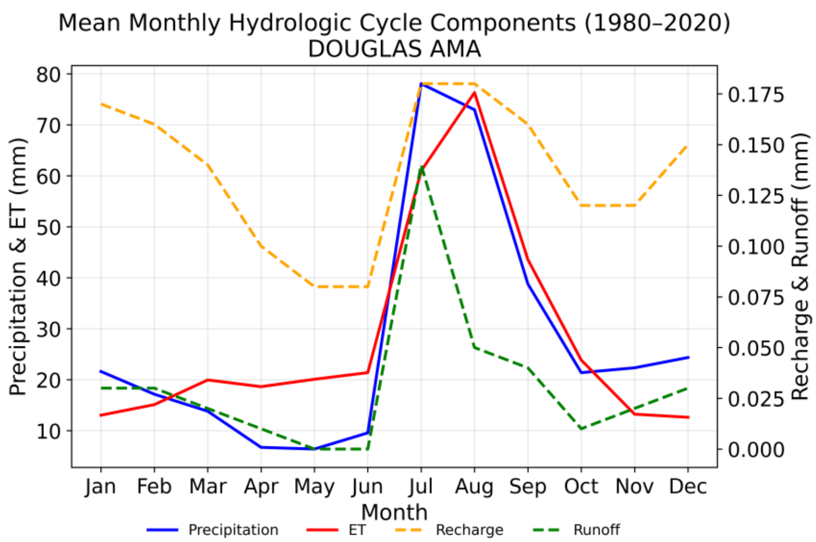

Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average across the Douglas AMA, resulting in near zero basin-wide averages for natural recharge (1.64 mm/yr) and runoff (0.38 mm/yr). Seasonally, P is affected by the North American Monsoon during the summer months. ET is greater than P from mid-February to June and tracks with P from June to October. Soil evaporation makes up 52.9% of total ET in the basin, while transpiration comprises 45.1% and canopy evaporation accounts for the remainder (2.0%).

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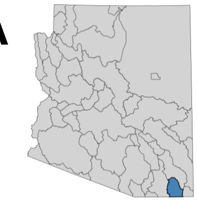


Figure 3 (below). Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.[6] Major cities/towns[7] and Native American Reservation boundaries[8] are shown (as applicable) to help orient the reader.

