



ARIZONA TRI-UNIVERSITY  
RECHARGE AND WATER  
RELIABILITY PROJECT REPORT

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APPENDIX A:  
GROUNDWATER  
BASIN PROFILES

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## Introduction

This appendix includes hydrologic summaries (“profiles”) for the state of Arizona as well as the 51 groundwater basins delineated by the Arizona Department of Water Resources (ADWR).

The appendix begins with the Arizona Statewide Profile followed by profiles for the 51 ADWR groundwater basins organized in alphabetical order. Each summary includes a wealth of information, ranging from general land cover, overall hydrology, historic precipitation, evapotranspiration, recharge and runoff patterns and a subsurface infiltration index. It includes how precipitation is partitioned, including how much water is evaporated or transpired by plants and how much water contributes to runoff and groundwater recharge. Subsequent pages illustrate projected changes in temperature, precipitation, recharge and runoff projected at the end of this century (2060–2099) compared to the historical period of 1981–2020.

The summaries include new information that has not been available previously, but has been rigorously evaluated using multiple methods. Although all models contain uncertainties, and there are greater uncertainties at smaller scales, the ATUR team is quite confident that the overall trends we are describing are well documented.

In addition to the maps, charts, and graphs, we have provided a narrative explanation of what they illustrate for both the Arizona Statewide Profile and for each of the 51 Groundwater Basin Profiles. Note that the narrative includes numbers that are very precise—in some cases to 100ths of millimeters. This is because this is a verbal version of the charts provided and not because the ATUR team believes it is possible to calculate or project these numbers to that degree of accuracy.

It is important to note the patterns that emerge when looking at the statewide scale, as opposed to at the basin scale. For example, the influence of the Mogollon Rim is highly visible in all of the maps except the change in temperature map, which essentially indicates that it will continue to be hotter *on average* in every month of the year, in every part of the state. Although there is significant potential for capture and recharge of water in this area, the greatest downward shifts in precipitation, runoff, and recharge are also anticipated in this region.

These summaries are intended to provide a general overview of our findings, but additional insights/investigations will be needed prior to making decisions about which capture and recharge efforts should be pursued and where.

## Table of Contents

*Click on the groundwater basin name to navigate to that profile.*

Arizona Statewide	Morenci
Agua Fria	Paria
Aravaipa Canyon	Parker
Big Sandy	Peach Springs
Bill Williams	Phoenix AMA
Bonita Creek	Pinal AMA
Butler Valley	Prescott AMA
Cienega Creek	Ranegras Plain
Coconino Plateau	Sacramento Valley
Detrital Valley	Safford
Donnelly Wash	Salt River
Douglas AMA	San Bernardino Valley
Dripping Spring Wash	San Rafael
Duncan Valley	San Simon Wash
Gila Bend	Santa Cruz AMA
Grand Wash	Shivwits Plateau
Harquahala INA	Tiger Wash
Hualapai Valley INA	Tonto Creek
Joseph City INA	Tucson AMA
Kanab Plateau	Upper Hassayampa
Lake Havasu	Upper San Pedro
Lake Mohave	Verde River
Little Colorado River Plateau	Virgin River
Lower Gila	Western Mexican Drainage
Lower San Pedro	Willcox AMA
McMullen Valley	Yuma
Meadview	

# Arizona Statewide Profile



## Statewide Summary Statistics

**Size**<sup>1</sup>: 113,990 square miles

**Elevation**<sup>2</sup>: Range: 70-12,633 ft; Median: 4,596 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (79%), Evergreen Forest (13%), Grassland Herbaceous (2.2%)

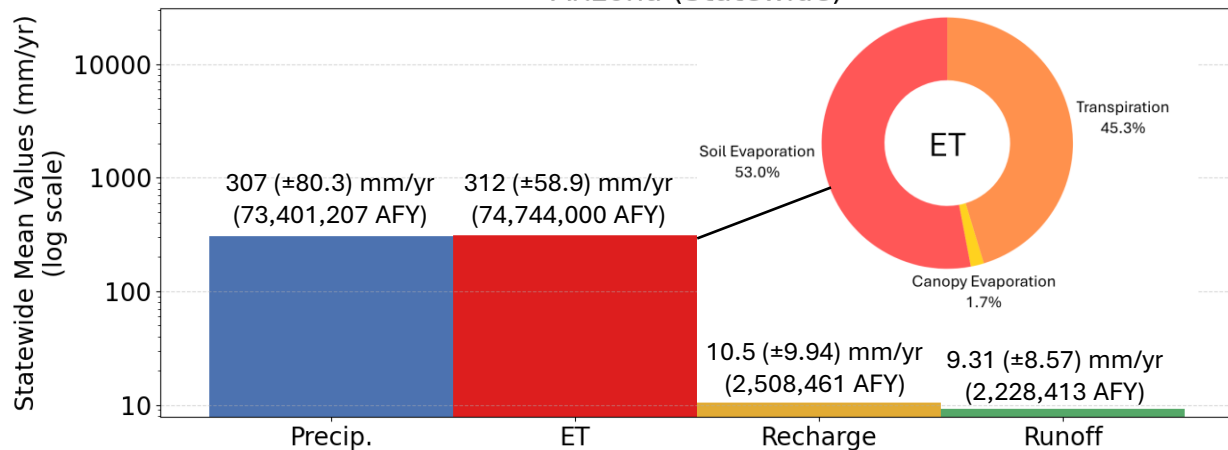
**Major surface watershed(s)**<sup>4</sup>: Gila River, Little Colorado River, Colorado River

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.32**

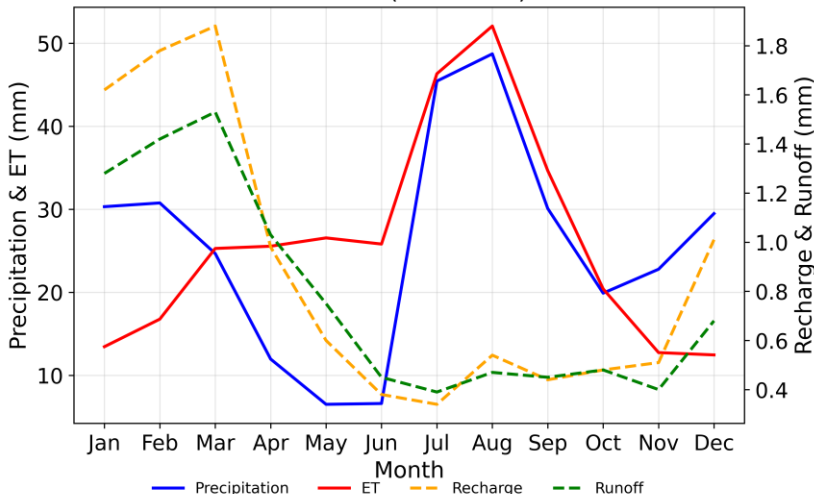


Mean Annual Hydrologic Cycle Components (1980-2020)  
Arizona (Statewide)



**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) statewide from 1980-2020.<sup>6</sup> 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)  
Arizona (Statewide)

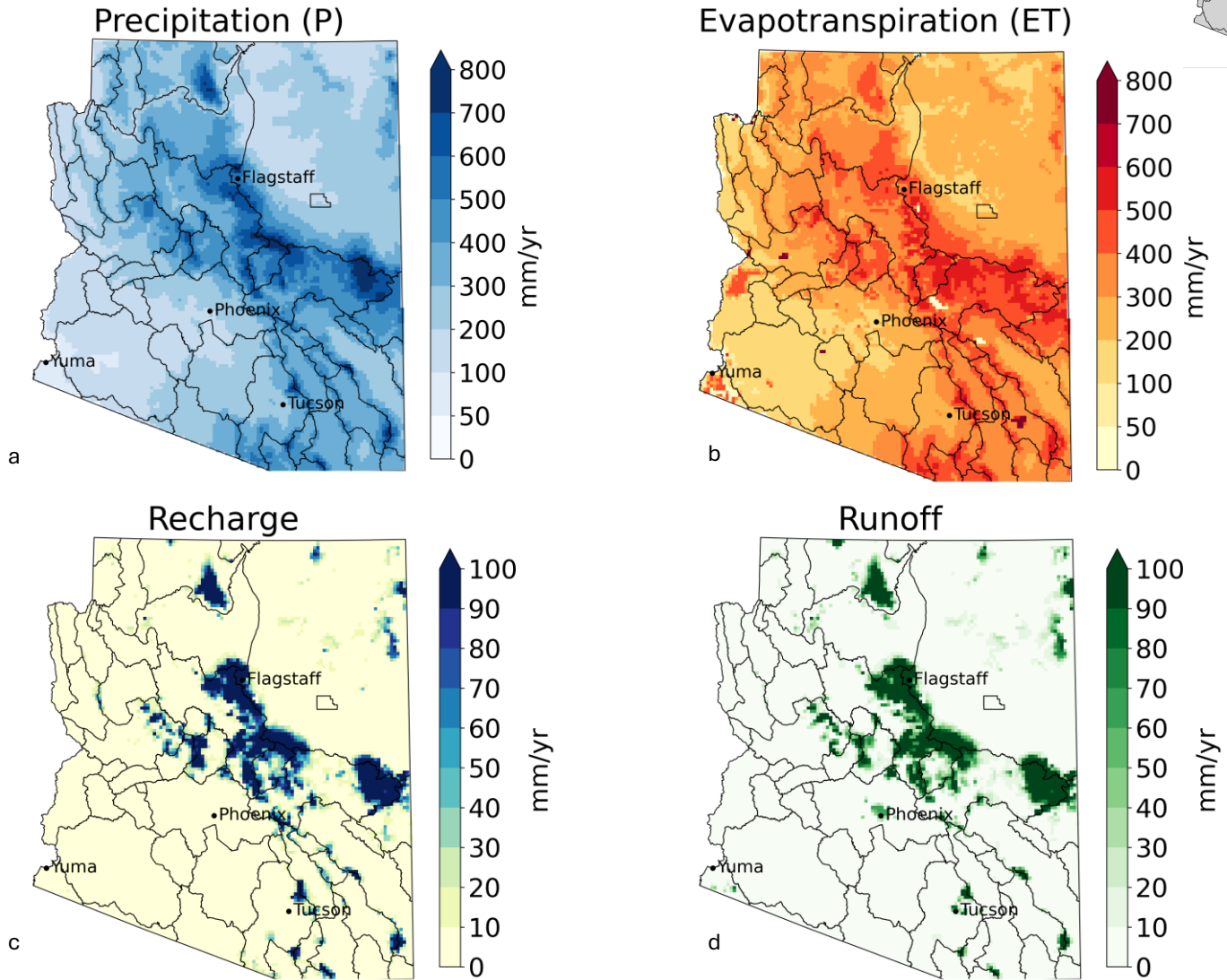


**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff statewide (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) on average statewide. P in Arizona is impacted by the North American Monsoon during the summer as well as large winter frontal systems during the cooler months. Seasonally, ET tracks with P from June to October when there is greater water availability, while P exceeds ET from October through March when evaporative demand is lower. Soil evaporation makes up the majority of ET across the state (53.0%). Transpiration comprises 45.3%, while canopy evaporation accounts for 1.7% of total ET. Natural recharge (10.5 mm/yr) and runoff (9.31 mm/yr) peak in March due to springtime snowmelt from Arizona's high-elevation regions.

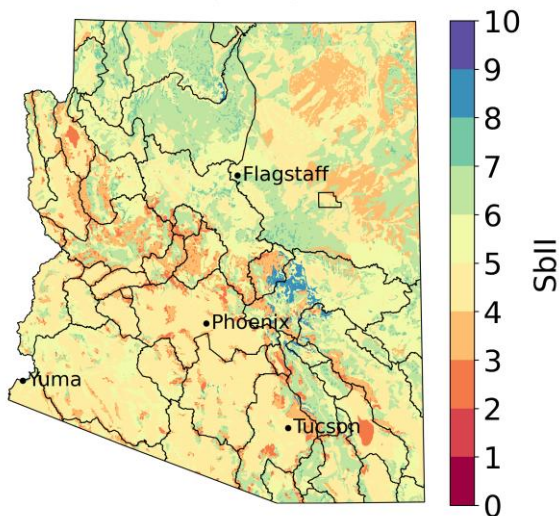
**Figure 3 (below).** Gridded depiction of major water fluxes across the state from Noah-MP modeling from 1980-2020: (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities are shown to help orient the reader.<sup>7</sup>

**Statewide**



**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the state on a scale of 1-10 based on geologic features.<sup>8</sup>

**Subsurface Infiltration Index (SbII)**



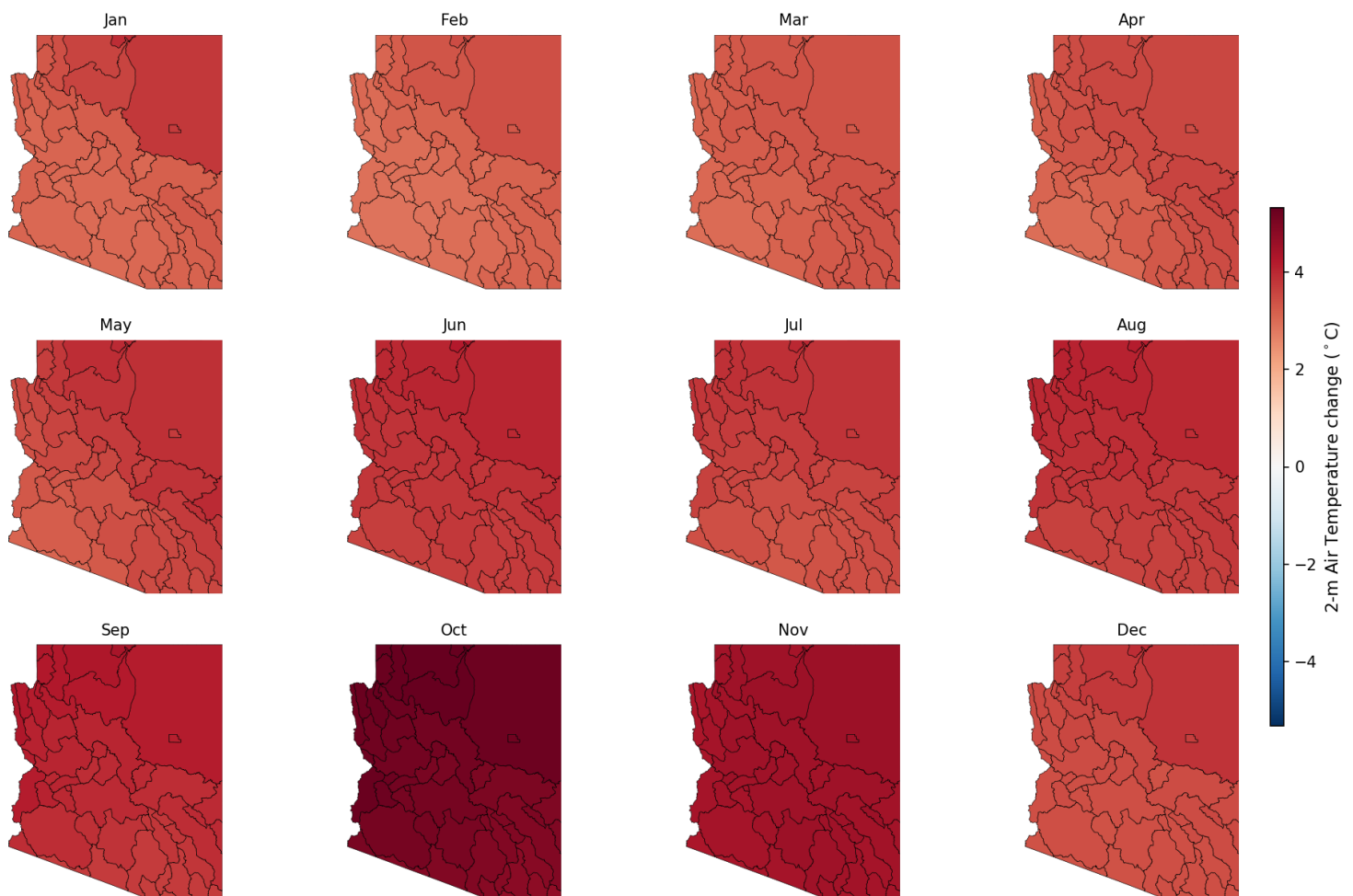
Modeling of the natural hydrologic cycle across Arizona reveals the Mogollon Rim as an area of critical importance to statewide water resources. Precipitation (P) is greatest along the Rim, where it exceeds 800 mm/yr on average at the highest elevations. Due to greater water availability, natural recharge (>100 mm/yr) and runoff (>100 mm/yr) are greatest in the higher-elevation regions of the state, including the Mogollon Rim and the Sky Islands. Evapotranspiration (ET) is greatest in the areas with highest water availability, including the Mogollon Rim (~500 mm/yr) and over open water such as lakes, reservoirs, and along the Colorado River (>1,000 mm/yr). Infiltration potential varies across the state, with areas of high potential along the Rim and in the Colorado Plateau province due to the presence of faults and fractures and karst-type geology. Across the Basin and Range, particularly in southern Arizona, alluvial deposits also present high infiltration potential.

## Statewide



Climate change projections for the natural hydrologic cycle through the year 2100 were conducted using 14 dynamically downscaled and bias-corrected global climate models (GCM) at 9-km resolution and the Noah-MP land surface model under the Intergovernmental Panel on Climate Change (IPCC) Shared Socio-economic Pathway (SSP) 3-7.0.<sup>9</sup> This SSP scenario is considered an intermediate-high emissions scenario and the most commonly used scenario in recent IPCC and US climate modeling efforts. The results project robust and continuing temperature increases alongside decreasing runoff and natural recharge driven by rising evaporative demand and precipitation declines concentrated in the state's high-elevation water source areas. The following figures compare the results of the ensemble mean of the 14 GCMs for the last 40 years of the century (2061-2099) to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0 averaged spatially across the 51 Arizona Department of Water Resources (ADWR) groundwater basins.<sup>1,9</sup>

Ensemble mean — 2-m Air Temperature delta  
SSP3-7.0 | 2060-2099 vs 1981-2020



**Figure 5.** Figure showing projected changes (delta) in temperature statewide for each month of the calendar year. Basin-wide averages for the monthly projected change in temperature at the end of the 21<sup>st</sup> century (2061-2099) under the IPCC SSP3-7.0 are compared to the historical record from 1981-2020 for each of the 51 ADWR groundwater basins.

