Grand Wash Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 959 square miles
Elevation[2]: Range: 1,095-7,715 ft; Median: 4,256 ft
Top 3 land cover types by area[3]: Shrub/Scrub (73%), Grassland Herbaceous (14%), Evergreen Forest (12%)
Major surface watershed(s)[4]: Grand Wash
Groundwater subbasins[1]: None
Groundwater-derived streamflow fraction[5]:

0.46 (Moderate)

0.01 avg (0.32) 0.73

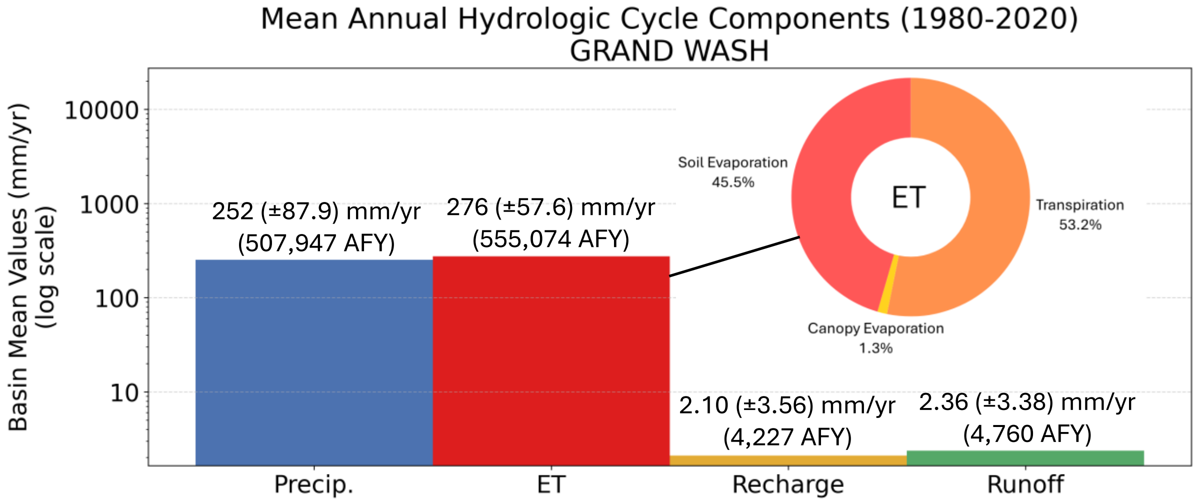

Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration.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

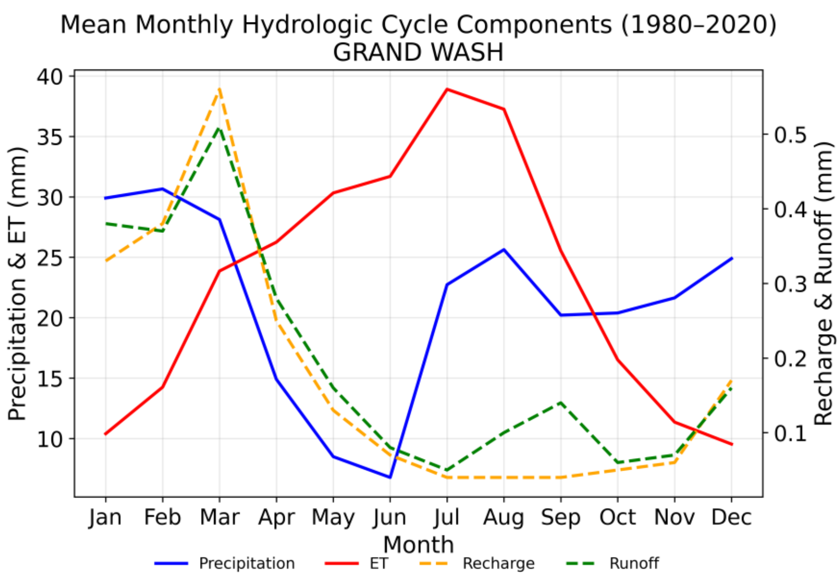

Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

Precipitation (P) in the Grand Wash 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 mid-September. Transpiration makes up the majority (53.2%) of total ET in the basin, while soil evaporation comprises 45.5% and canopy evaporation accounts for the remainder (1.3%). Natural recharge (2.10 mm/yr) and runoff (2.36 mm/yr) peak in March due to springtime snowmelt. Groundwater is estimated to supply 46% of total streamflow in the Grand Wash 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.