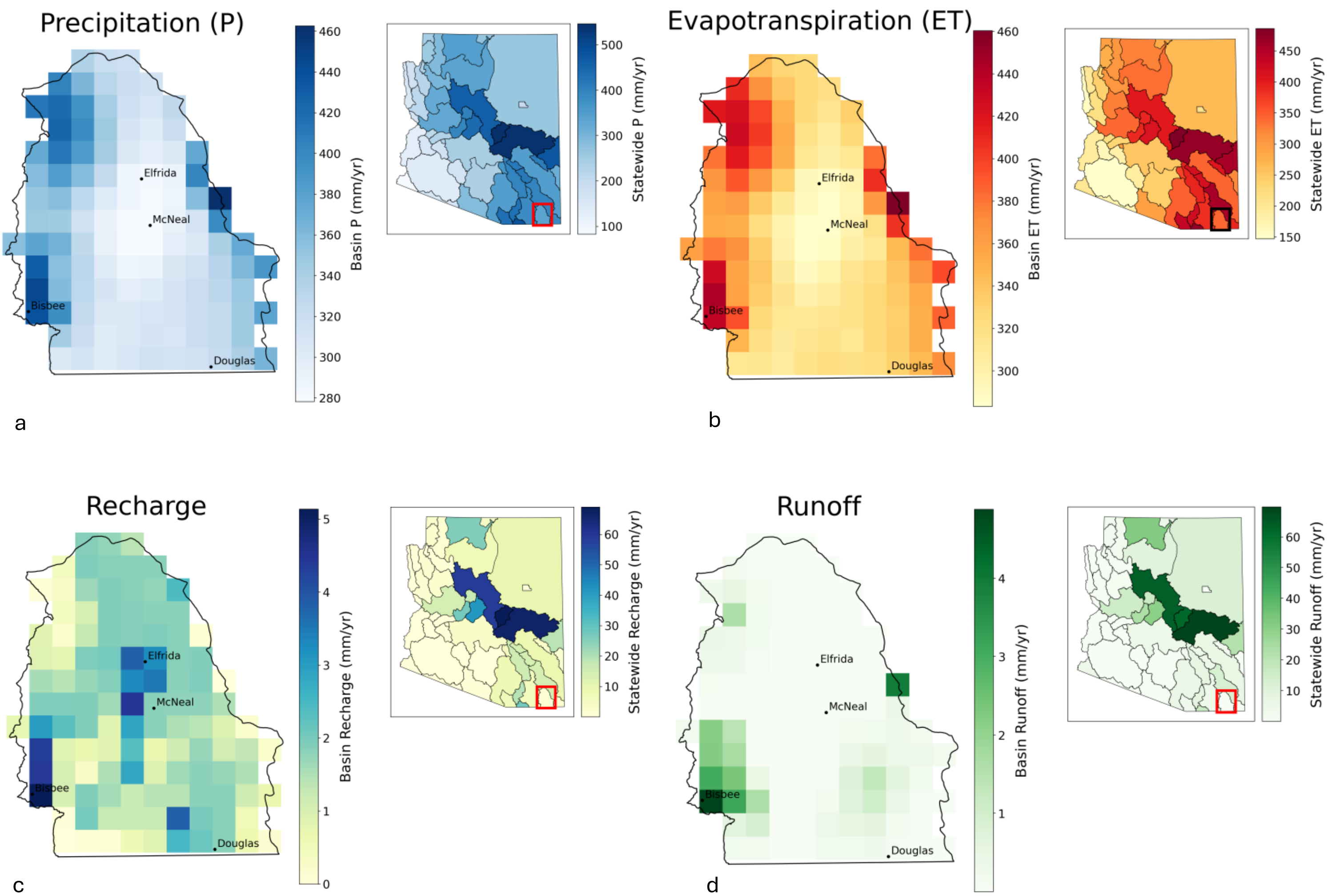
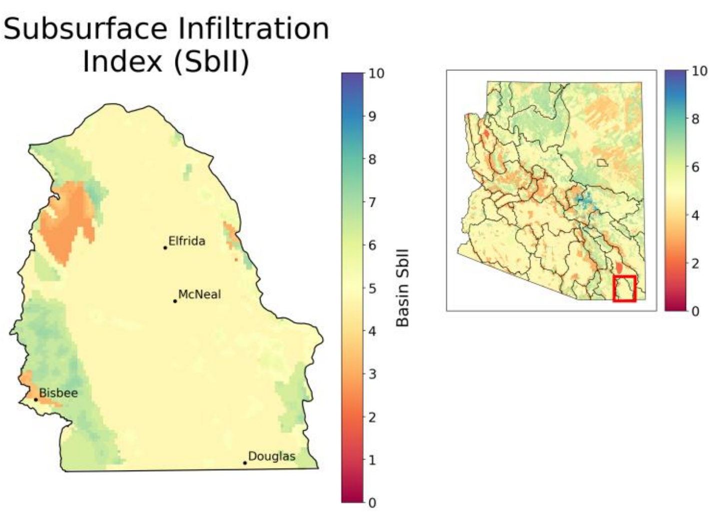


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



Precipitation (P) in the Douglas AMA is highest in the Mule Mountains near Bisbee, the Swisshelm Mountains east of McNeal, and in the southern tip of the Dragoon Mountains to the northwest. These regions receive over 440 mm/yr of P on average. Evapotranspiration (ET) is also highest in these higher-elevation areas (~420 mm/yr). Natural recharge varies from 0-5 mm/yr across the basin, with the highest recharge areas in the Mule Mountains (4-5 mm/yr) and in the alluvial deposits near Elfrida (3-4 mm/yr). Runoff is highest in the Mule Mountains and Swisshelm Mountains (2-3 mm/yr). Subsurface infiltration potential is generally moderate across the basin, with higher infiltration potential in the karst-type geology of the Mule Mountains, the southern tip of the Dragoons, and the Perilla Mountains east of Douglas.