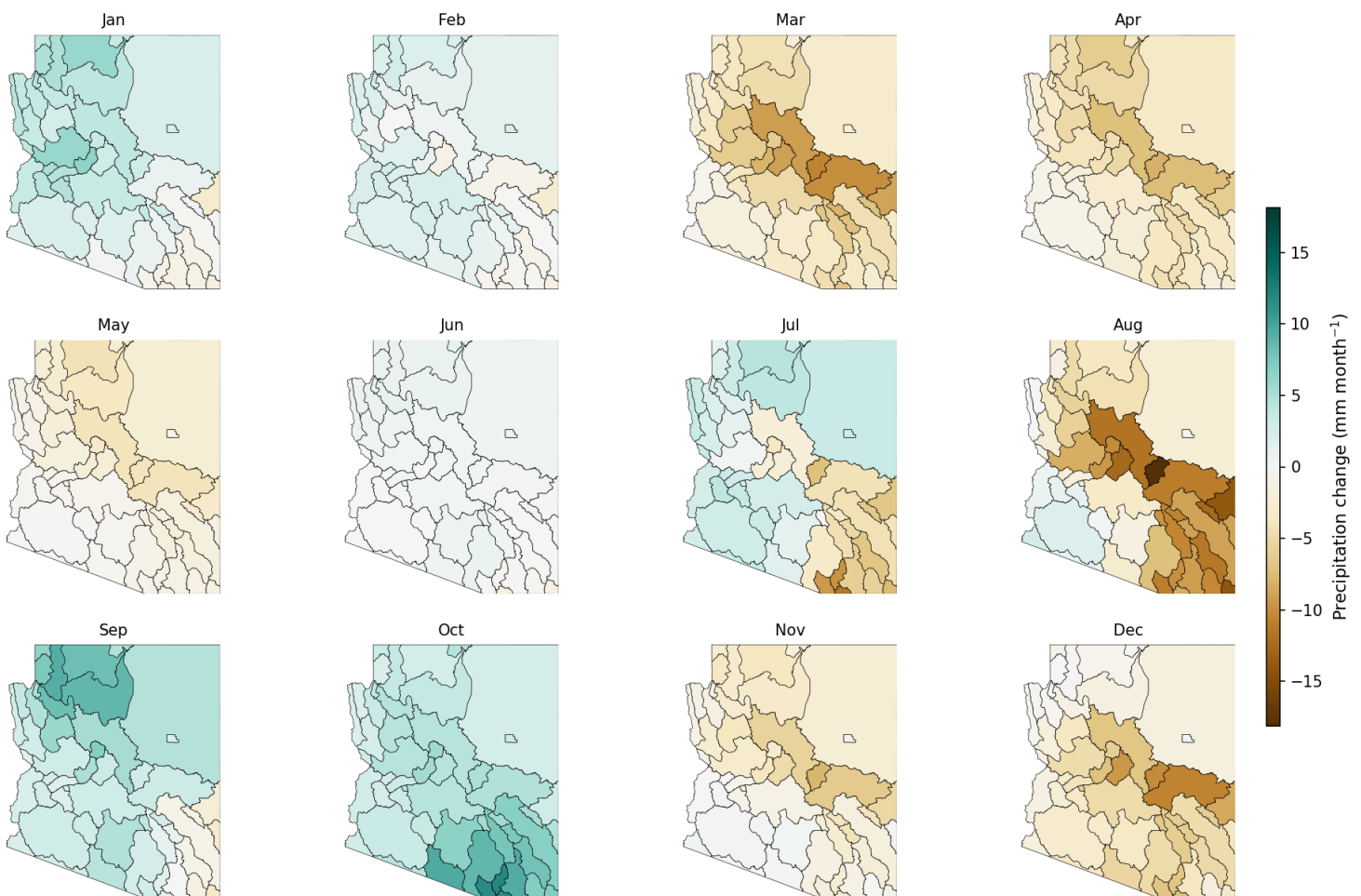
Projections show surface air temperature is projected to increase at a statistically significant rate of 0.05 °C/year over the period of 1981–2099. Seasonally, the greatest change in temperature is projected to occur during October (~5 °C by the end of the century). Spatially, projected changes in temperature appear fairly consistent across the state (3-5 °C depending on the season).

## Statewide



Statewide annual precipitation shows no statistically significant trend over the period of 1981-2099; however, this area-averaged result masks important spatial heterogeneity, as shown in Figure 6 below. Results for 2061–2099, when changes are projected to be most pronounced, indicate substantial decreases in annual precipitation over high-elevation areas. These high-elevation zones, such as the Mogollon Rim and White Mountains, function as Arizona's primary water sources and therefore dominate the area-averaged hydrological trends. The apparent contradiction between a statistically insignificant statewide precipitation trend and significant regional decreases reflects the state's diverse topography. Seasonally, the greatest changes in precipitation are projected to occur in August (10-15 mm in the Mogollon Rim and White Mountains), however, drier springs (March-May) and early winters (November-December) are also projected for most of the state. In contrast, September and October are projected to be 5-15 mm/month wetter across much of the state by the end of the century, which is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity.

Ensemble mean — Precipitation delta  
SSP3-7.0 | 2060-2099 vs 1981-2020



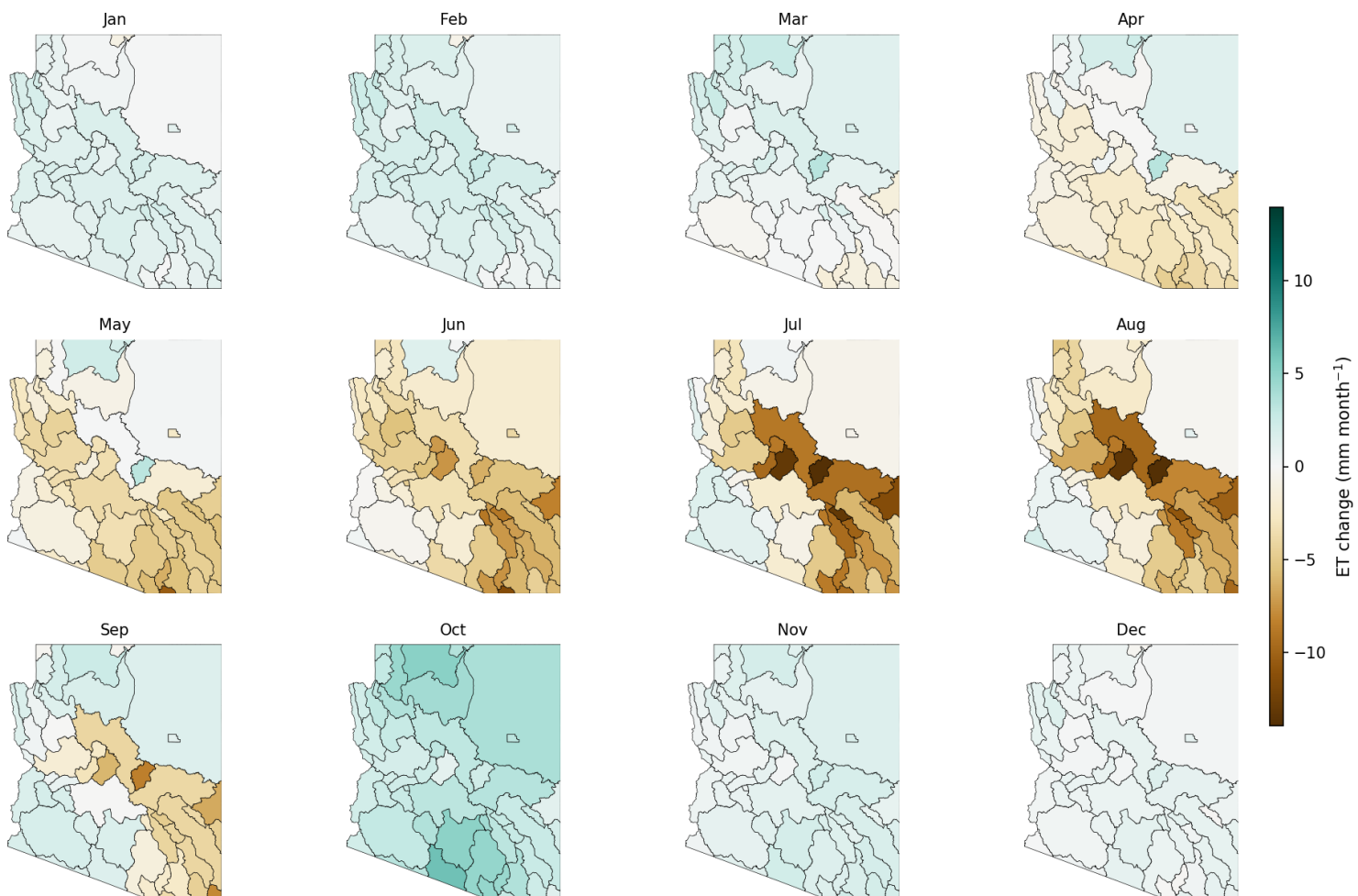
**Figure 6.** Figure showing projected changes (delta) in precipitation statewide for each month of the calendar year. Basin-wide averages for the monthly projected change in precipitation at the end of the 21<sup>st</sup> century (2061-2099) under the IPCC SSP3-7.0 are compared to the historical record from 1981-2020 for each of the 51 ADWR groundwater basins.

## Statewide



At the statewide scale, the interannual variation of evapotranspiration (ET) from 1981-2099 closely tracks that of precipitation, consistent with the water-limited regime characteristic of semi-arid environments like Arizona, where atmospheric moisture supply, rather than energy availability, is the primary constraint on ET. Projected changes in annual ET are spatially complex. Across most high-elevation areas, reduced precipitation drives a corresponding decrease in ET, consistent with a water-limited regime. This trend is visible along the Mogollon Rim and White Mountains, particularly during the North American Monsoon season (June-August) in Figure 7 below. While not visible in Figure 7 due to area-averaging across the 51 ADWR groundwater basins, it should be noted that a subset of the highest-elevation mountainous areas is projected to experience increased ET by the end of the century, potentially attributable to shifts in snowmelt timing, which can alter the seasonal distribution of moisture availability.

Ensemble mean — ET delta  
SSP3-7.0 | 2060-2099 vs 1981-2020



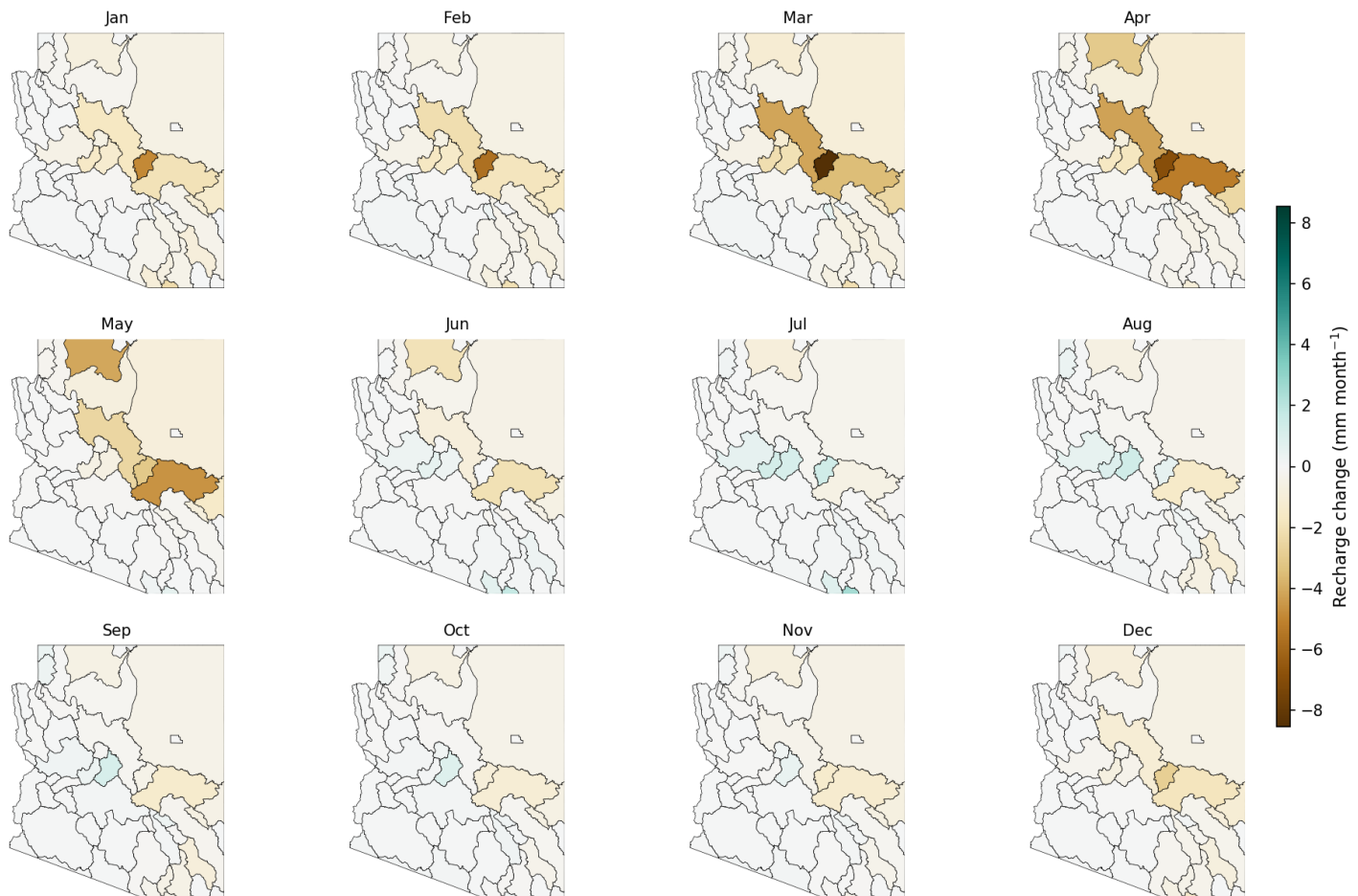
**Figure 7.** Figure showing projected changes (delta) in evapotranspiration (ET) statewide for each month of the calendar year. Basin-wide averages for the monthly projected change in evapotranspiration at the end of the 21<sup>st</sup> century (2061-2099) under the IPCC SSP3-7.0 are compared to the historical record from 1981-2020 for each of the 51 ADWR groundwater basins.

## Statewide



On average statewide, natural groundwater recharge and runoff are projected to decrease by approximately 0.07 mm/yr and 0.05 mm/yr, respectively, through the end of the century. This statewide decline is driven by increasing evaporative demand under rising temperatures even in the absence of a significant precipitation trend. As with precipitation and ET, declines in natural recharge and runoff are spatially nuanced and projected to be greatest in the areas of the state that have greatest water availability – the Mogollon Rim and White Mountains. As shown in Figure 8 (natural recharge) and Figure 9 (runoff), these declines are greatest in the spring months (March-May). This may be attributable to the projected declines in winter and early-spring precipitation by the end of the century, with significant implications for water resources planning across the state. Additional information related to climate change projections and impacts on the state’s water resources can be found in Section 2 of the Arizona Tri-University Recharge and Water Reliability Project Report to the Arizona Department of Water Resources.