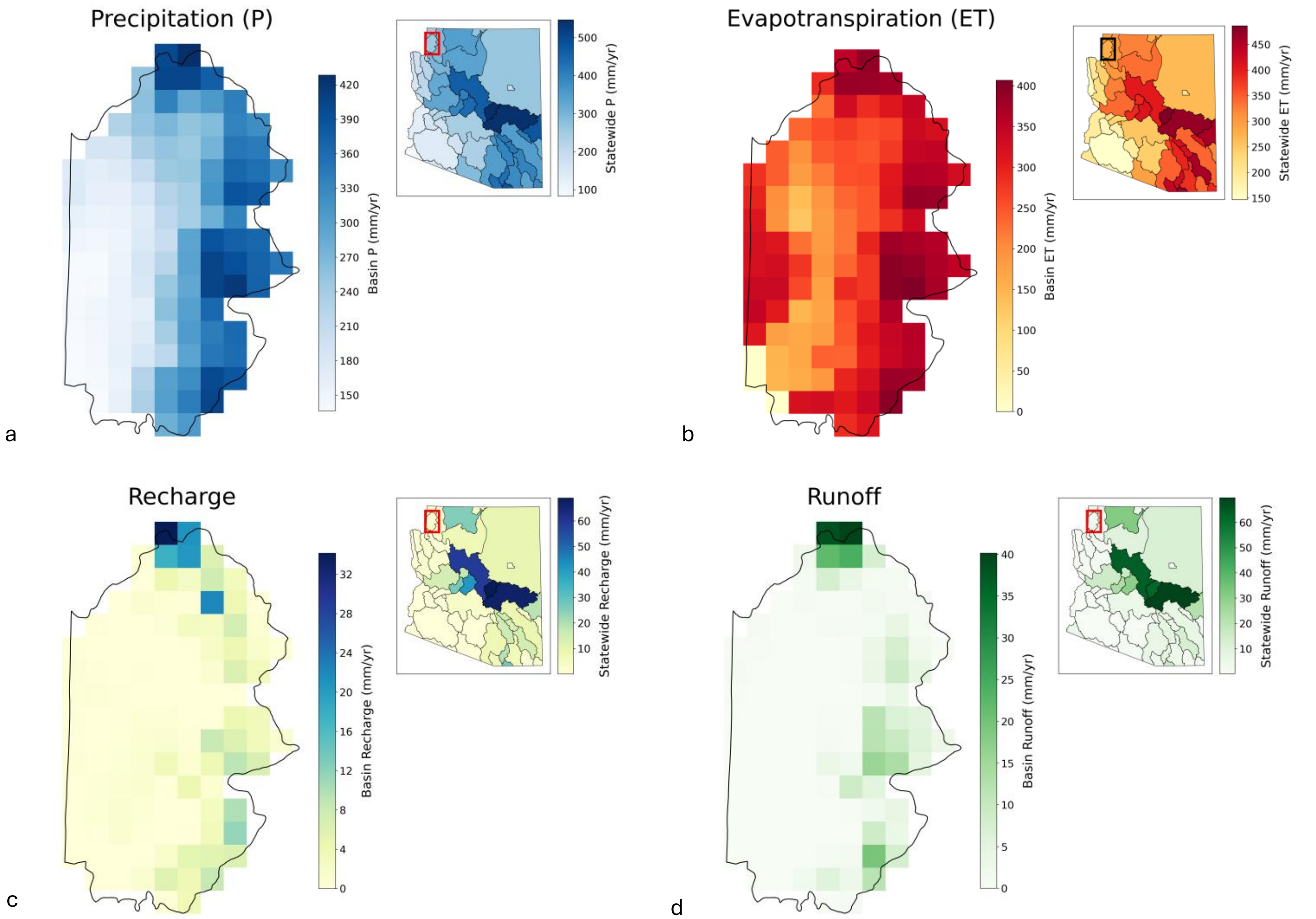
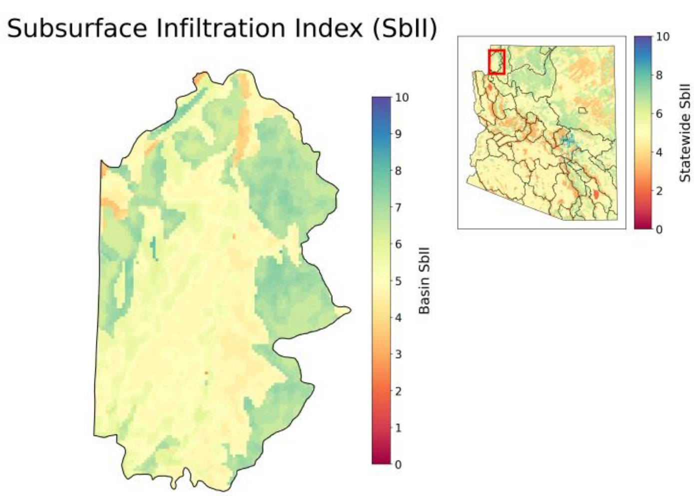


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



Precipitation (P) in the Grand Wash basin is greatest in the higher elevation, eastern and northern portions of the basin, where P exceeds 400 mm/yr on average. ET (~370 mm/yr) is also highest in these regions. Natural recharge (20 mm/yr) and runoff (30 mm/yr) are highest in the Paiute Wilderness to the north. The basin has relatively high infiltration potential, particularly on the eastern side of the basin, due to the presence of karst-type geology.

