Virgin River Groundwater Basin Profile

ARIZONA TRI-UNIVERSITY
RECHARGE AND WATER RELIABILITY PROJECT

Basin Summary Statistics

Size[1]: 434 square miles
Elevation[2]: Range: 1,586-7,977 ft; Median: 3,224 ft
Top 3 land cover types by area[3]: Shrub/Scrub (71%), Evergreen Forest (17%), Grassland Herbaceous (9.2%)
Major surface watershed(s)[4]: Virgin River
Groundwater subbasins[1]: None
Groundwater-derived streamflow fraction[5]:

0.42 (Moderate)

0.01 avg (0.32) 0.73

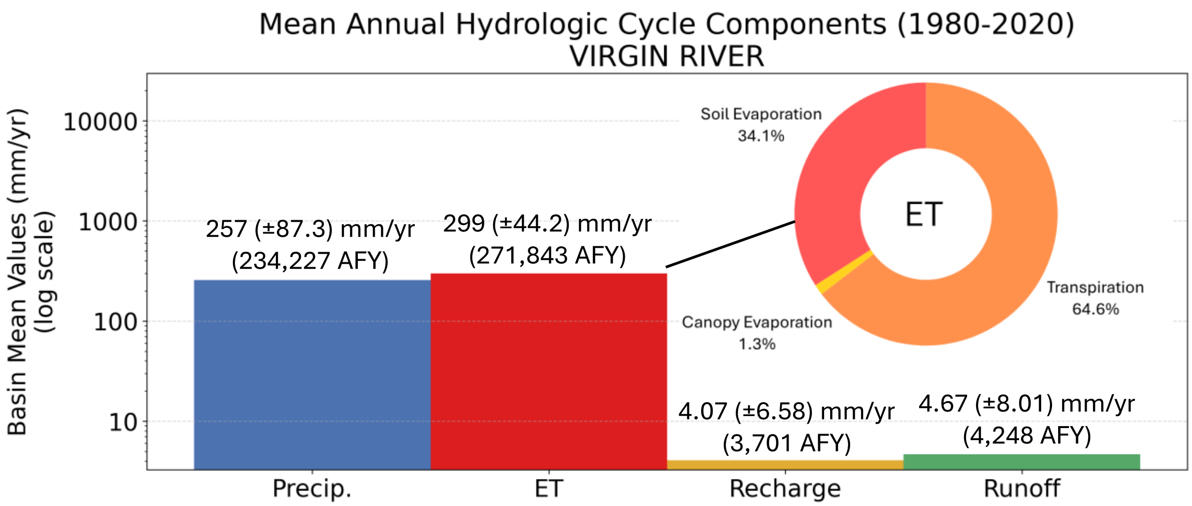


Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.[6] ET is partitioned into soil evaporation, canopy evaporation, and transpiration.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

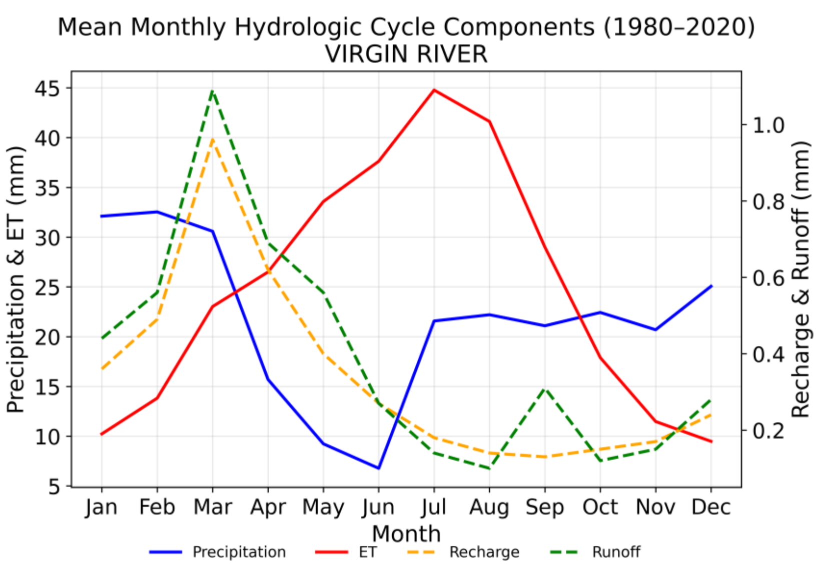


Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.[6]

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (4.07 mm) and runoff (4.67 mm). Natural recharge and runoff both peak in March due to springtime snowmelt. The greatest atmospheric losses occur during the summer months, while P exceeds ET in the cooler months (mid-Sept. to mid-March). Transpiration makes up the majority (64.6%) of total ET in the basin, while soil evaporation comprises 34.1% and canopy evaporation accounts for the remainder (1.3%). Groundwater is estimated to supply 42% of total streamflow in the Virgin River basin.