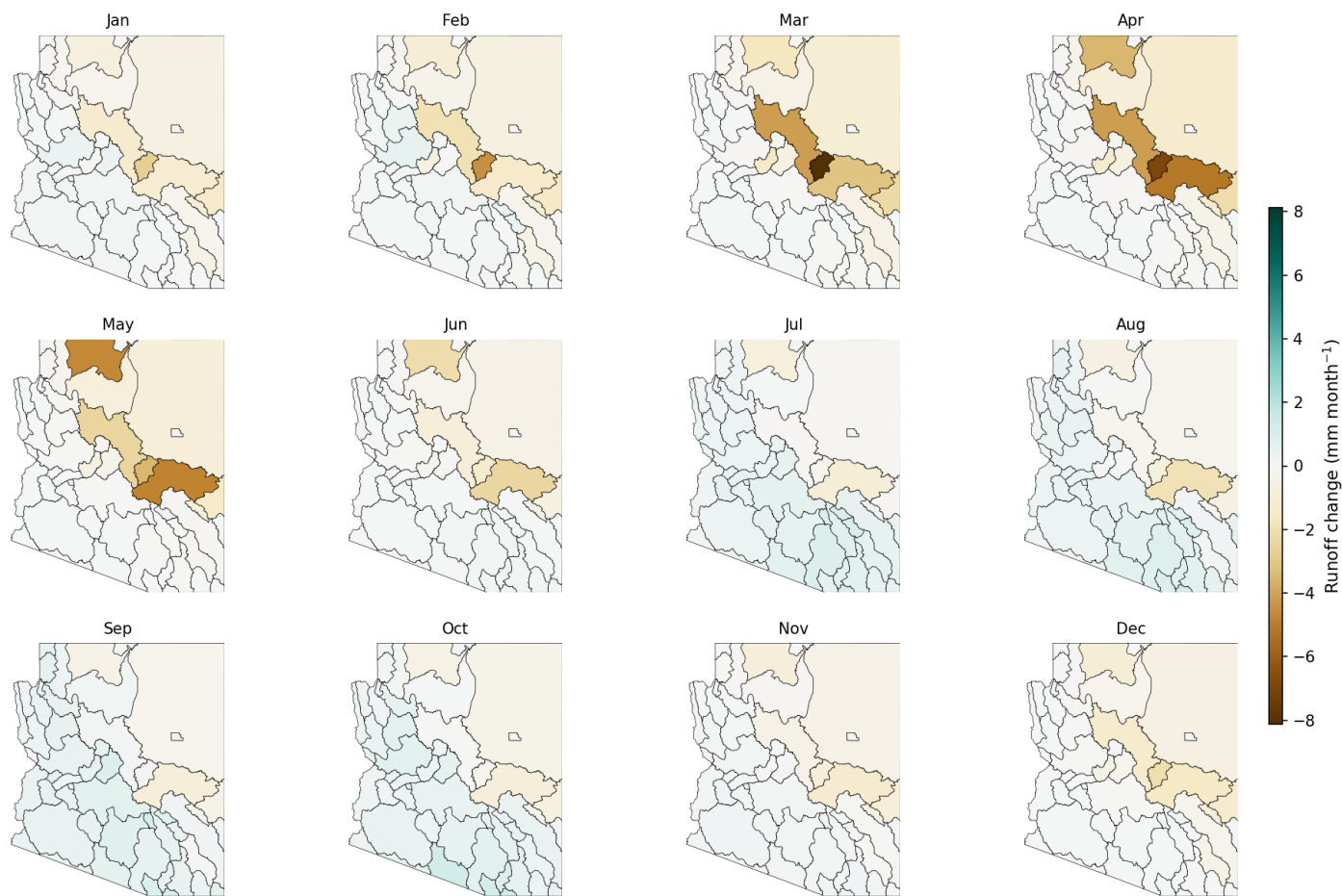
Ensemble mean — Recharge delta  
SSP3-7.0 | 2060–2099 vs 1981–2020



**Figure 8.** Figure showing projected changes (delta) in natural recharge statewide for each month of the calendar year. Basin-wide averages for the monthly projected change in natural recharge at the end of the 21<sup>st</sup> century (2061-2099) under the IPCC SSP3-7.0 are compared to the historical record from 1981-2020 for each of the 51 ADWR groundwater basins.



Ensemble mean — Runoff delta  
 SSP3-7.0 | 2060–2099 vs 1981–2020



**Figure 9.** Figure showing projected changes (delta) in runoff statewide for each month of the calendar year. Basin-wide averages for the monthly projected change in runoff at the end of the 21<sup>st</sup> century (2061–2099) under the IPCC SSP3-7.0 are compared to the historical record from 1981–2020 for each of the 51 ADWR groundwater basins.



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# Agua Fria Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 1,263 square miles

**Elevation**<sup>2</sup>: Range: 1,548-7,953 ft; Median: 4,065 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (86%), Evergreen Forest (10%), Grassland Herbaceous (1.7%)

**Major surface watershed(s)**<sup>4</sup>: Agua Fria River

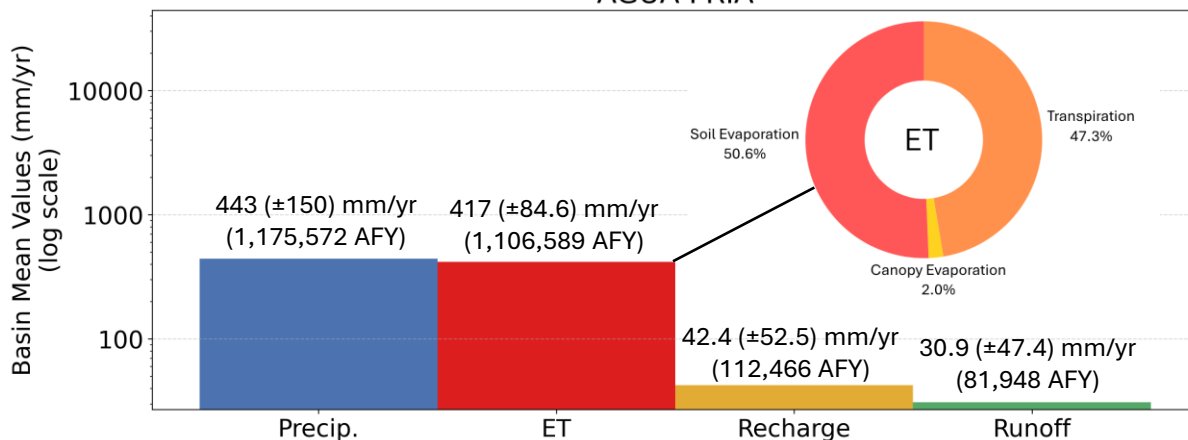
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.43** (Moderate)

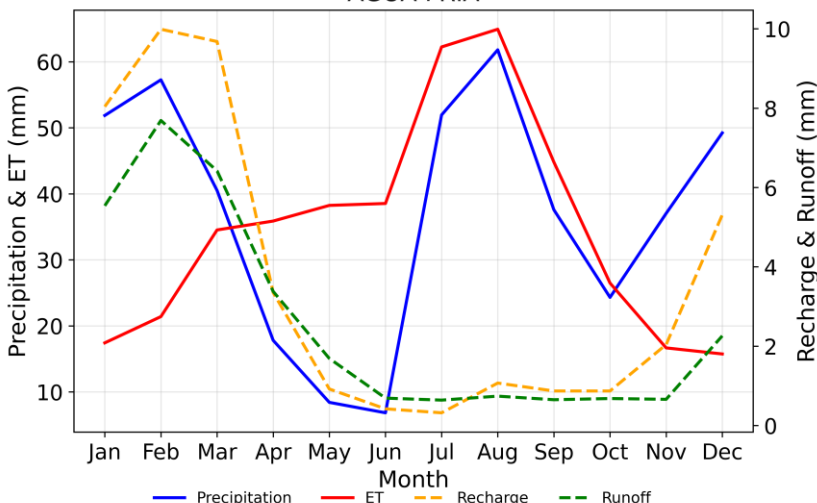


Mean Annual Hydrologic Cycle Components (1980-2020)  
AGUA FRIA



**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.<sup>6</sup> 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)  
AGUA FRIA



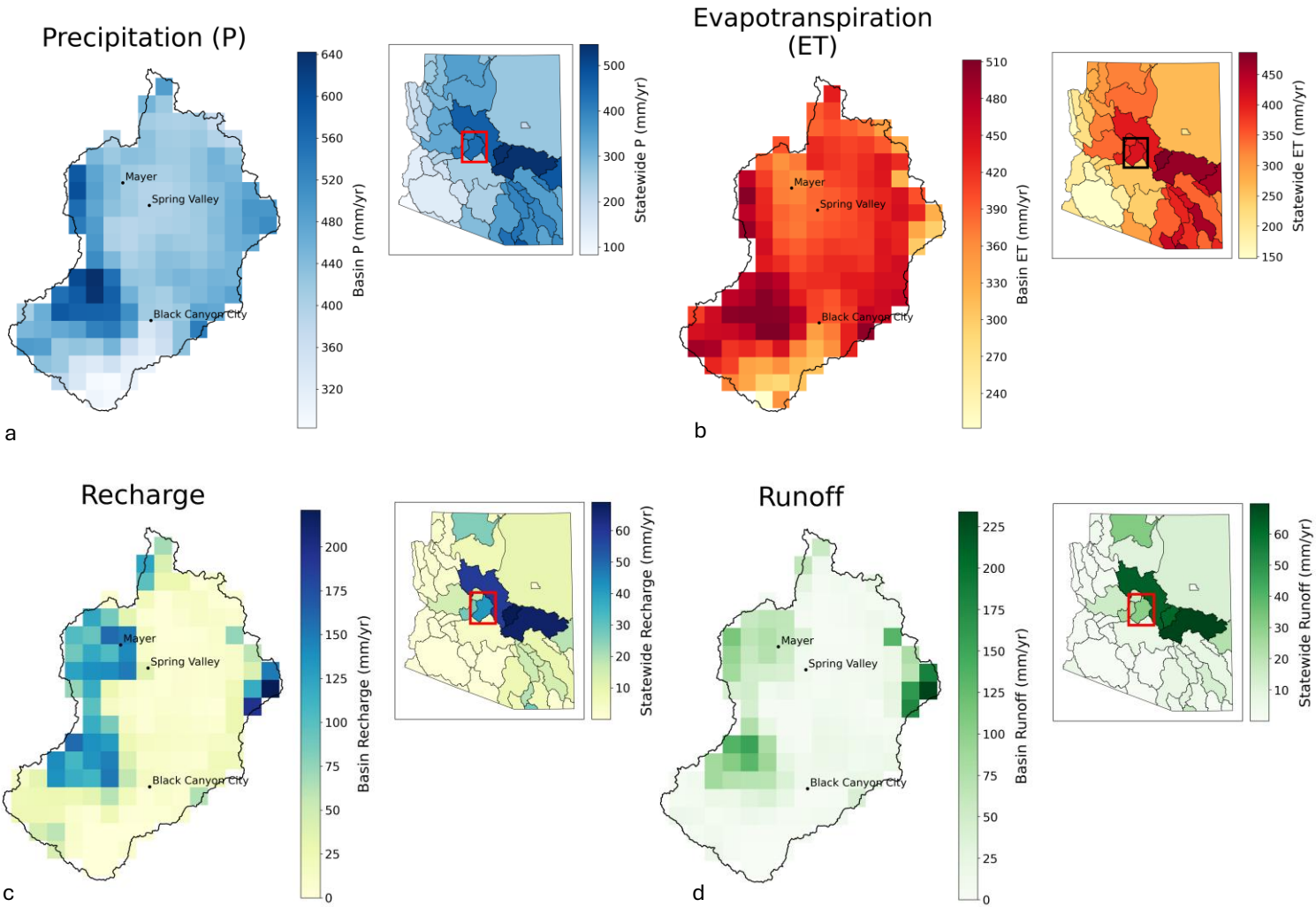
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Agua Fria 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 (42.4 mm/yr) and runoff (30.9 mm/yr) are highest in February as a result of springtime snowmelt and low evaporative demand. Soil evaporation makes up 50.6% of total ET in the basin, while transpiration comprises 47.3% and canopy evaporation accounts for the remainder (2.0%). Groundwater is estimated to supply 43% of total streamflow in the Agua Fria basin.

# Agua Fria

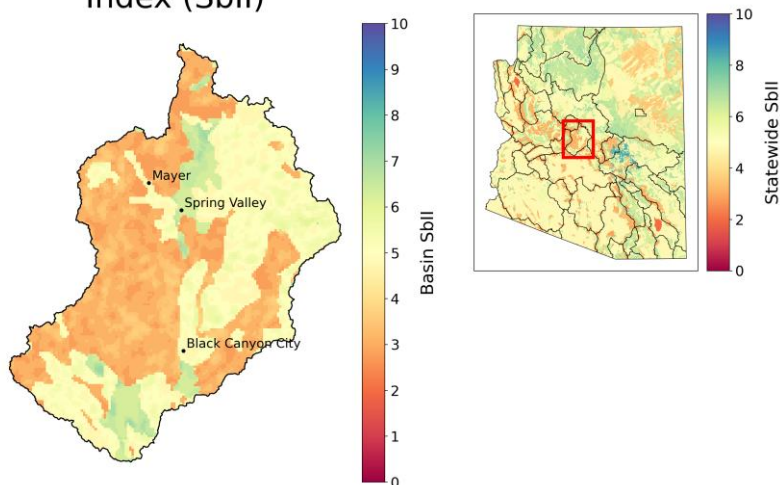


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

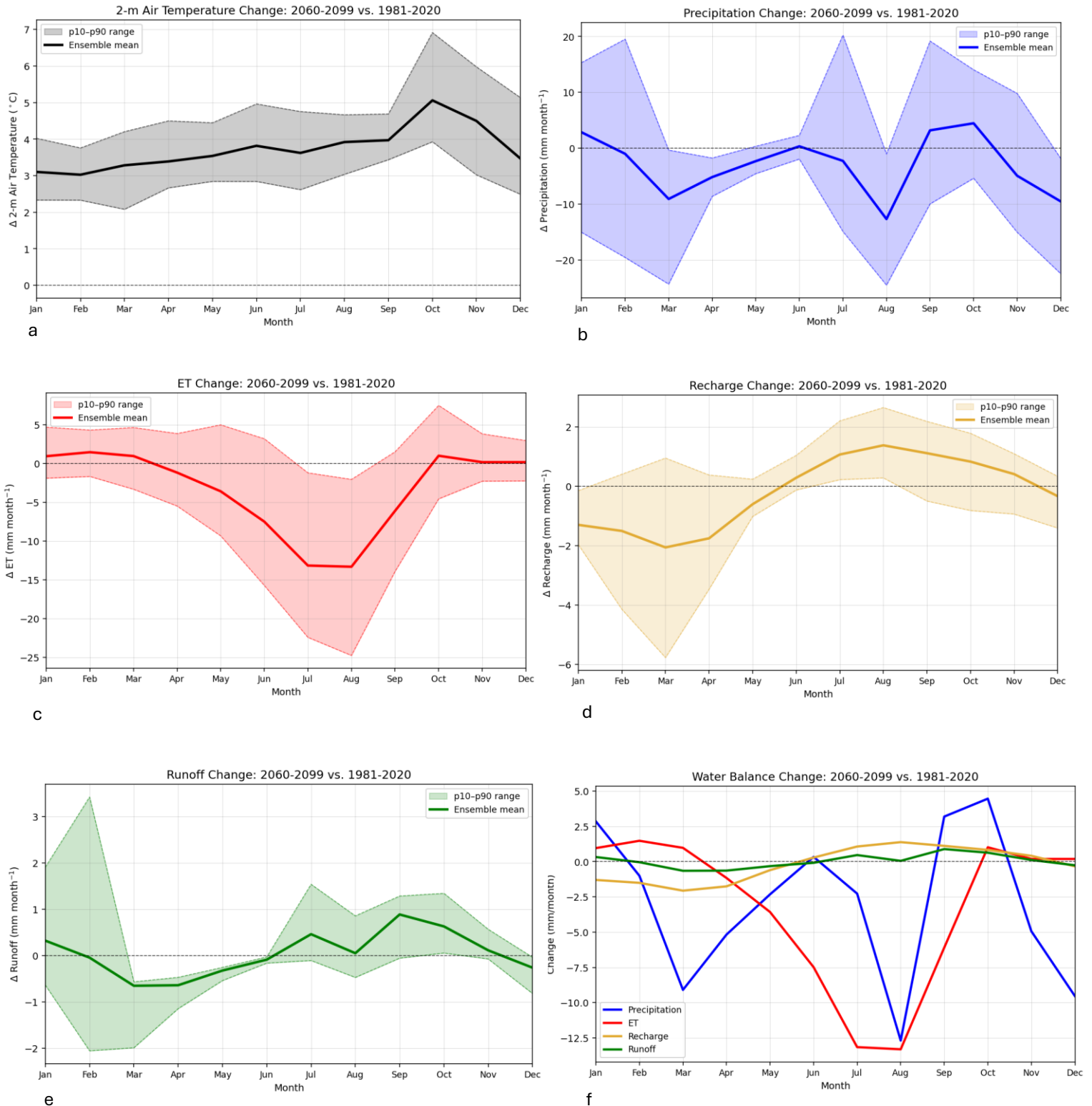
## Subsurface Infiltration Index (SbII)



Precipitation (P) in the Agua Fria basin is greatest in the Bradshaw Mountains in the western portion of the basin where it can exceed 600 mm/yr on average. Evapotranspiration (ET) is also highest in this region (~500 mm/yr). Natural recharge (150-200 mm/yr) and runoff (150-200 mm/yr) are greatest in the higher elevation regions of the basin, namely the Pine Mountain Wilderness to the east and the Bradshaw Mountains to the west. The Agua Fria basin contains pockets of moderate infiltration potential in the alluvial drainage to Lake Pleasant in the south and in the areas of moderately consolidated, limestone-containing conglomerate north of Spring Valley.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Agua Fria basin show drier springs (21-34% drier March through May) and a drier July (4%), August (19%), November (15%), and December (19%). September and October are projected to be 8-16% (2.8-4.4 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 37-49% (-1.6 to -2.1 mm/month) are projected for the highest recharge months (February-April), while projections for June-December show negative recharge (-0.47 to -1.6 mm/month).<sup>\*</sup> Negative recharge is projected despite less water loss in the system (shown as an increase from the baseline in Figure 8(d)). Runoff is projected to decrease March-May (49-85%), or -0.33 to -0.66 mm/month), while increasing in July (0.46 mm), September (0.88 mm), and October (0.64 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 19% (-13 mm) decrease in evapotranspiration (ET) during that month.

