

Donnelly Wash Groundwater Basin Profile



Basin Summary Statistics

Size¹: 293 square miles

Elevation²: Range: 1,570-4,476 ft; Median: 2,872 ft

Top 3 land cover types by area³: Shrub/Scrub (98%), Grassland Herbaceous (0.84%), Woody Wetlands (0.78%)

Major surface watershed(s)⁴: Middle Gila River

Groundwater subbasins¹: None

Groundwater-derived streamflow fraction⁵:

0.66 (Very High)



Mean Annual Hydrologic Cycle Components (1980-2020)
DONNELLY WASH

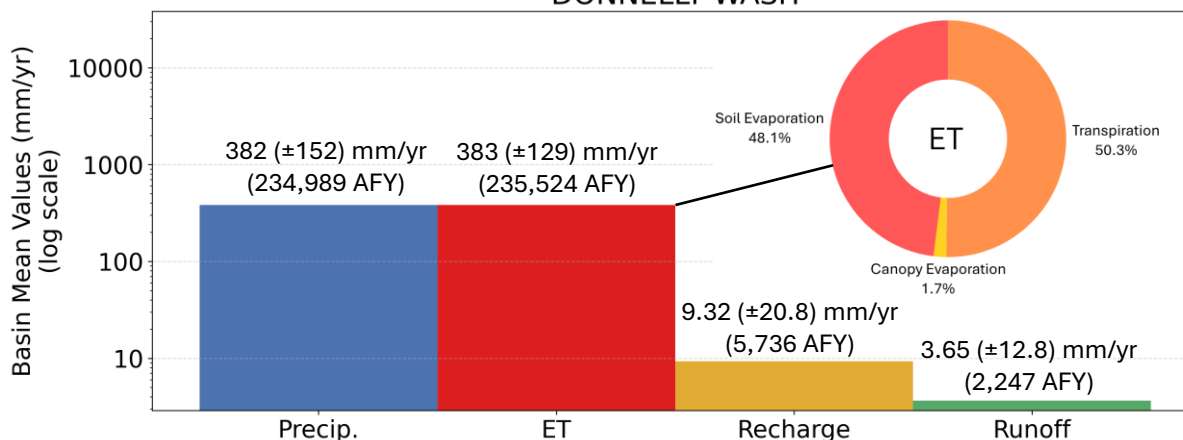


Figure 1 (above). Bar chart showing Noah-MP modeling results of the historical mean annual hydrologic cycle components (precipitation [P], evapotranspiration [ET], natural recharge, and runoff) in the basin from 1980-2020.⁶ ET is partitioned into soil evaporation, canopy evaporation, and transpiration. It is possible for ET to be greater than P when there are other sources such as groundwater, surface water, or water in storage.

Mean Monthly Hydrologic Cycle Components (1980-2020)
DONNELLY WASH

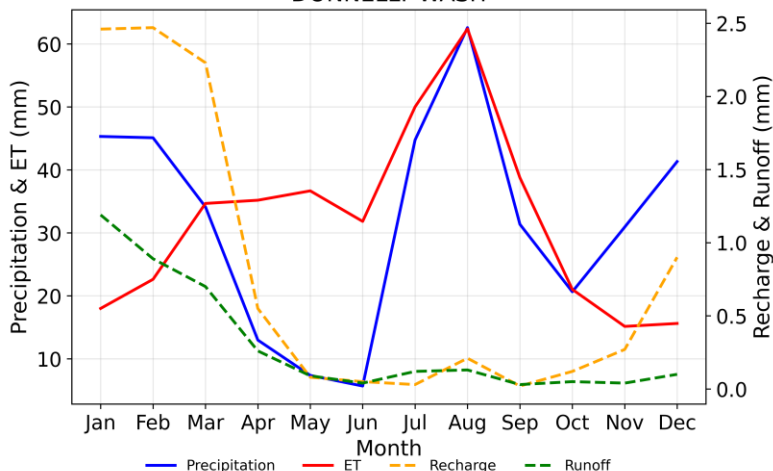


Figure 2. Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.⁶

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) on average across the basin, resulting in moderately low averages for natural recharge (9.32 mm) and runoff (3.65 mm). P in the Donnelly Wash basin is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET is greater than P from March to June and tracks with P from July to October. Soil evaporation makes up 48.1% of total ET in the basin, while transpiration comprises 50.3% and canopy evaporation accounts for the remainder (1.7%). Groundwater supplies an estimated 66% of total streamflow in the basin. Natural recharge and runoff peak in January-February due to winter precipitation and lower atmospheric demand.