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

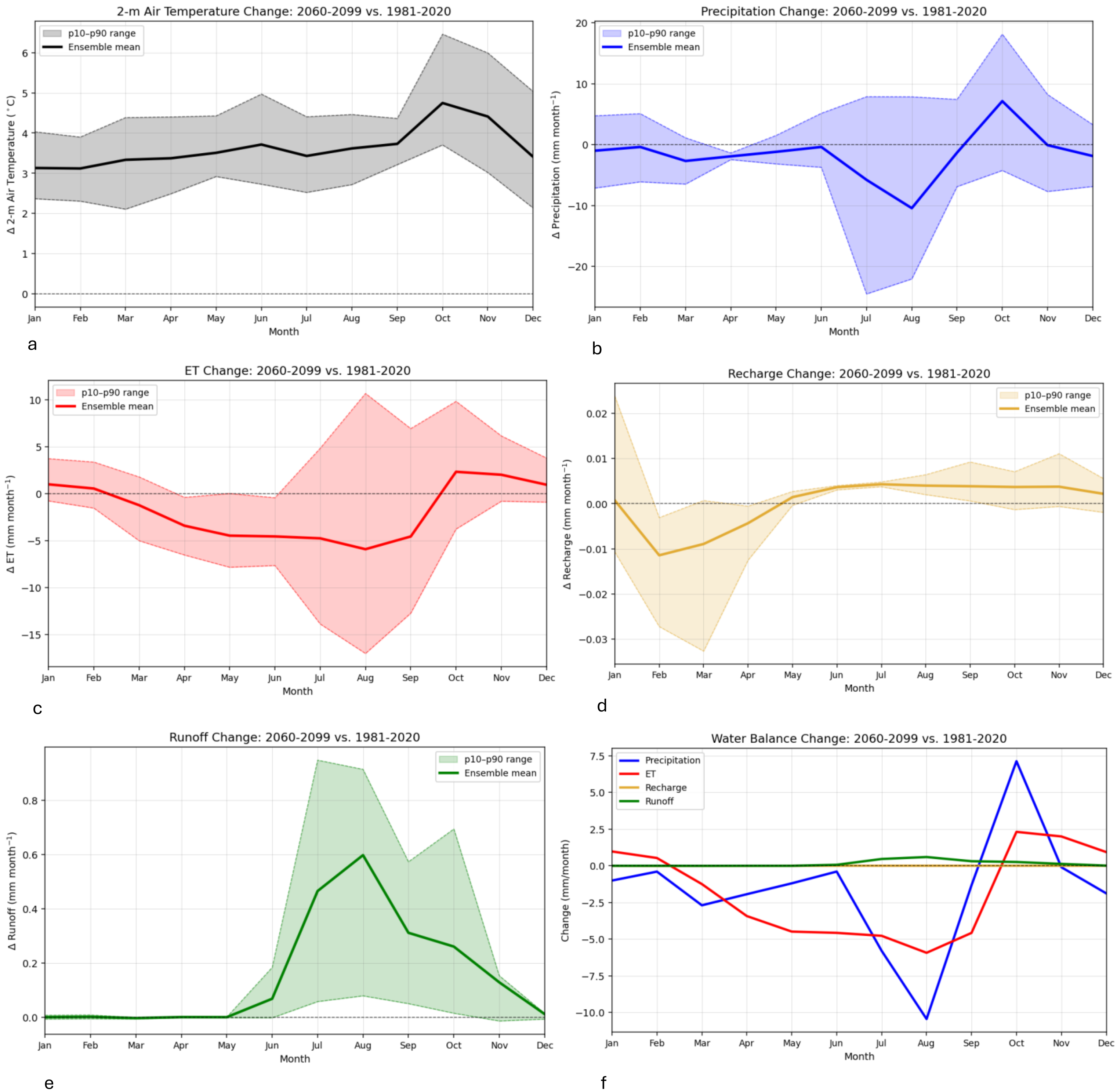

Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change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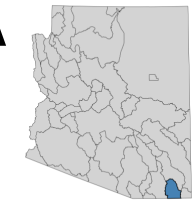

Climate change projections across the Douglas AMA show less precipitation throughout most months of the year, with the exception of October, which shows a 32% (7.2 mm) increase in precipitation. The greatest declines in precipitation are projected for March-May (18-32% drier) and July-August (7-14% drier). Natural recharge is projected to remain near zero, with slightly negative projections (-0.002 to -0.006 mm/month) from May through December.* While remaining below 0.7 mm/month, runoff is projected to increase by 0.27-0.60 mm/month from July to October by the end of the century. Projected increases in temperature range from approximately 3.2 °C in February to 4.8 °C in October. Less water availability from March to September leads to projected declines of 6-25% (-1.3 to -6.1 mm/month) in evapotranspiration (ET) during the warmer months, while higher temperatures and greater precipitation are consistent with a projected 9% (2.3 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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