<sup>\*</sup>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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# Aravaipa Canyon Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 517 square miles

**Elevation<sup>2</sup>:** Range: 2,456-8,415 ft; Median: 4,523 ft

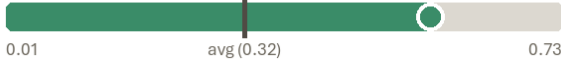
**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (87%), Evergreen Forest (12%), Grassland Herbaceous (0.44%)

**Major surface watershed(s)<sup>4</sup>:** Lower San Pedro

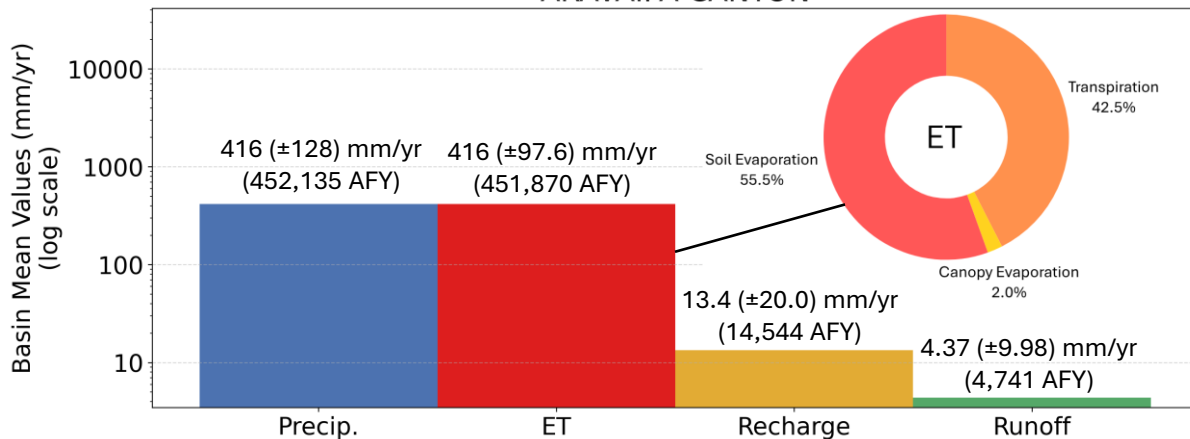
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.56** (High)

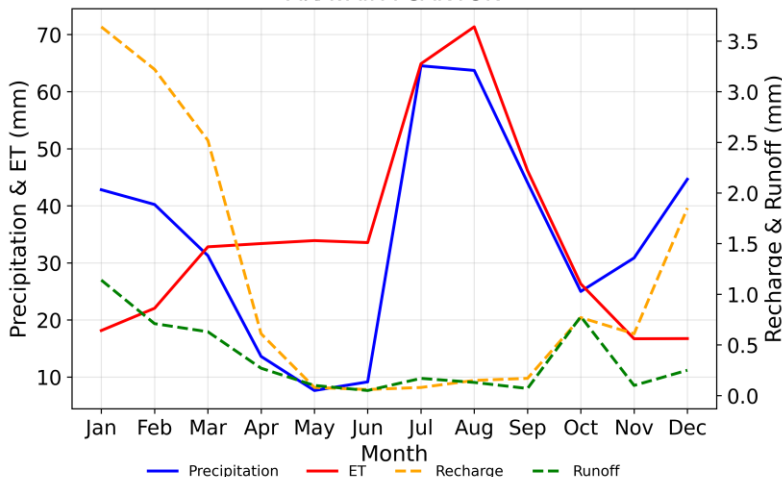


Mean Annual Hydrologic Cycle Components (1980-2020)  
ARAIPA CANYON



**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.<sup>6</sup> 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)  
ARAIPA CANYON



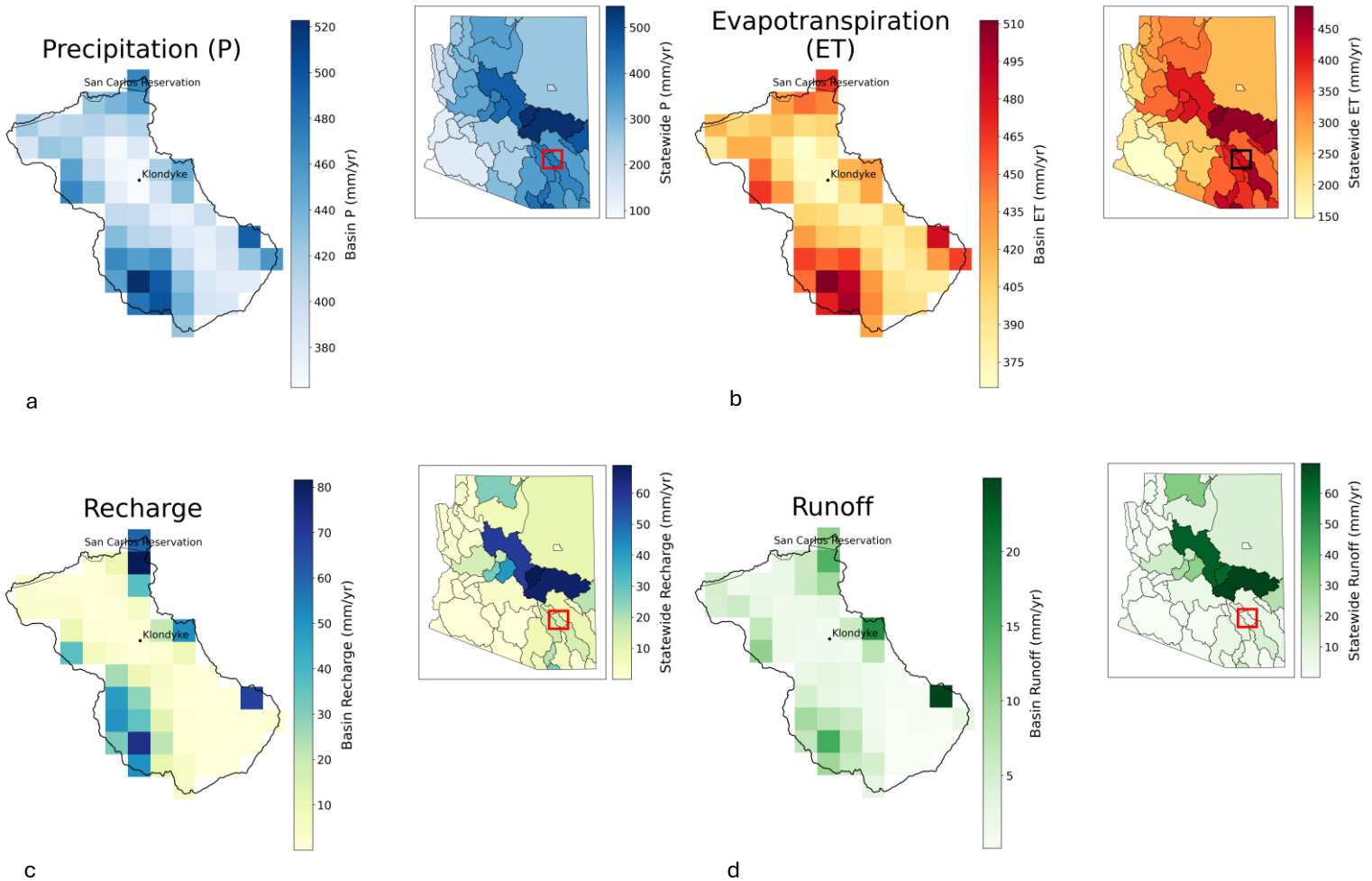
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) on average across the basin. P in the Aravaipa Canyon basin is affected by the North American Monsoon during the summer months. ET is greater than P from March to June and tracks with P from July to October. Soil evaporation makes up 55.5% of total ET in the basin, while transpiration comprises 42.5% and canopy evaporation accounts for the remainder (2.0%). Natural recharge (13.4 mm/yr) and runoff (4.37 mm/yr) are greatest in January due to winter precipitation and relatively low evaporative demand during the cooler months. Groundwater supplies an estimated 56% of total streamflow in the basin.

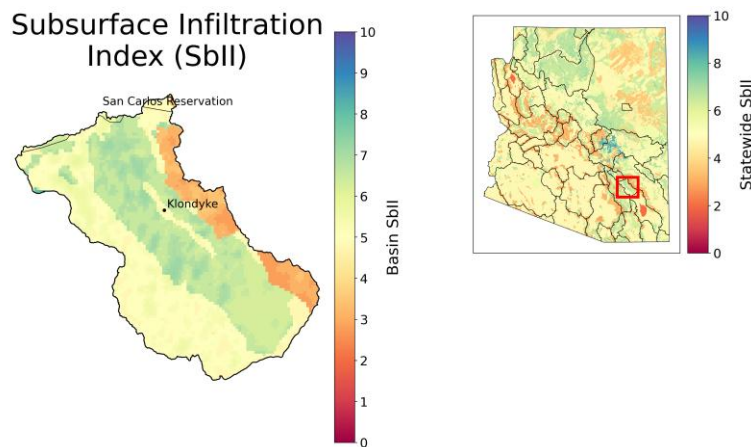
# Aravaipa Canyon



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

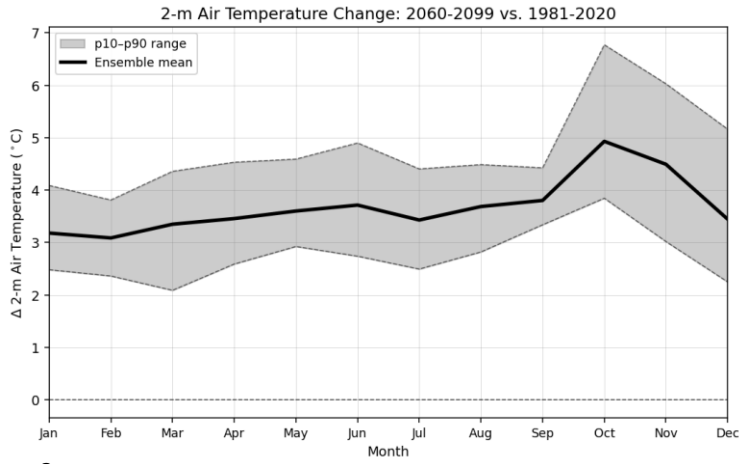


Precipitation in the Aravaipa Canyon basin is highest in the high-elevation areas of the basin, including the Galiuro Mountains to the southwest, the Santa Teresa Wilderness to the northeast, and Mount Graham to the southeast. These regions receive over 500 mm/yr of precipitation on average. Evapotranspiration (ET, ~500 mm/yr), natural recharge (~60 mm/yr) and runoff (~15 mm/yr) are greatest in these regions. Subsurface infiltration potential is moderate to high across the basin due to the presence of conglomerates containing limestone along Aravaipa Creek.

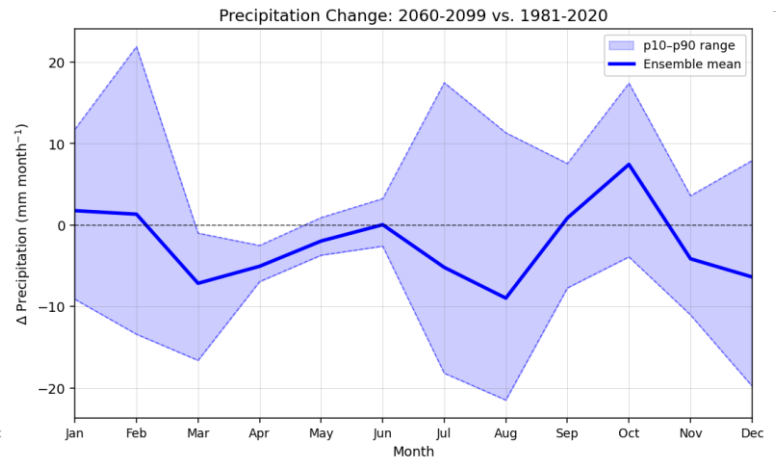
# Aravaipa Canyon



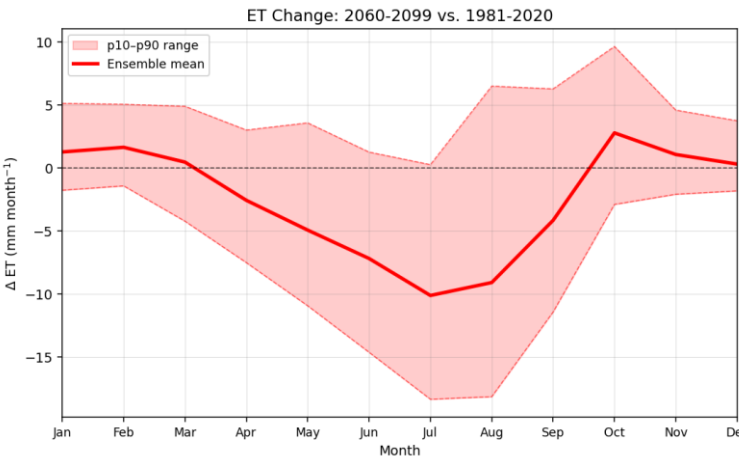
## Climatic Change Projections: Changes in Temperature, Precipitation, ET, Recharge, and Runoff (2060-2099 vs. 1981-2020)



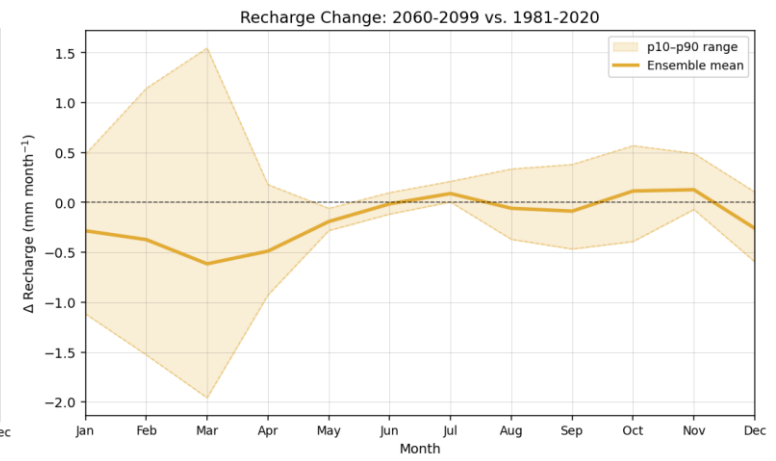
a



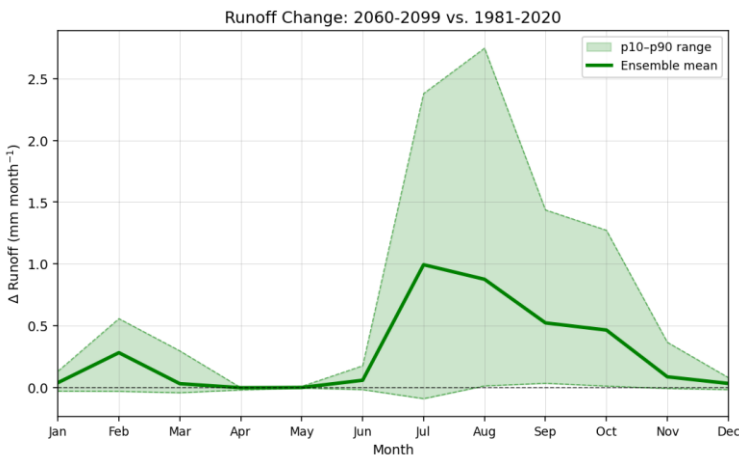
b



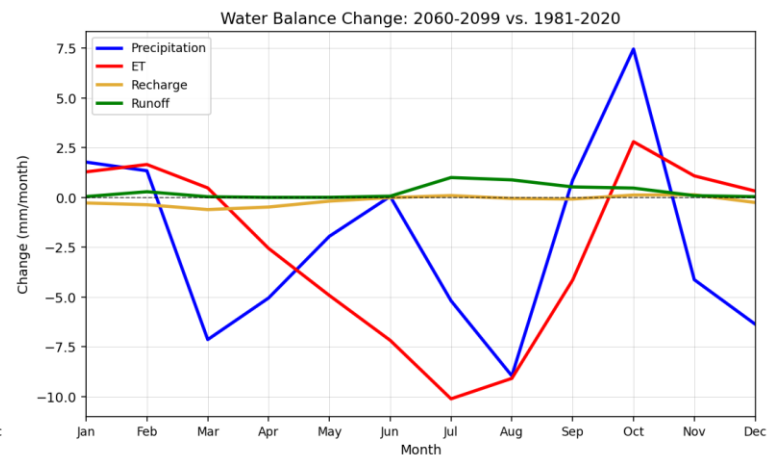
c



d



e



f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Aravaipa Canyon basin show less precipitation throughout much of the year, with the exception of January-February (3-4% or 1.3-1.6 mm/month increase) and October, which shows a 30% (7.4 mm) increase in precipitation. The greatest declines in precipitation are projected for March-May (21-40% drier), July-August (8-14%), and November-December (14%). Declines in recharge ranging from 18-24% (-0.34 to -0.62 mm/month) are projected for highest recharge months from January to March. Recharge is projected to be slightly negative in June and July (-0.05 to -0.07 mm/month).<sup>\*</sup> While remaining below 1.3 mm/month, runoff is projected to increase by 0.47-1.0 mm/month from July to October by the end of the century. Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Less water availability from April to August leads to projected declines (7-16% or -2.6 to -10 mm/month) in evapotranspiration (ET) during the warmer months, while higher temperatures and greater precipitation are consistent with a projected 10% (2.7 mm) increase in ET in October compared to the baseline period.