Donnelly Wash



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/towns⁷ and Native American Reservation boundaries⁸ are shown (as applicable) to help orient the reader.

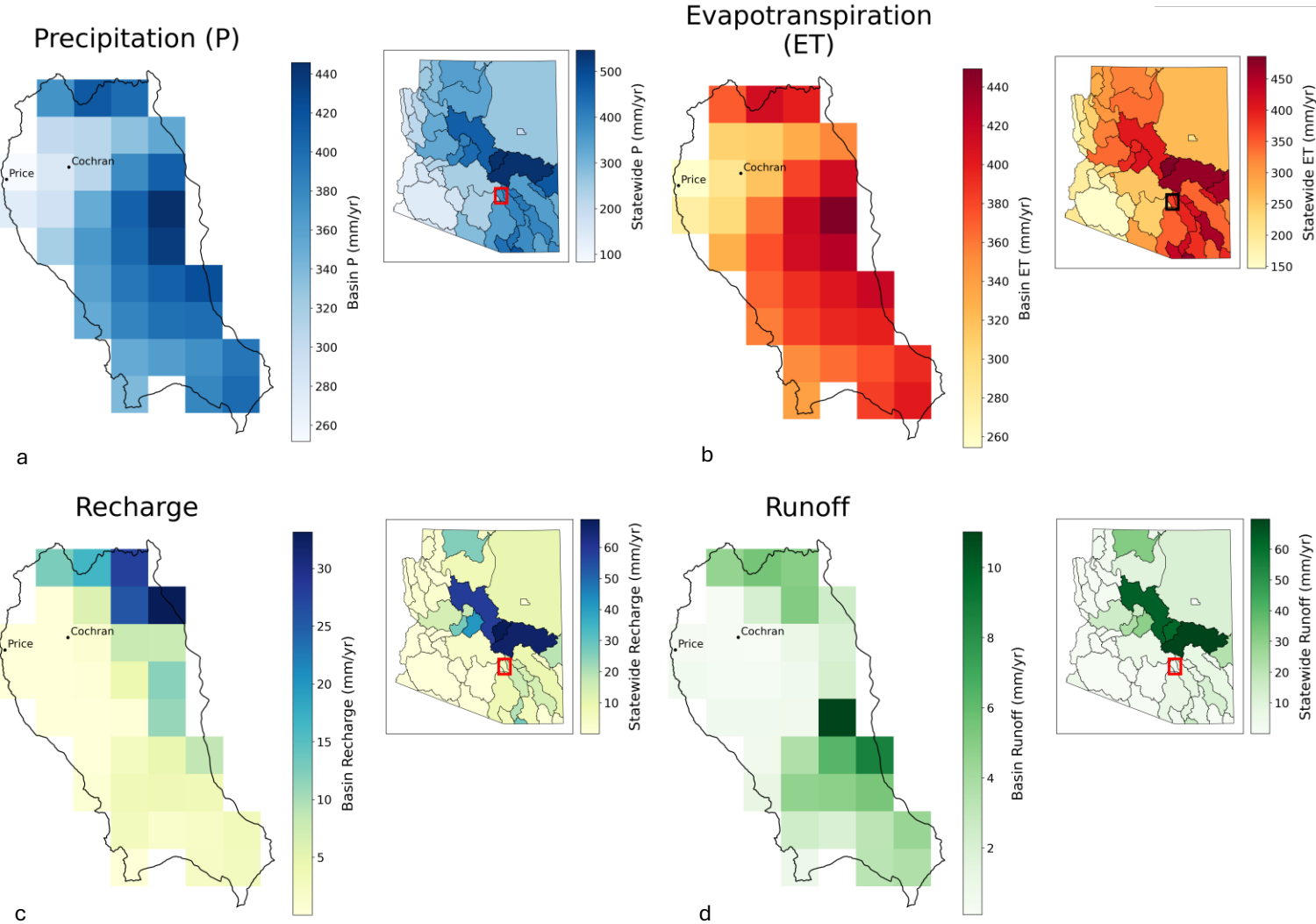
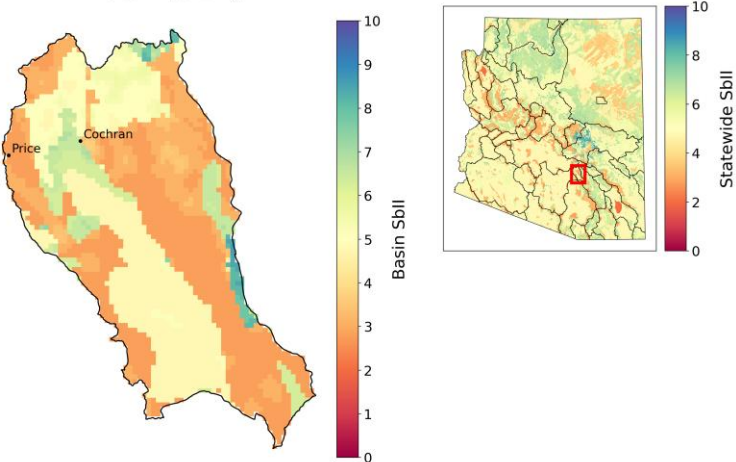