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

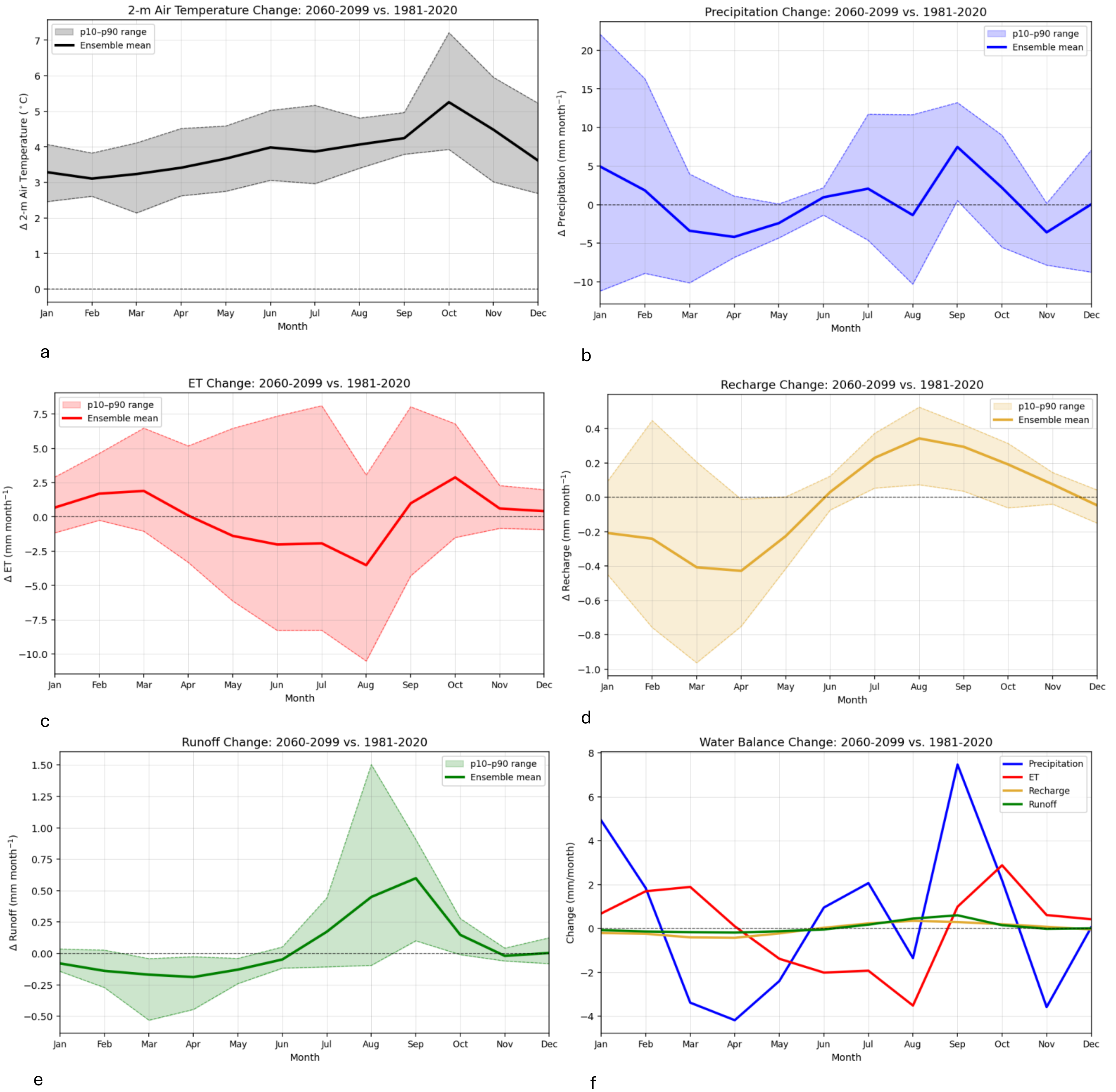

Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change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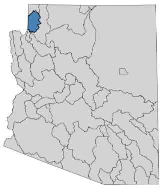

Climate change projections across the Grand Wash basin show drier springs (11-27% drier March through May), and a drier August (4%) and November (18%). September and October are projected to be 10-36% (2.1-7.5 mm/month) wetter on average, which is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity by the end of the century. The months with the highest natural recharge (February-April) are projected to have declines of 45-63% (0.25 to -0.43 mm/month). Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections are slightly negative from June through December (-0.02 to -0.15 mm/month).* Runoff is projected to decline by -0.14 to -0.19 mm/month in February-April and increase by 0.17-0.61 mm/month in July-October. Projected increases in temperature range from approximately 3.1 °C in February to 5.3 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 18% (2.9 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability in August leads to a projected decline in ET (10% or -3.4 mm).

*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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