<sup>\*</sup>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/>
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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>
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7. AZGeo City Points shapefile. Retrieved from AZGeo Data Hub: <https://azgeo-open-data-agic.hub.arcgis.com/datasets/azgeo::city-points/about>
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# Big Sandy Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 1,988 square miles

**Elevation**<sup>2</sup>: Range: 1,638-8,383 ft; Median: 4,817 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (86%), Evergreen Forest (12%), Grassland Herbaceous (1.2%)

**Major surface watershed(s)**<sup>4</sup>: Big Sandy River

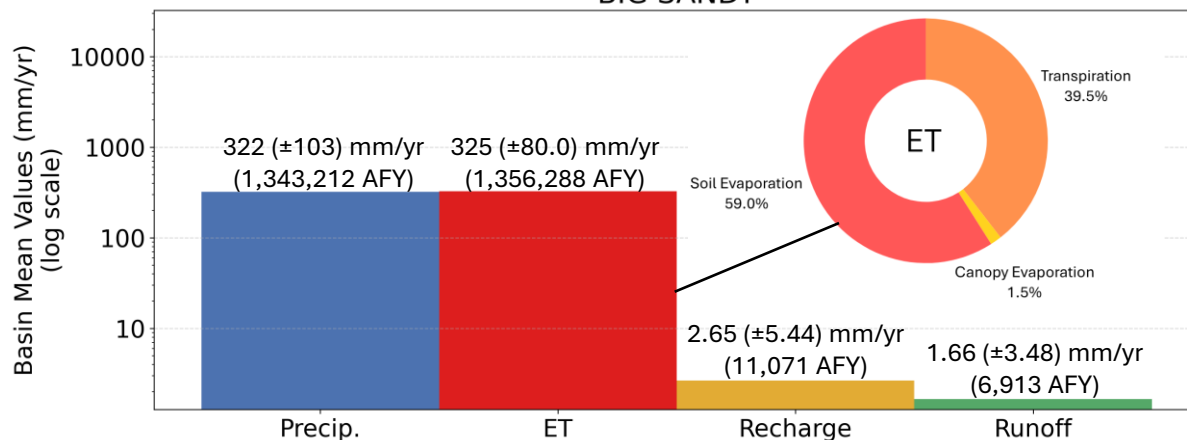
**Groundwater subbasins**<sup>1</sup>: Wikieup, Fort Rock

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.66** (Very High)

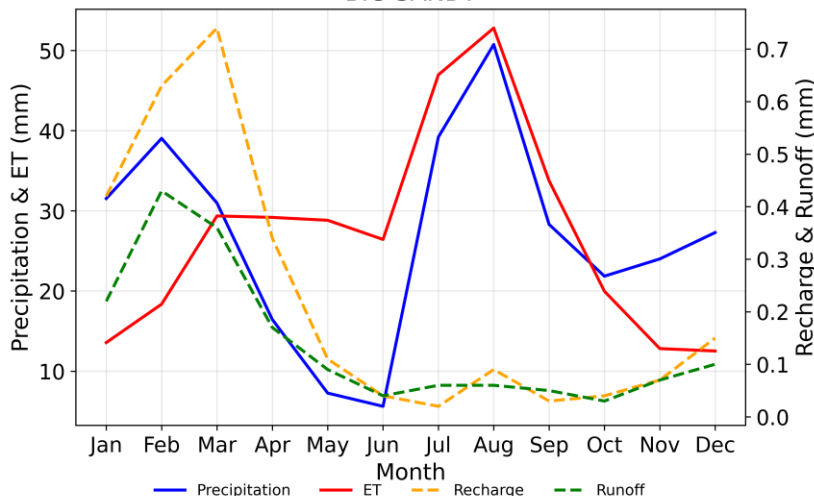


Mean Annual Hydrologic Cycle Components (1980-2020)  
BIG SANDY



**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.<sup>6</sup> 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)  
BIG SANDY



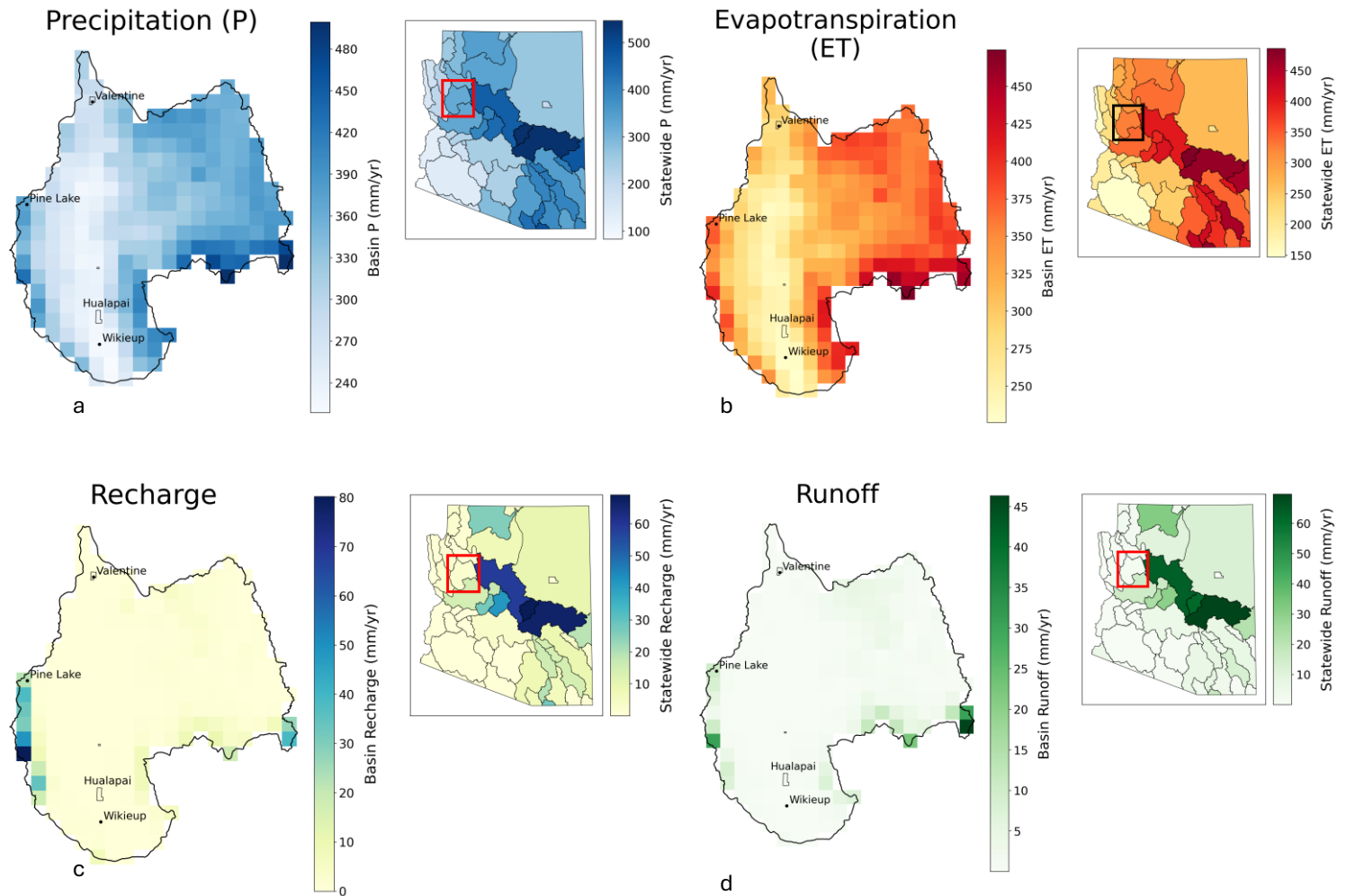
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Big Sandy basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. On annual timescales, evapotranspiration (ET) is approximately equal to P, resulting in low basin-wide averages of natural recharge (2.65 mm/yr) and runoff (1.65 mm/yr). Soil evaporation makes up 59.0% of total ET in the basin, while transpiration comprises 39.5% and canopy evaporation accounts for the remainder (1.5%). Natural recharge and runoff are slightly higher in the cooler months when P exceeds ET. Groundwater is estimated to supply 66% of total streamflow in the Big Sandy basin.

# Big Sandy

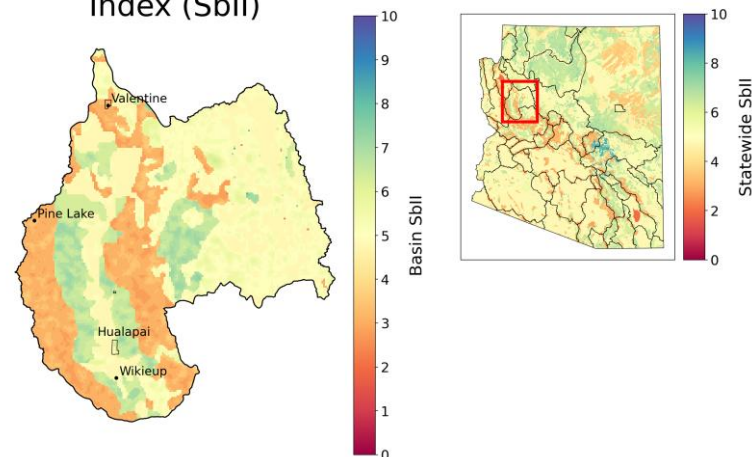


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

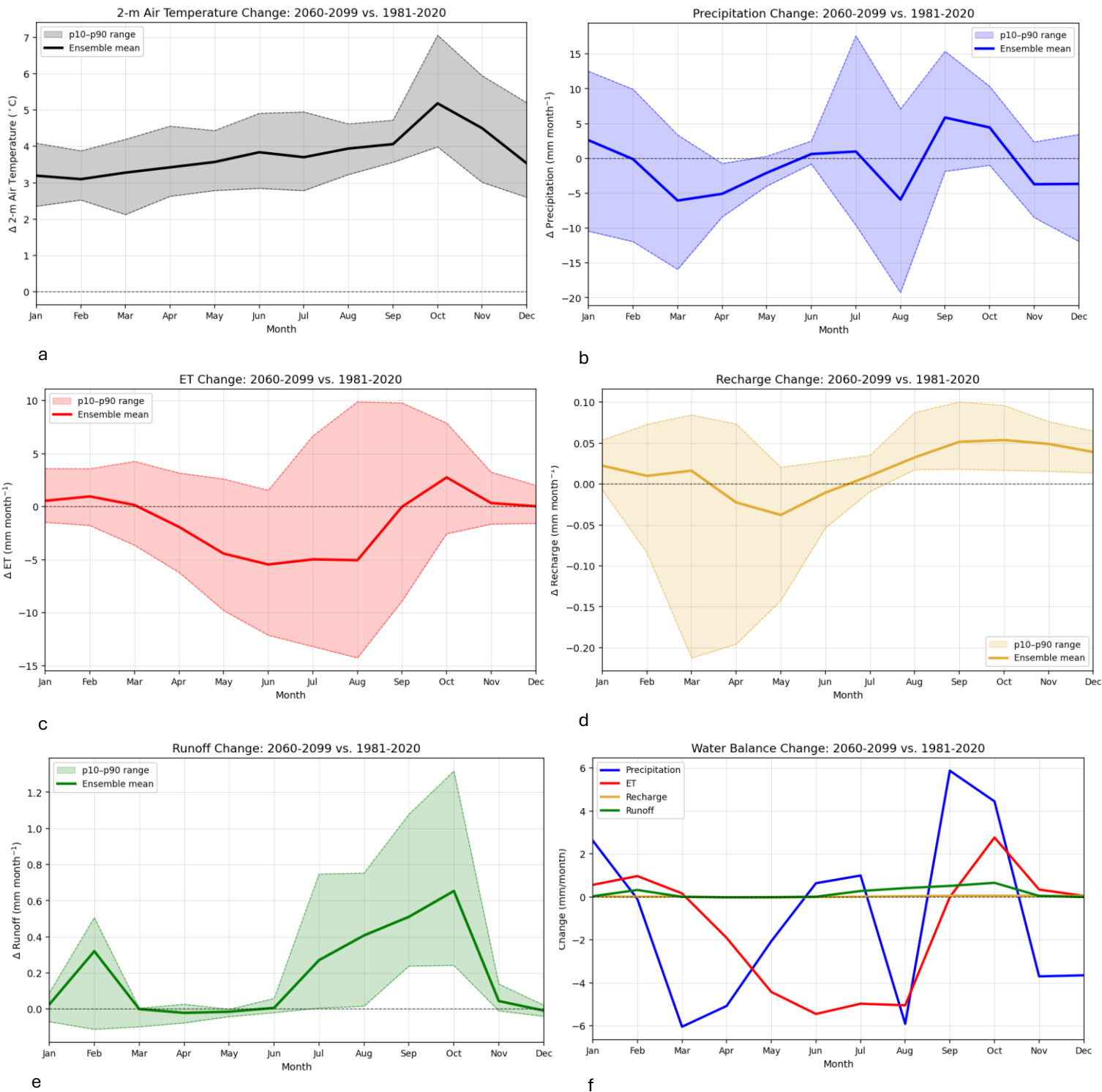
## Subsurface Infiltration Index (SbII)



Precipitation (P) in the Big Sandy basin is greatest at the higher elevations, particularly in the Hualapai and Mohon Mountains where P can exceed 430 mm/yr on average. ET (~430 mm/yr), natural recharge (~60 mm/yr), and runoff (~30 mm/yr) are also highest in these regions. Infiltration potential varies across the basin. Areas with higher potential result from higher permeability soils in the alluvial fans at the mountain fronts to the east and west of the Big Sandy 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Big Sandy basin show drier springs (18-33% drier March through May), and a drier August (10%), November (17%), and December (13%). September and October are projected to be 19-20% (4.4-5.7 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. Natural recharge is projected to remain near zero throughout the year and be slightly negative from May through February (-0.02 to -0.11 mm/month).<sup>\*</sup> While runoff is projected to remain below 0.9 mm/month, minor increases of 0.28-0.67 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.1 °C in February to 5.2 °C in October. Less precipitation in August leads to a projected 9% (-4.9 mm) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 13% (2.7 mm) increase in ET in October compared to the baseline period.

<sup>\*</sup>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/>
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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Bill Williams Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 3,350 square miles

**Elevation<sup>2</sup>:** Range: 450-7,379 ft; Median: 3,023 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (90%), Evergreen Forest (7.2%), Grassland Herbaceous (1.1%)

**Major surface watershed(s)<sup>4</sup>:** Santa Maria River, Burro Creek, Big Sandy River, Bill Williams River

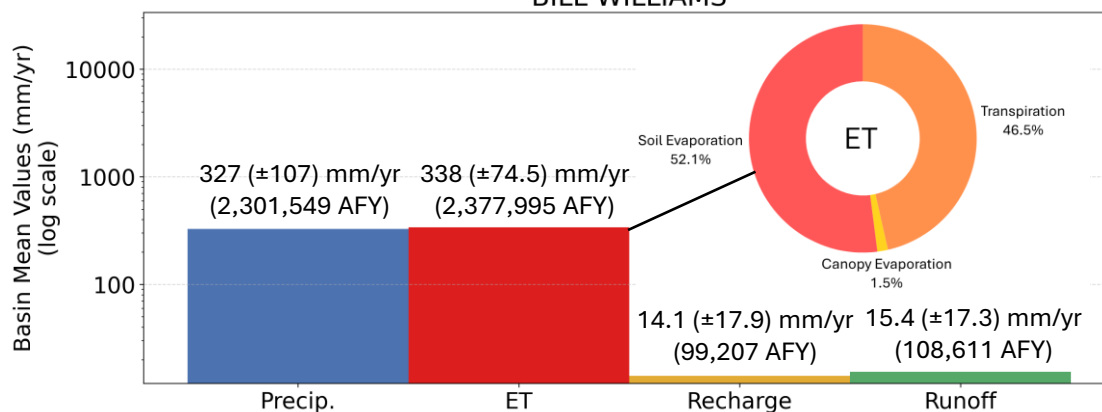
**Groundwater subbasins<sup>1</sup>:** Santa Maria, Burro Creek, Alamo Reservoir, Skull Valley, Clara Peak

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.45** (Moderate)

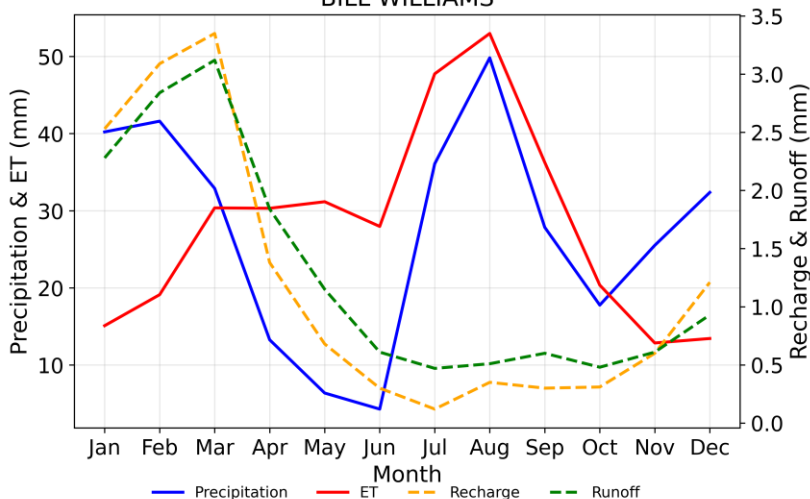


Mean Annual Hydrologic Cycle Components (1980-2020)  
BILL WILLIAMS



**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.<sup>6</sup> 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)  
BILL WILLIAMS