Figure 4 (below). Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.⁹

Subsurface Infiltration Index (SbII)



Precipitation in the Donnelly Wash basin is highest in the White Canyon Wilderness to the north and the higher elevation areas to the east. These regions receive over 430 mm/yr of precipitation on average. Evapotranspiration (ET, 430 mm/yr), natural recharge (~25 mm/yr), and runoff (~9 mm/yr) are also highest in these regions. Subsurface infiltration potential is generally low to moderate across the basin, with pockets of higher infiltration potential due to karst-type geology in the northern and eastern portions of the basin.



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

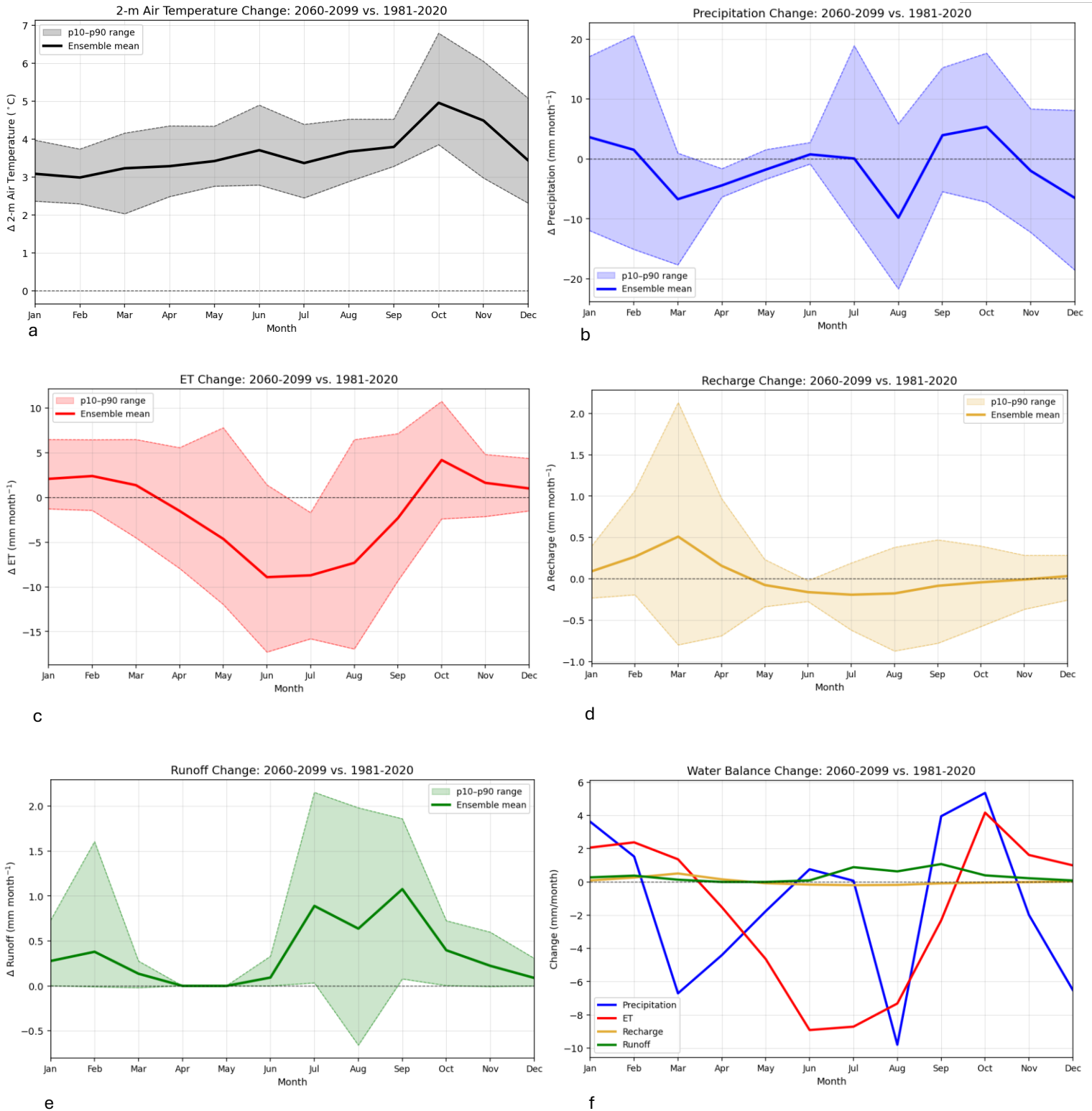


Figure 5. Plots (a)-(e) show projected changes in (a) temperature, (b) precipitation, (c) evapotranspiration (ET), (d) natural recharge, and (e) runoff statewide, comparing end of the 21st century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.¹⁰ Plot (f) shows the change in 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.



Climate change projections across the Donnelly Wash basin show drier springs (18-39% drier March through May) and a drier August (16%), November (7%), and December (15%). January (8%), September (13%), and October (21%) are projected to be wetter on average. This increase in precipitation in September and October (3.9-5.3 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity by the end of the century. During the highest recharge months (January-March), recharge is projected to increase slightly by 0.08-0.50 mm/month. From June through December, recharge is projected to remain near zero and slightly negative (-0.18 to -0.53 mm/month).