Virgin River

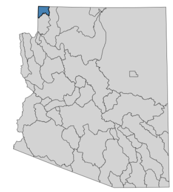


Figure 3 (below). Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.[6] Major cities/towns[7] and Native American Reservation boundaries[8] are shown (as applicable) to help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

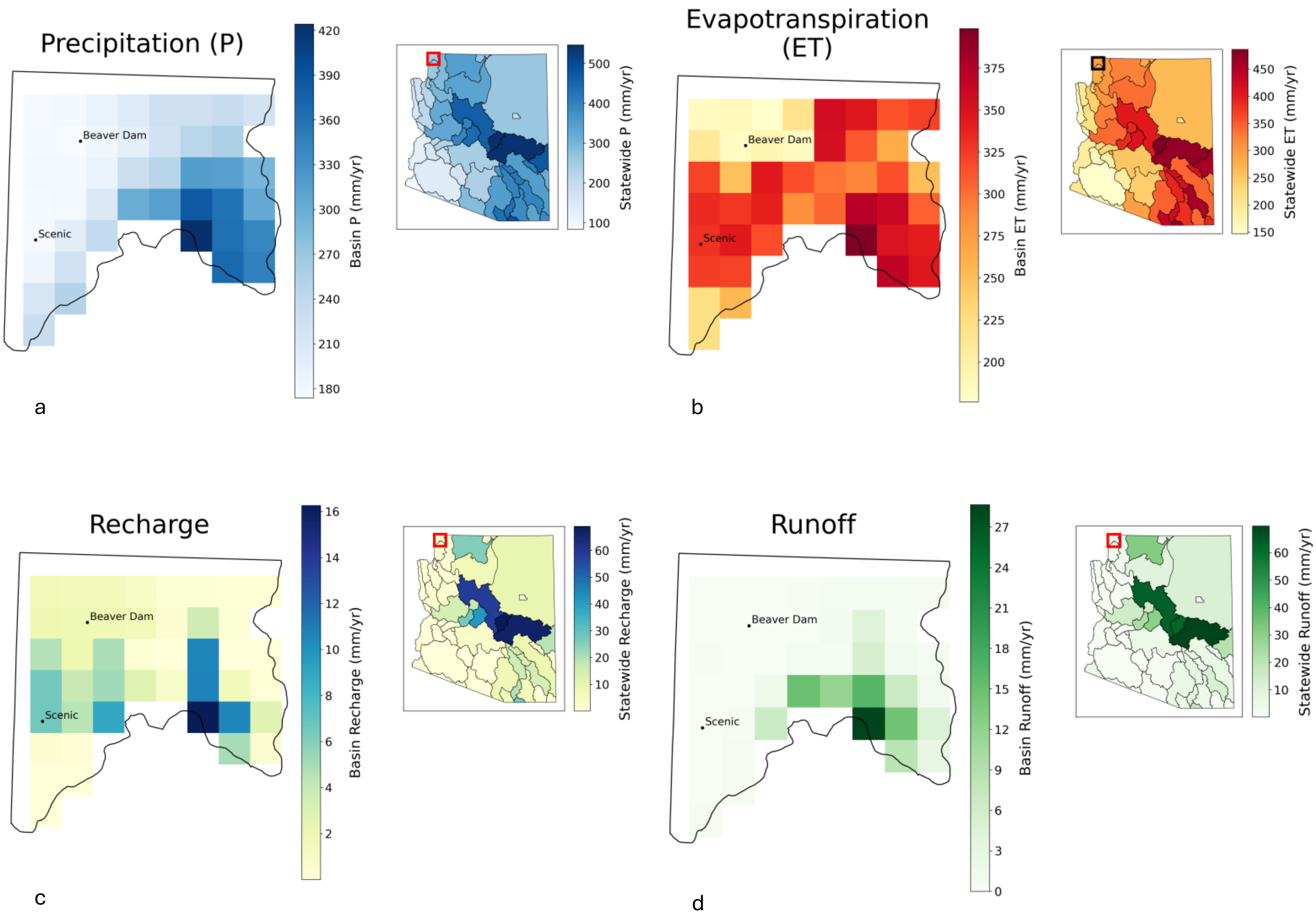
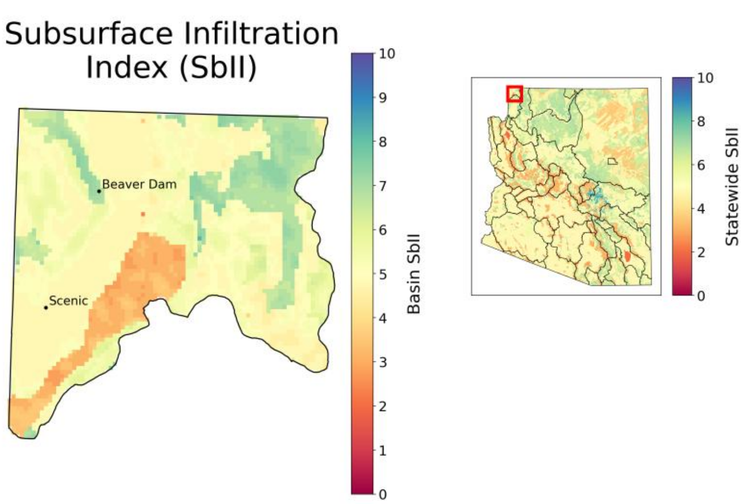


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.[9]



Precipitation (P) in the Virgin River basin is greatest in southern portion of the basin in the Paiute Wilderness, where P can exceed 400 mm/yr. ET is generally higher south of the Virgin River in the higher elevations of the basin where it can exceed 350 mm/yr. Natural recharge and runoff are both highest in the mountains of the Paiute Wilderness. Infiltration potential is highest is the northeast region of the basin due to the presence of karst-type geology.