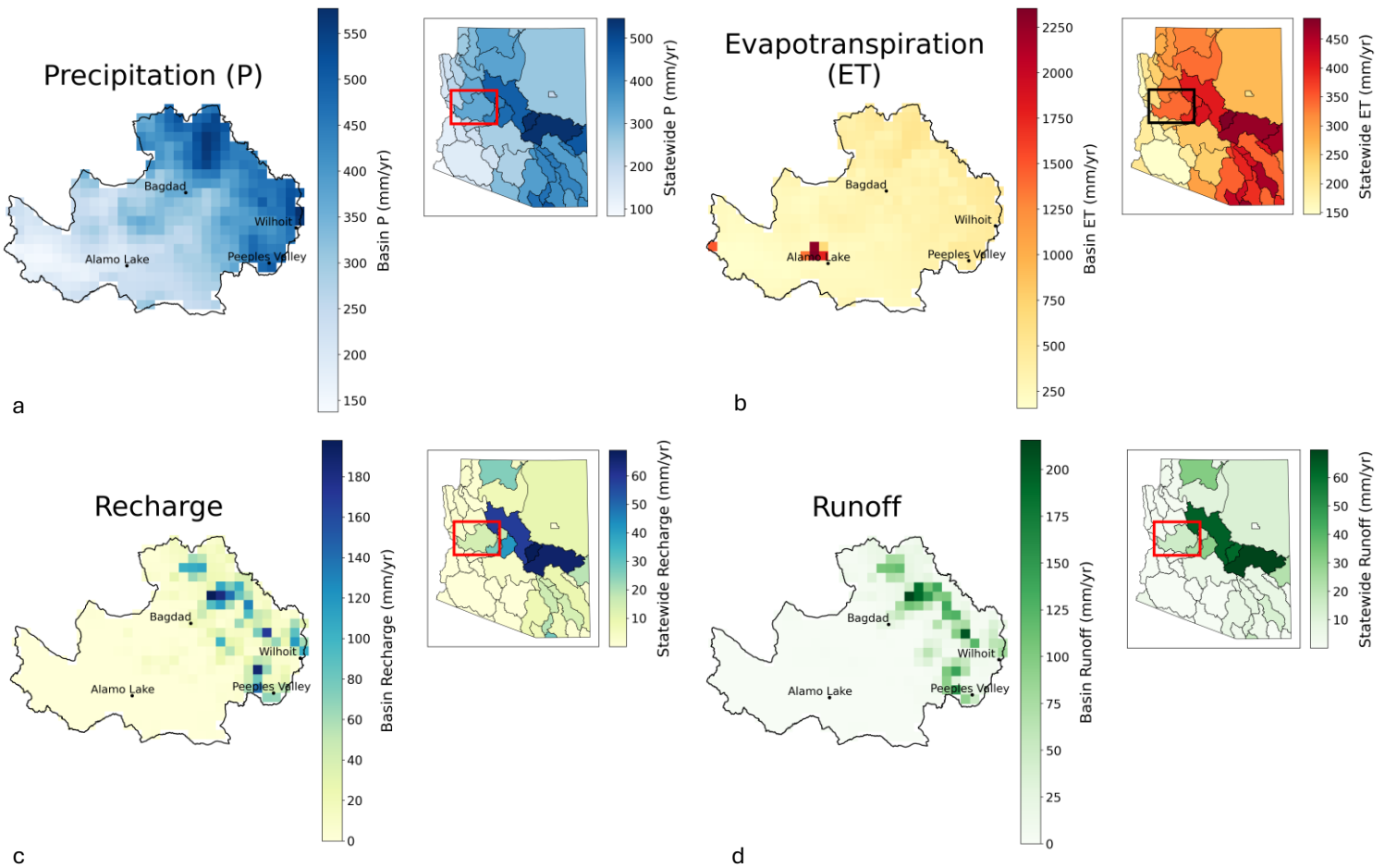


**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

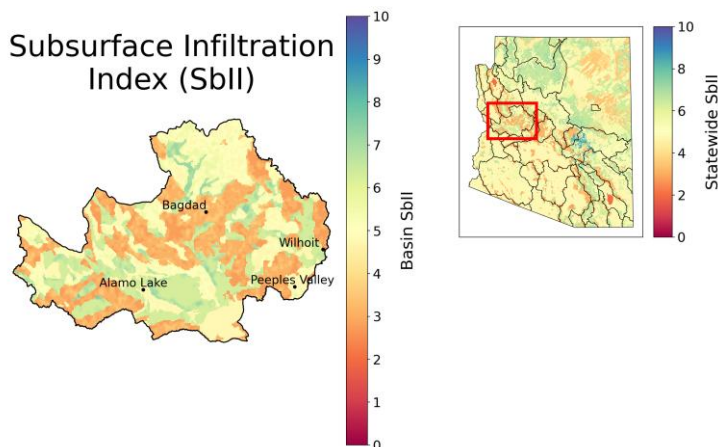
Precipitation (P) in the Bill Williams basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. On annual timescales, evapotranspiration (ET) is greater than P; however, P exceeds ET in the cooler seasons from mid-October to March. Soil evaporation makes up 52.1% of total ET in the basin, while transpiration comprises 46.5% and canopy evaporation accounts for the remainder (1.5%). Natural recharge (14.1 mm/yr) and runoff (15.4 mm/yr) peak in March due to springtime snowmelt. Groundwater supplies an estimated 45% of total streamflow in the Bill Williams basin.



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



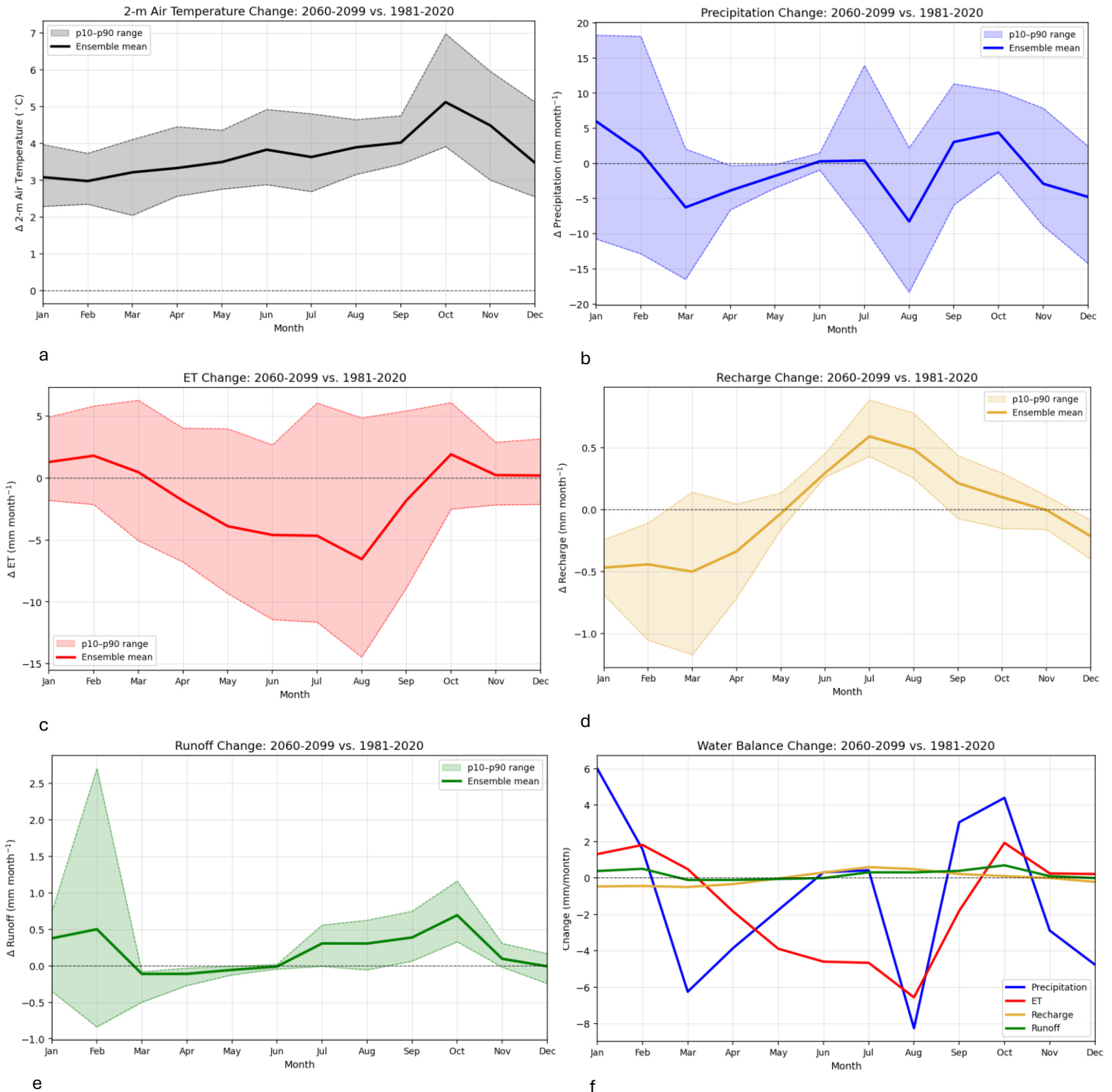
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Bill Williams basin is greatest at the higher elevations in the eastern portion of the basin, where P can exceed 500 mm/yr on average. Natural recharge (~160 mm/yr) and runoff (~175 mm/yr) are also highest in this region. ET (~2,000 mm/yr) is highest over the open water of Alamo Lake. Infiltration potential varies across the basin, with the areas of highest potential along alluvial deposits and drainages throughout 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Bill Williams basin show drier springs (18-32% drier March through May), and a drier August (16%), November (13%), and December (14%). September and October are projected to be 11-22% (3.0-4.5 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. The months with the highest natural recharge (January-April) are projected to have declines of 45-95% (-0.34 to -0.52 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 (-0.14 to -0.41 mm/month).<sup>\*</sup> While runoff is projected to remain below 1.0 mm/month, minor increases of 0.36-0.44 mm/month are projected for January-February, while increases of 0.31-0.71 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.0 °C in February to 5.2 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 10% (1.9 mm) increase in evapotranspiration (ET) in October and 8% (1.3-1.7 mm) in January-February compared to the baseline period, while less water availability in August leads to a projected decline in ET (13% or -6.5 mm).

<sup>\*</sup>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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# Bonita Creek Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 457 square miles

**Elevation<sup>2</sup>:** Range: 3,155-7,534 ft; Median: 5,134 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (79%), Evergreen Forest (14%), Grassland Herbaceous (6.5%)

**Major surface watershed(s)<sup>4</sup>:** Upper Gila River - San Carlos Reservoir, San Carlos River

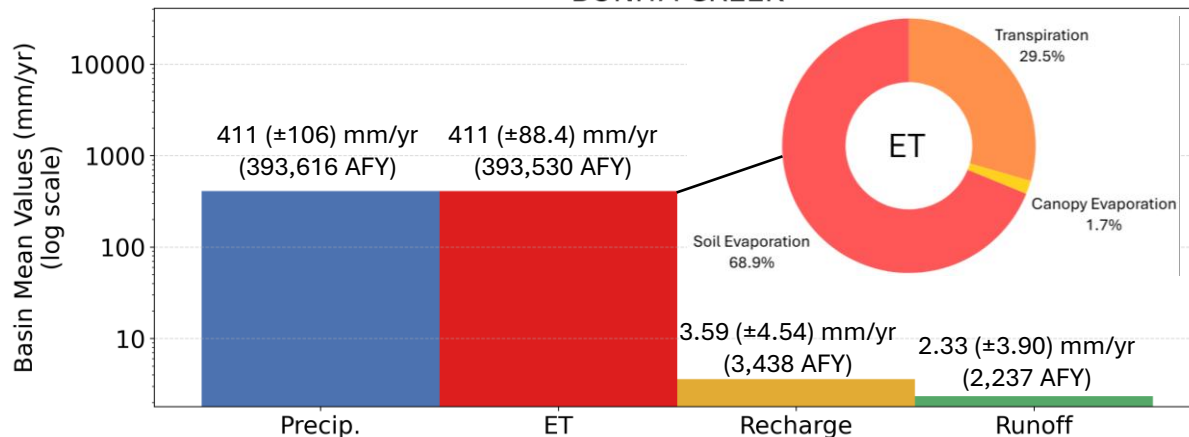
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.66** (Very High)

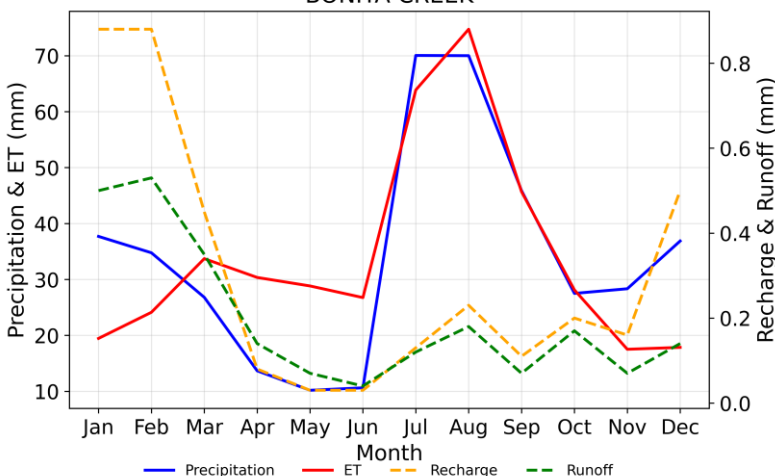


Mean Annual Hydrologic Cycle Components (1980-2020)  
BONITA CREEK



**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.<sup>6</sup> 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)  
BONITA CREEK



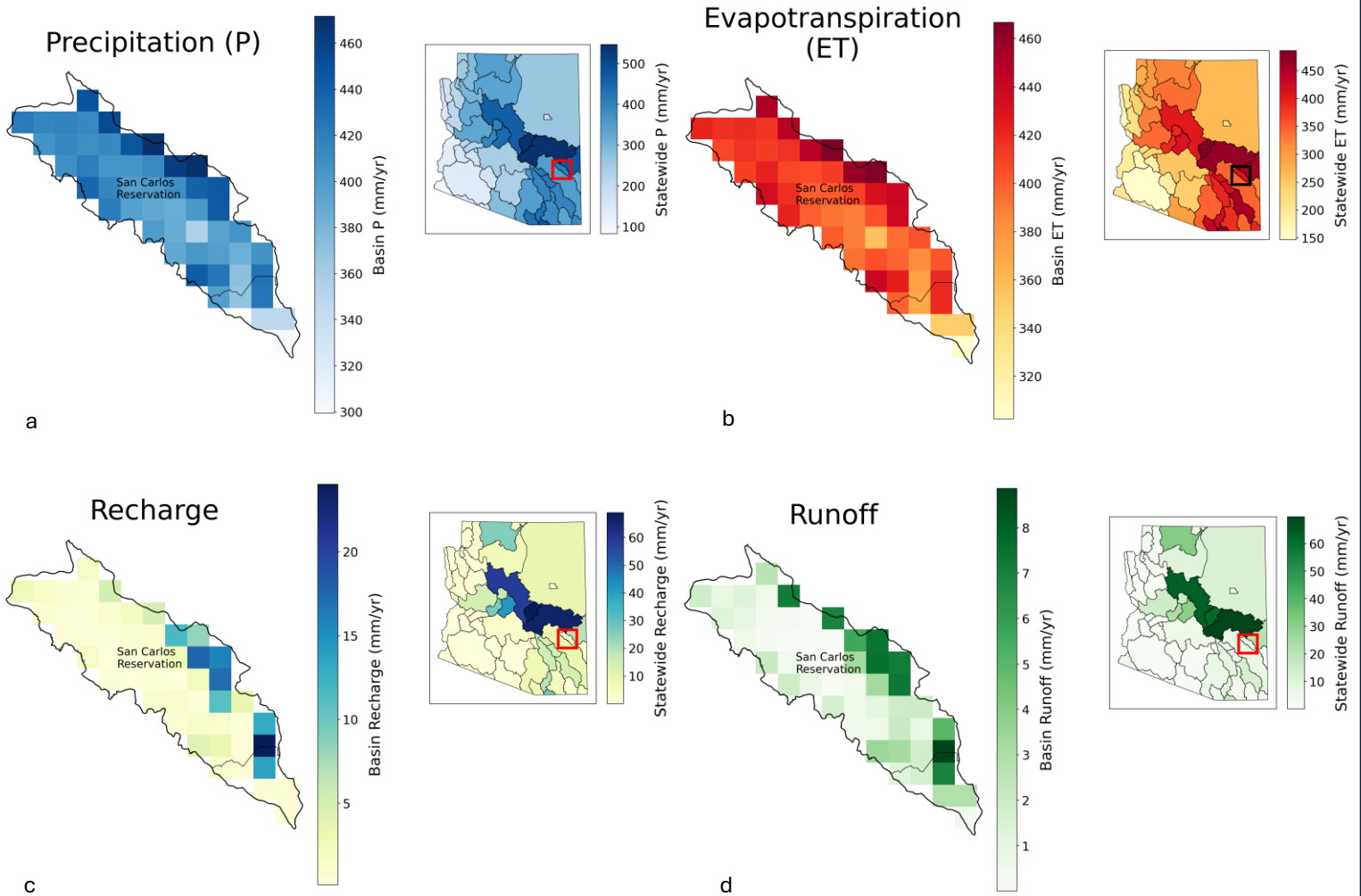
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in relatively low basin-wide annual averages for natural recharge (3.59 mm) and runoff (2.33 mm). P in the Bonita Creek basin is affected by the North American Monsoon during the summer months. ET is approximately equal to P during these months due to enhanced water availability. ET exceeds P from mid-February through mid-June. Soil evaporation makes up 68.9% of total ET in the basin, while transpiration comprises 29.5% and canopy evaporation accounts for the remainder (1.7%). Natural recharge and runoff are highest in January and February due to winter precipitation and relatively low atmospheric demand during the cooler months.