^{*} While remaining below 1.8 mm/month, runoff is projected to increase by 0.23-1.1 mm/month from July to November by the end of the century. Projected increases in temperature range from approximately 3.0 °C in February to 5.0 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 18% (4.1 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability in April-August leads to projected declines in ET (4-27% or -1.6 to -9.0 mm/month) during those months.

^{*}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

1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
2. USGS Digital Elevation Model data. Retrieved from: <https://apps.nationalmap.gov/downloader/>
3. Annual National Land Cover Database – Land Cover (2024). Retrieved from the Multi-Resolution Land Characteristics Consortium: <https://www.mrlc.gov/data>
4. USGS HUC8 Watersheds. Retrieved from: <https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer>
5. Mroczek, C., Springer, A. E., Gupta, N., Sankey, T., & Lucas, B. (2025). Regional base-flow index in arid landscapes using machine learning and instrumented records. *Journal of Hydrology: Regional Studies*, 62, 102778. <https://doi.org/10.1016/j.ejrh.2025.102778>
6. Gupta, A., Qiu, Y., Behrangi, A., & Niu, G. (2026). Noah-MP 40-Years Climatology for Water Balance over Ground Water Basins in Arizona, HydroShare, <http://www.hydroshare.org/resource/a3cc182071124849a463b6132213af23>. (Figures by Hinkley, M. & Mohsenzadeh Karimi, S.)
7. AZGeo City Points shapefile. Retrieved from AZGeo Data Hub: <https://azgeo-open-data-agic.hub.arcgis.com/datasets/azgeo::city-points/about>
8. Federal American Indian Reservation boundaries shapefile. Retrieved from: https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/Federal_American_Indian_Reservations_v1/FeatureServer
9. Lima, R., Springer, A., Sankey, T. (2026). Arizona Subsurface Infiltration Index v.2, HydroShare, <https://doi.org/10.4211/hs.abcd8aa1a793463ab33677ce9d46db58>
10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>