Virgin River

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

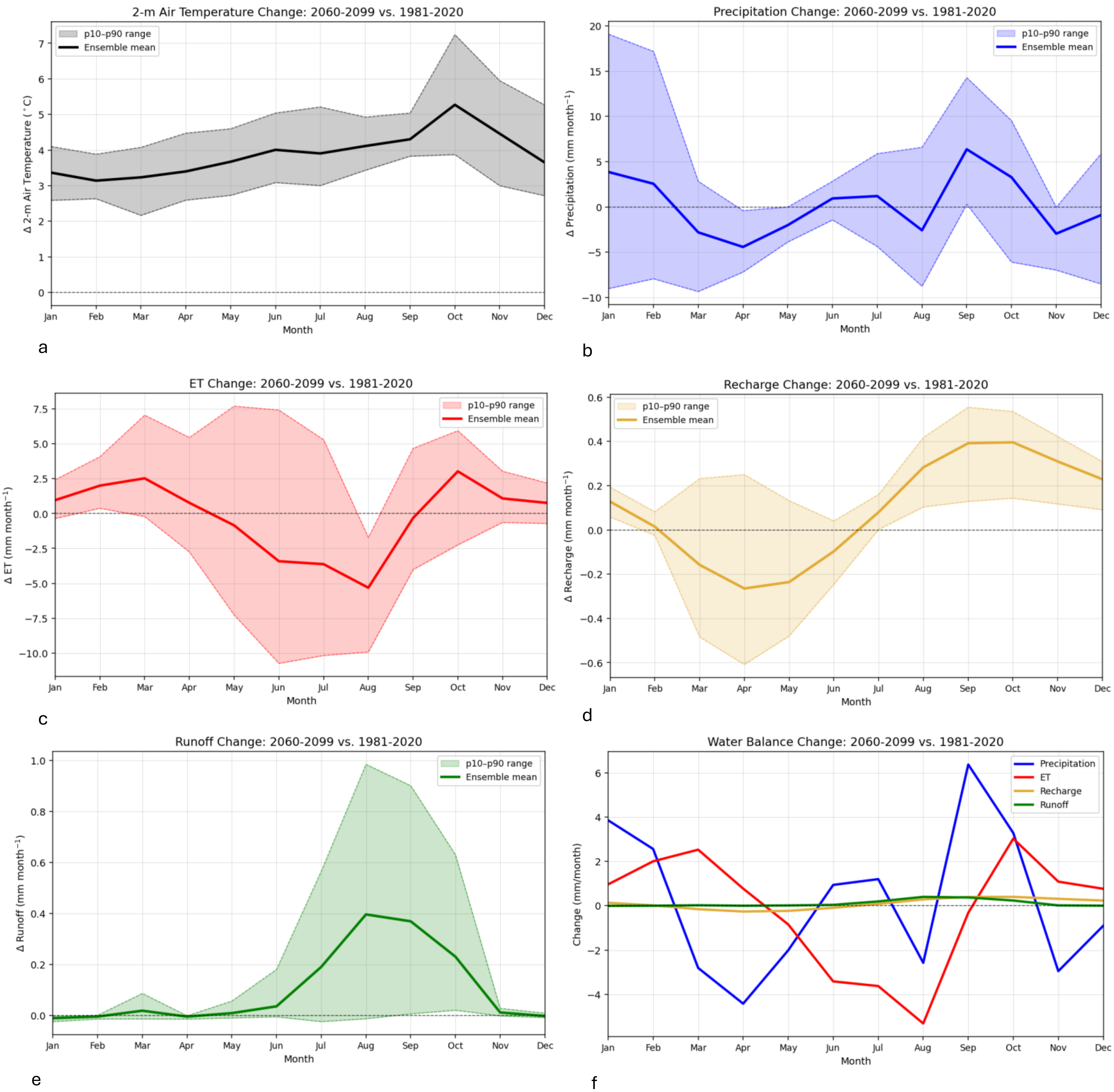
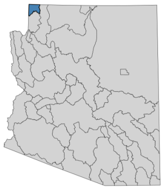


Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.[10] Plot (f) shows the change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

Virgin River



Climate change projections across the Virgin River basin show drier springs (10-30% drier March through May), and a drier August (12%), November (16%), and December (3%). September and October are projected to be 15-34% (3.3-6.4 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 (March-May) are projected to have declines of 57-72% (-0.16 to-0.26 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 July through January (-0.08 to -0.16 mm/month).* While remaining below 0.5 mm/month, runoff is projected to increase by 0.19 to 0.41 mm/month from July through October. Projected increases in temperature range from approximately 3.2 °C in February to 5.3 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 21% (3.1 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 (19% or -5.3 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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