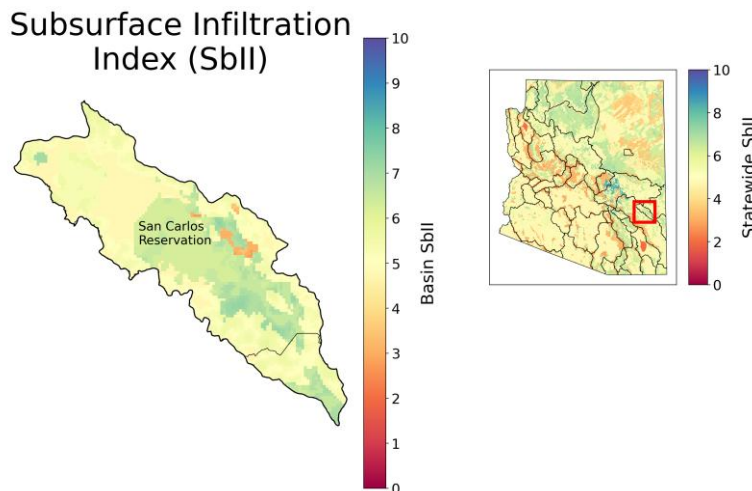
# Bonita Creek



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



**Figure 4 (below).** Subsurface infiltration index (Sbll) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

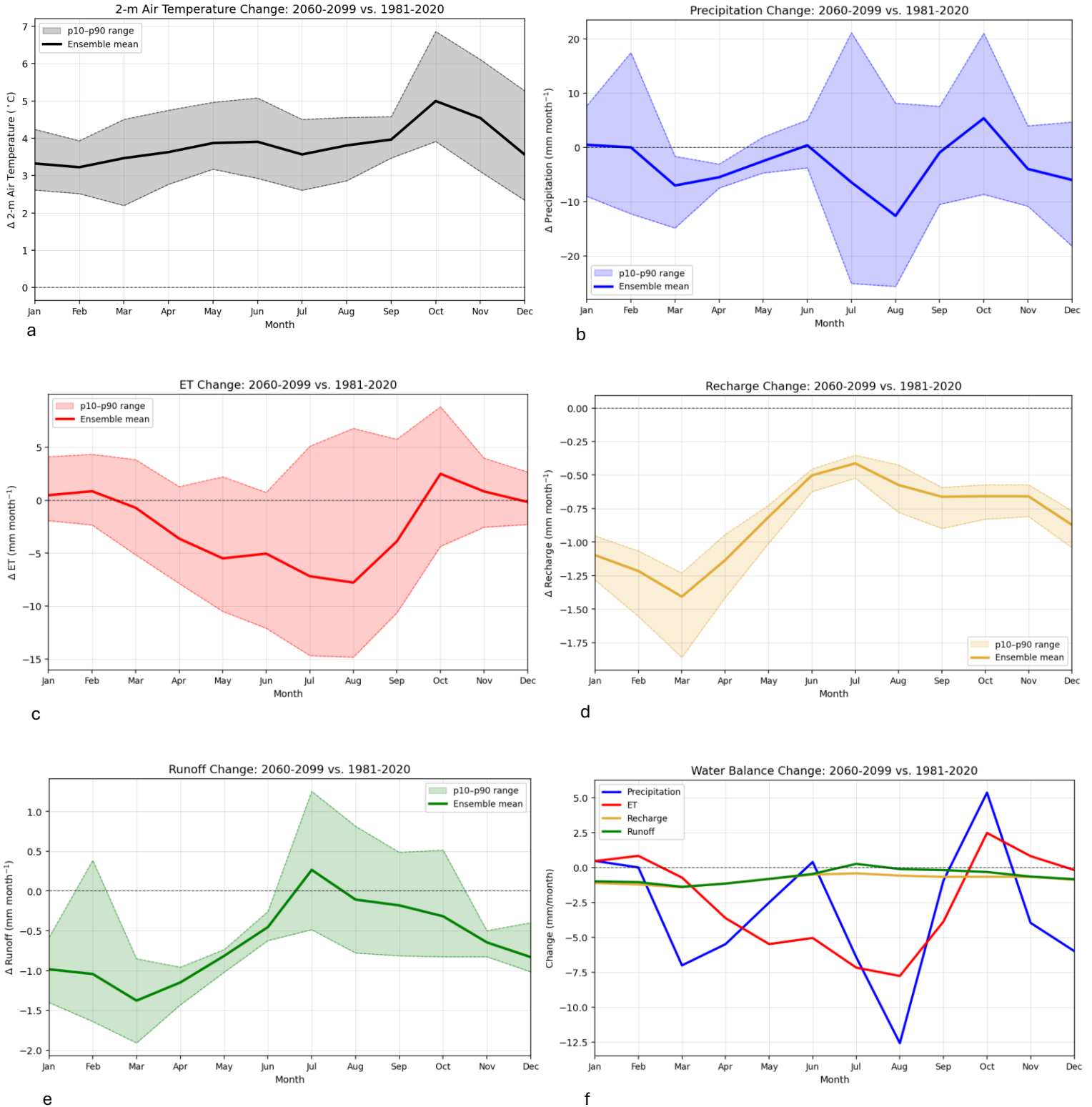


Precipitation in the Bonita Creek basin is highest along its northeast boundary, which receives 450 mm/yr on average. This higher elevation region also has the highest evapotranspiration in the basin (~450 mm/yr). Natural recharge and runoff are also highest in this region (over 15 mm/yr and 7 mm/yr, respectively). Subsurface infiltration potential is moderately high across the basin, particularly in areas of moderately consolidated conglomerate that contain limestone.

# Bonita Creek



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Bonita Creek basin show less precipitation throughout the majority of the year, with the exception of October, which shows an 18% (5.3 mm) increase in precipitation. The greatest declines in precipitation are projected for March-May (24-42%), July-August (9-17%), and November-December (15-16%). Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (January-April) showing declines of 79-87% (-1.1 to -1.4 mm/month). Runoff is projected to decrease during most months of the year, with 67-81% (-0.99 to -1.4 mm/month) declines in the highest runoff months (January-April). Runoff is projected to increase by 0.28 mm in July. Projected increases in temperature range from approximately 3.3 °C in February to 5.0 °C in October. Less water availability from precipitation in April-August leads to a projected 11-16% (-3.7 to -7.8 mm/month) decrease in evapotranspiration (ET) in those months 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

1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
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7. AZGeo City Points shapefile. Retrieved from AZGeo Data Hub: <https://azgeo-open-data-agic.hub.arcgis.com/datasets/azgeo::city-points/about>
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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Butler Valley Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 287 square miles

**Elevation<sup>2</sup>:** Range: 1,319-5,123 ft; Median: 1,856 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (98%), Cultivated Crops (1.6%), Grassland Herbaceous (0.20%)

**Major surface watershed(s)<sup>4</sup>:** Bouse Wash

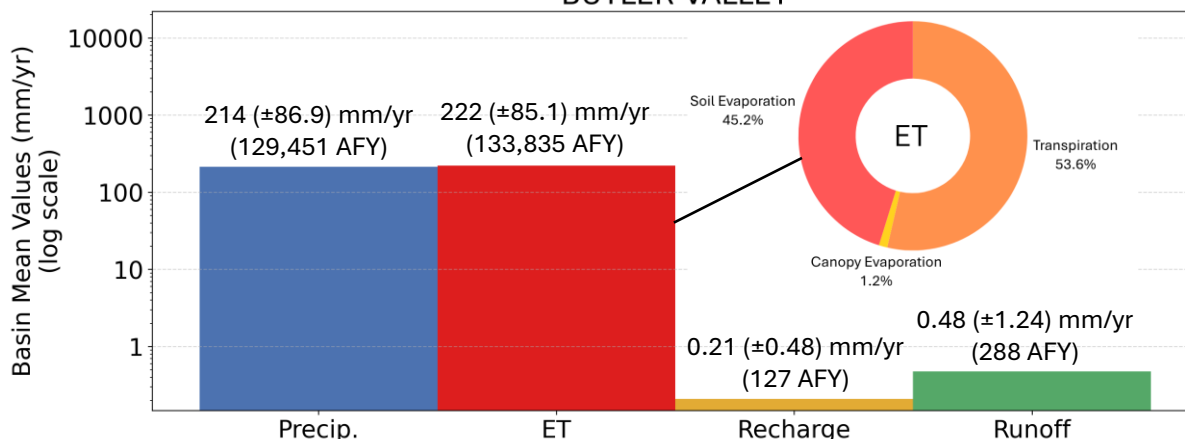
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.68** (Very High)

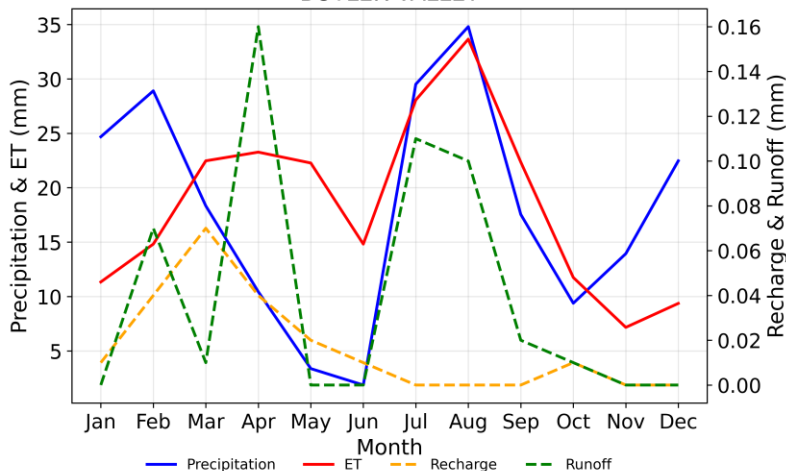


Mean Annual Hydrologic Cycle Components (1980-2020)  
BUTLER VALLEY



**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.<sup>6</sup> 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)  
BUTLER VALLEY



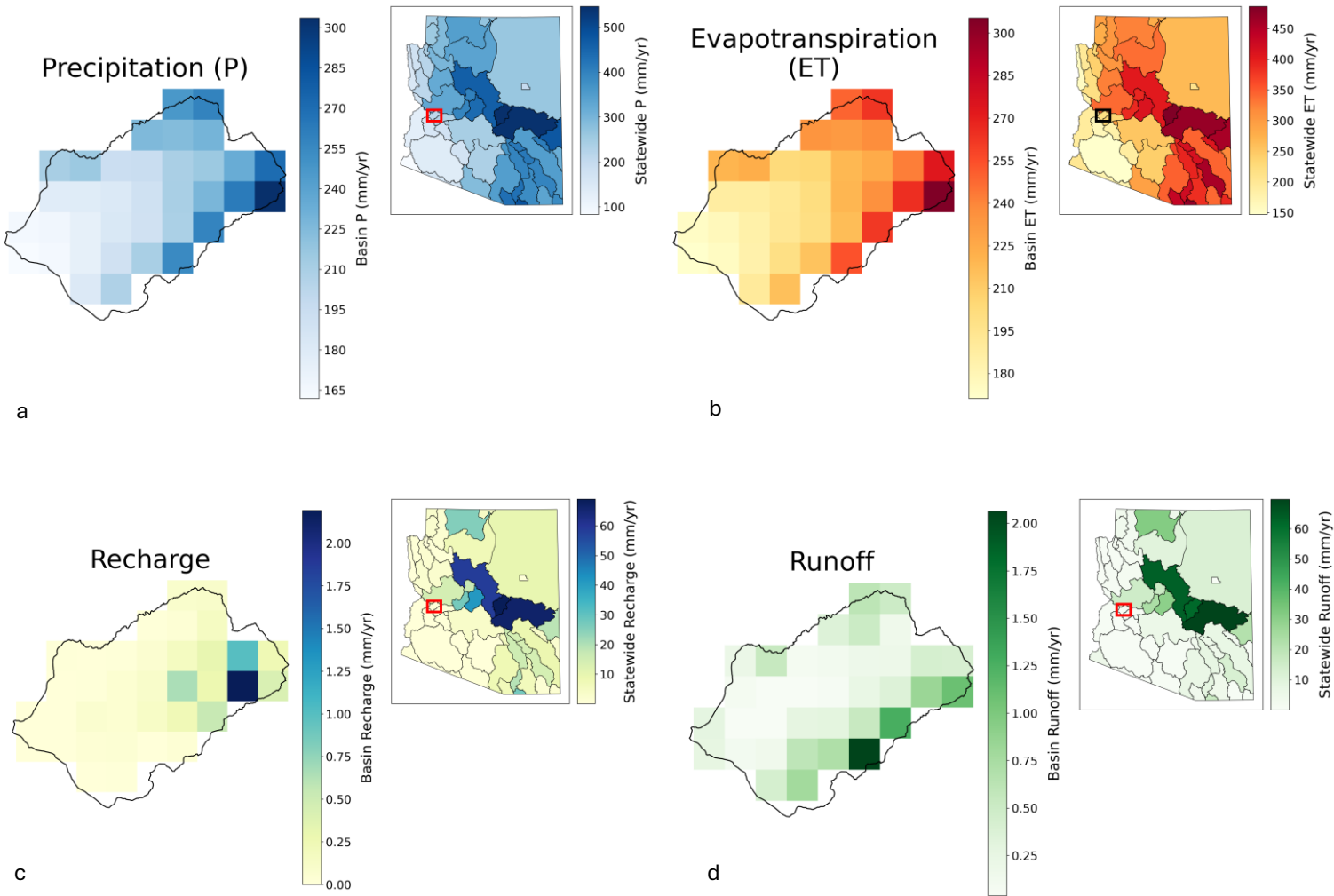
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the Butler Valley basin. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P during the warmer months from March to June, and then tracks with P from July through October. Soil evaporation makes up 45.2% of total ET, while transpiration comprises 53.6% and canopy evaporation accounts for the remainder (1.2%).

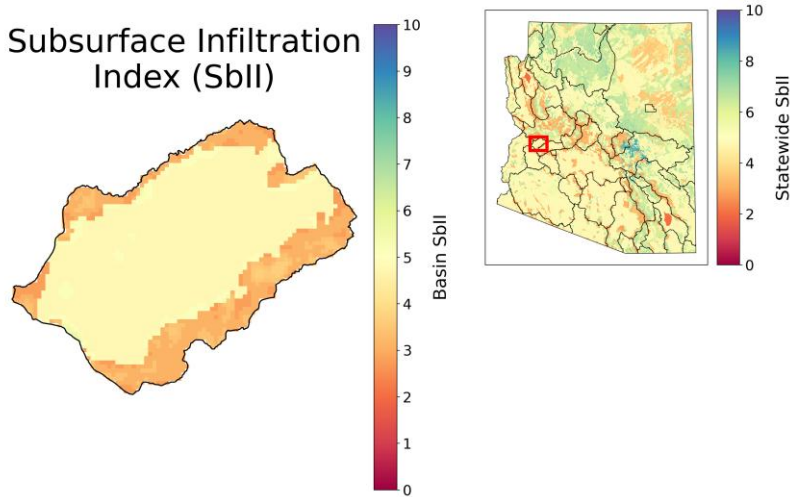
# Butler Valley



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

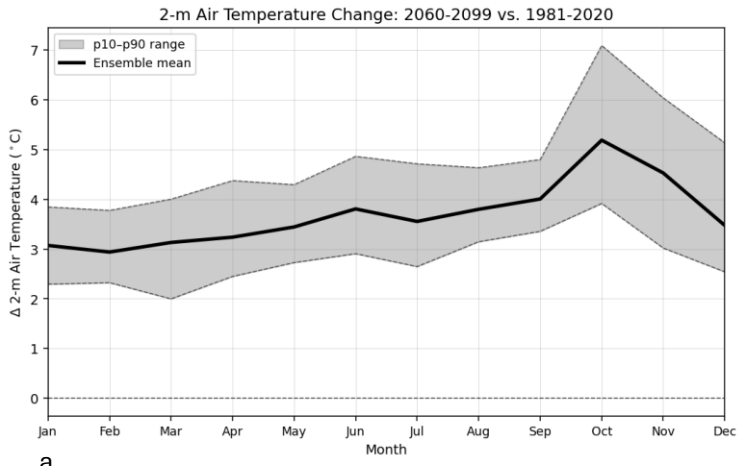


Precipitation (P) in the Butler Valley basin is greatest in the Harcuvar Mountains Wilderness in the eastern portion of the basin, where P can exceed 270 mm/yr on average. Evapotranspiration (ET, ~280 mm/yr) is also greatest in this region. Natural recharge and runoff are minimal (less than 2.0 mm) across the basin. The Butler Valley basin has low to moderate infiltration potential, with the moderate infiltration areas resulting from unconsolidated deposits along Cunningham Wash.

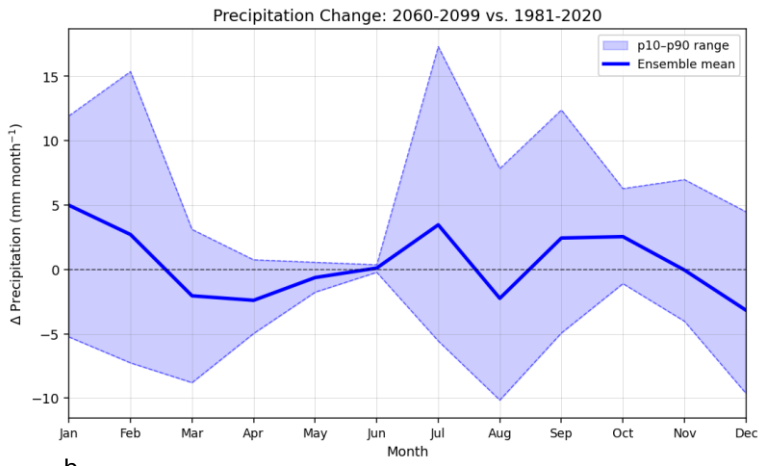
# Butler Valley



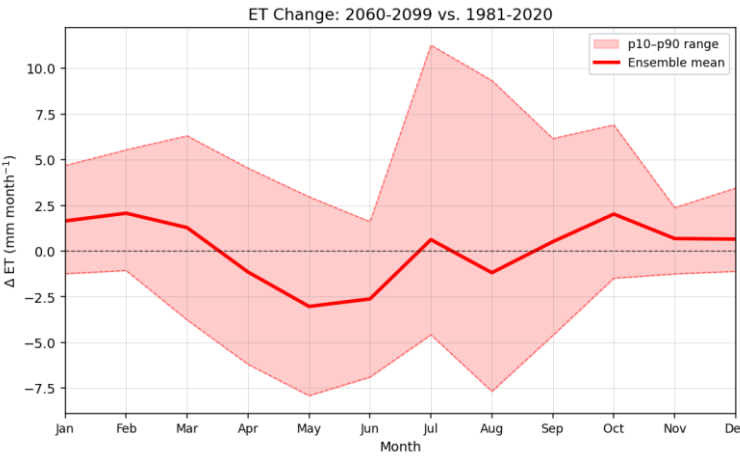
## Climate Change Projections: Changes in Temperature, Precipitation, ET, Recharge, and Runoff (2060-2099 vs. 1981-2020)



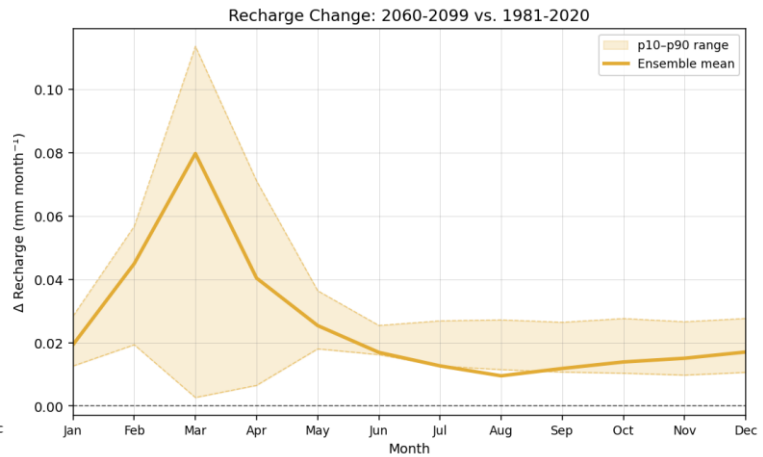
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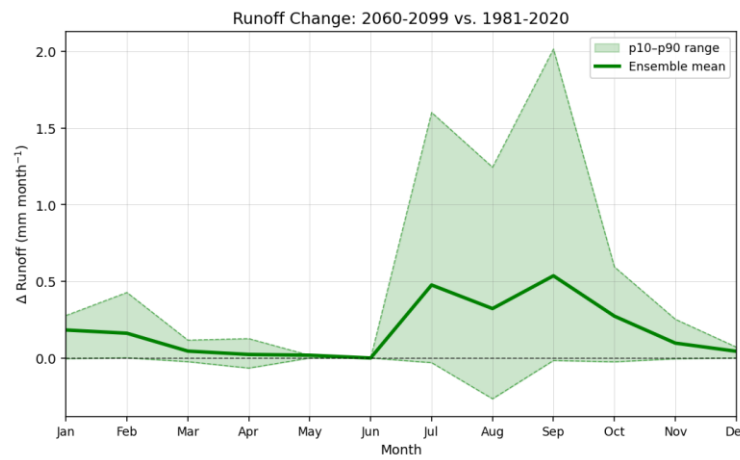
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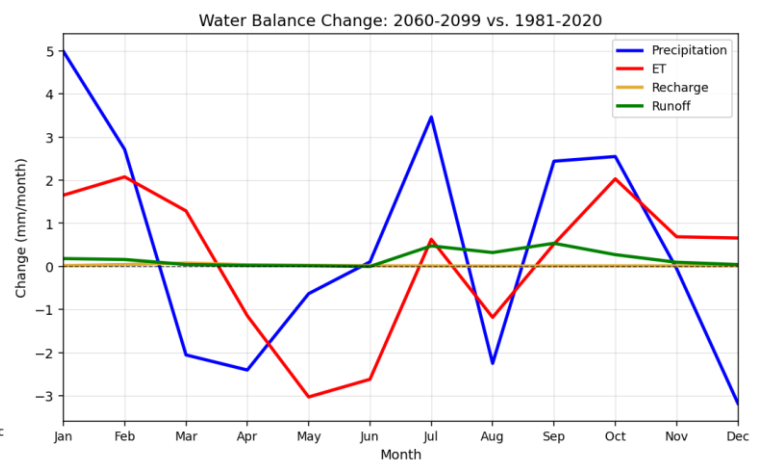
c



d



e



f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Butler Valley basin show drier springs (10-25% drier March through May) and a drier August (6%) and December (14%). September and October are projected to be 15-25% (2.5 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. Natural recharge is projected to remain near zero, with slightly negative projections from May through January (-0.01 to -0.03 mm/month).\* While runoff is projected to remain below 0.8 mm/month, minor increases of 0.28-0.55 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.0 °C in February to 5.2 °C in October. Less precipitation in April and May leads to a projected 5-16% (-1.3 to -3.2 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 17% (2.1 mm) increase in ET in October, a 14% (1.5 mm) increase in January, and a 12% (1.8 mm) increase in February 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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# Cienega Creek Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 614 square miles

**Elevation<sup>2</sup>:** Range: 3,446-9,404 ft; Median: 4,773 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (84%), Evergreen Forest (10%), Grassland Herbaceous (3.4%)

**Major surface watershed(s)<sup>4</sup>:** Cienega Creek, Sonoita Creek, Upper Santa Cruz, Rillito, Upper San Pedro

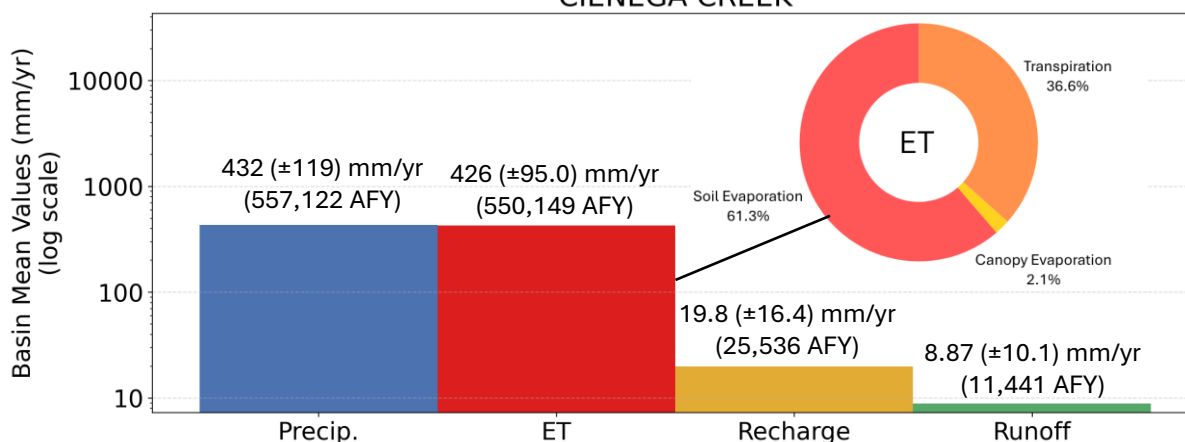
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.49** (Moderate)

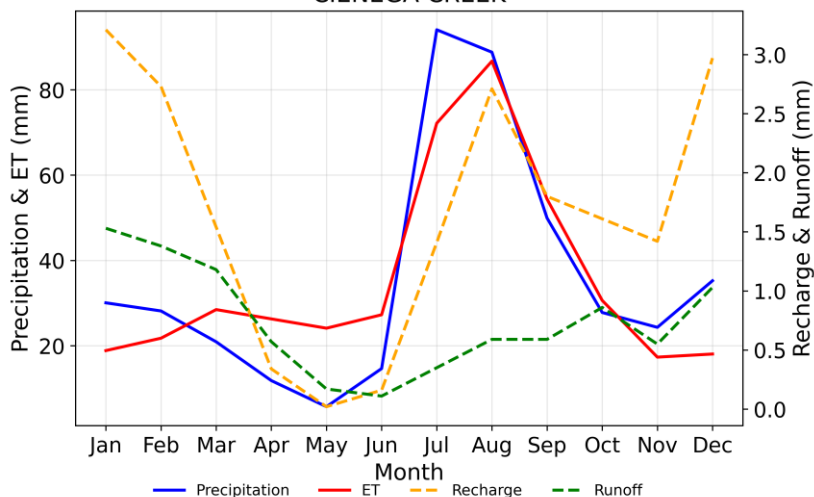


Mean Annual Hydrologic Cycle Components (1980-2020)  
CIENEGA CREEK



**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.<sup>6</sup> 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)  
CIENEGA CREEK



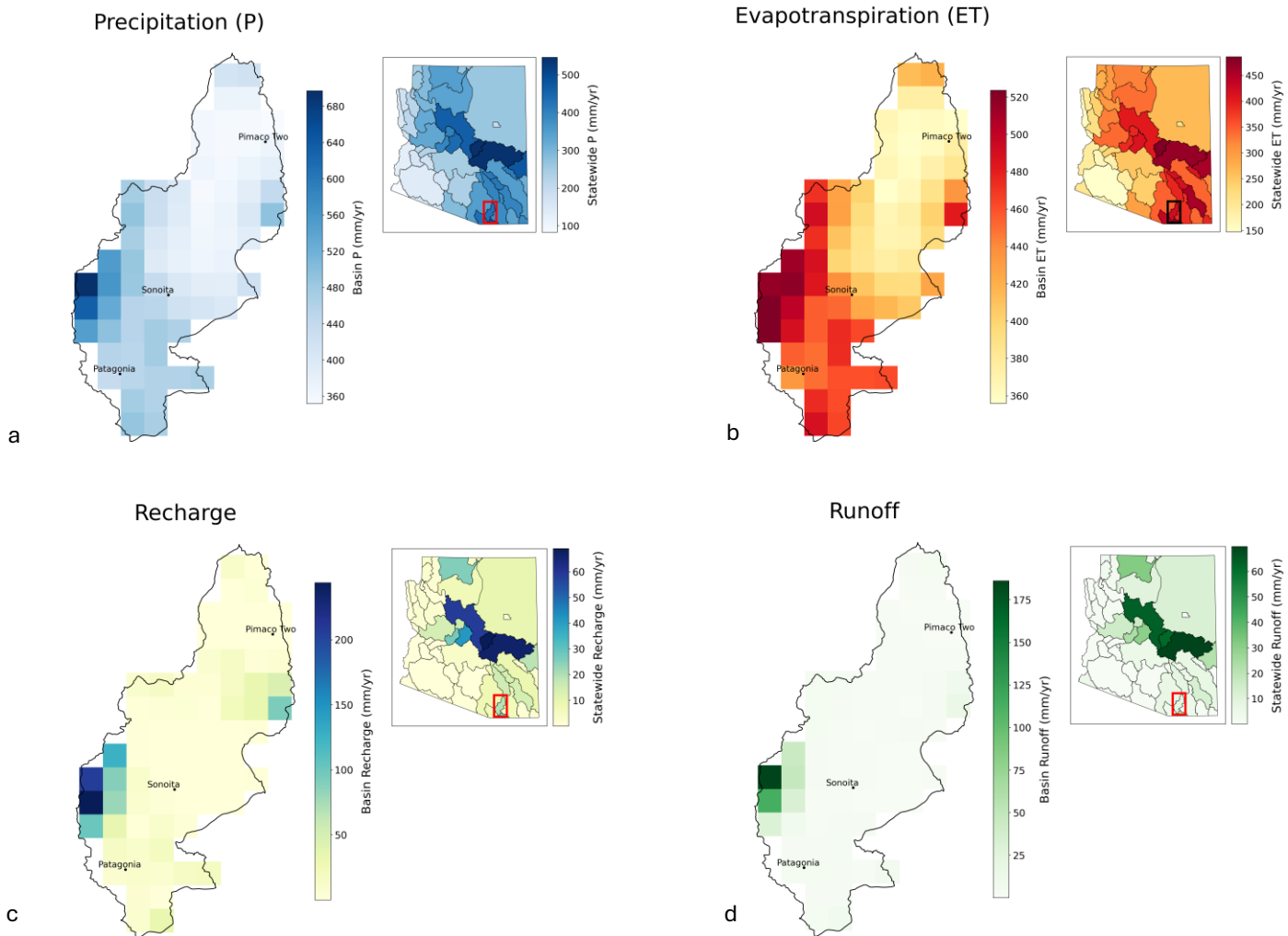
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, precipitation (P) exceeds evapotranspiration (ET) on average across the Cienega Creek basin. 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 61.3% of total ET in the basin, while transpiration comprises 36.6% and canopy evaporation accounts for the remainder (2.1%). Natural recharge (19.8 mm/yr) is greatest in the cooler months (December-February) and during the monsoon season (August). Runoff (8.87 mm/yr) is highest during the winter season (January-February). Groundwater supplies an estimated 49% of total streamflow in the basin.

# Cienega Creek

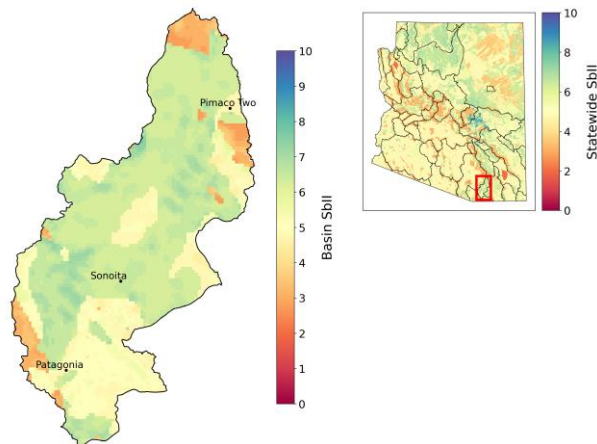


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

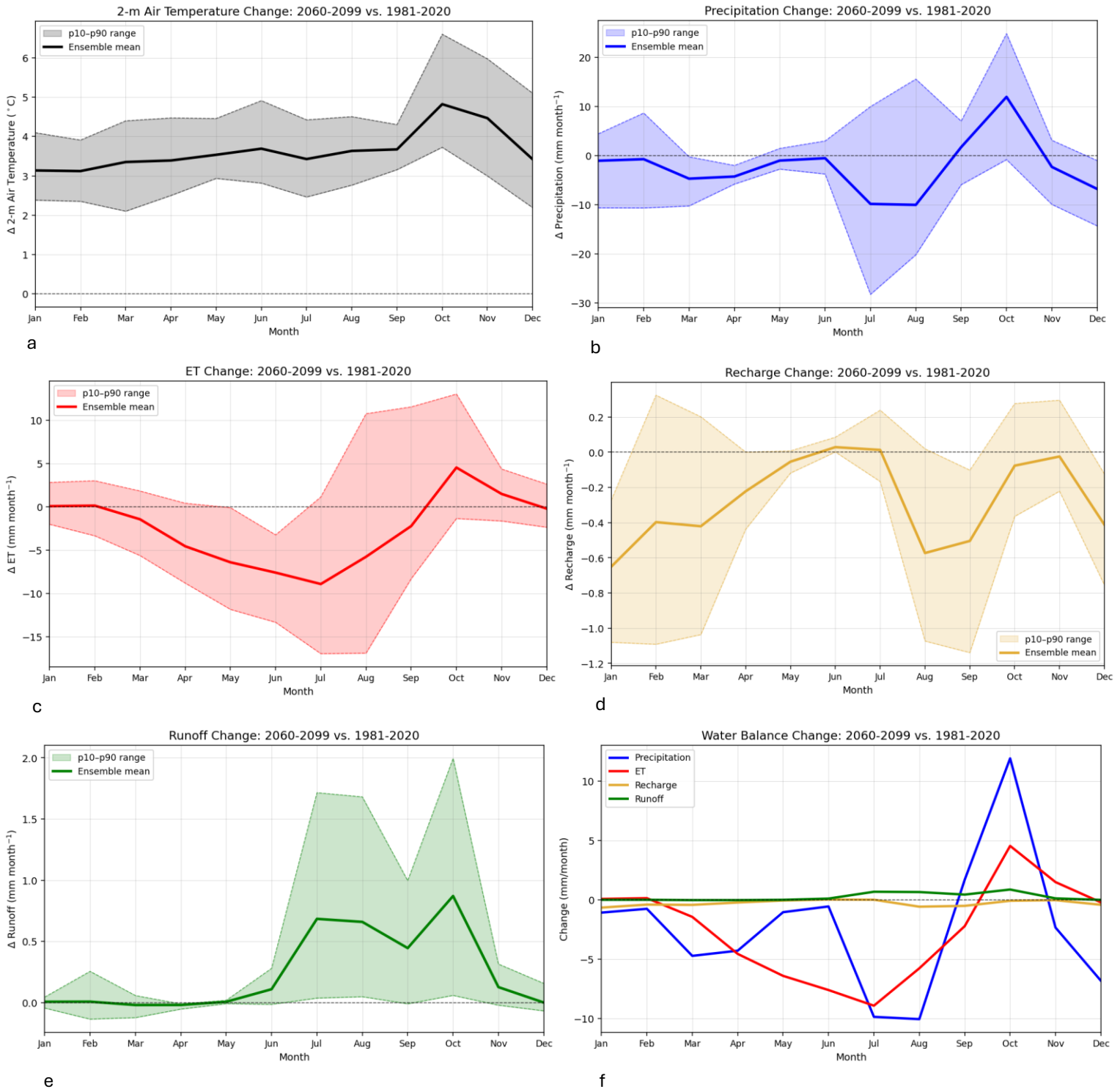
## Subsurface Infiltration Index (SbII)



Precipitation in the Cienega Creek basin is highest in the Santa Rita Mountains to the southwest, which receive over 650 mm/yr on average. Evapotranspiration (ET, ~520 mm/yr), natural recharge (~200 mm/yr), and runoff (~150 mm/yr) are also highest in this region. Subsurface infiltration potential is moderately high in the Cienega Creek basin due to the presence of limestone-containing conglomerate across much 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Cienega Creek basin show less precipitation throughout most months of the year, with the exception of September and October, which show a 4% (1.7 mm) and 41% (12 mm) increase in precipitation, respectively. This increase in precipitation in September-October is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. The greatest declines in precipitation are projected for March-May (20-40% drier), July-August (10-11%), and November-December (12-19%). Declines in recharge ranging from 27-53% (-0.42 to -0.69 mm/month) are projected for highest recharge months from January-March and August-September. Recharge is projected to be slightly negative in June (-0.03 mm).\* While remaining below 1.1 mm/month, runoff is projected to increase by 0.46-0.90 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 4.9 °C in October. Less water availability from March to August leads to projected declines (5-22% or -1.5 to -8.8 mm/month) in evapotranspiration (ET) during the warmer months, while higher temperatures and greater precipitation are consistent with a projected 14% (4.6 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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# Coconino Plateau Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 5,810 square miles

**Elevation**<sup>2</sup>: Range: 1,341-12,621 ft; Median: 5,933 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (77%), Evergreen Forest (21%), Barren Land (1.2%)

**Major surface watershed(s)**<sup>4</sup>: Havasu Canyon, Lower Little Colorado

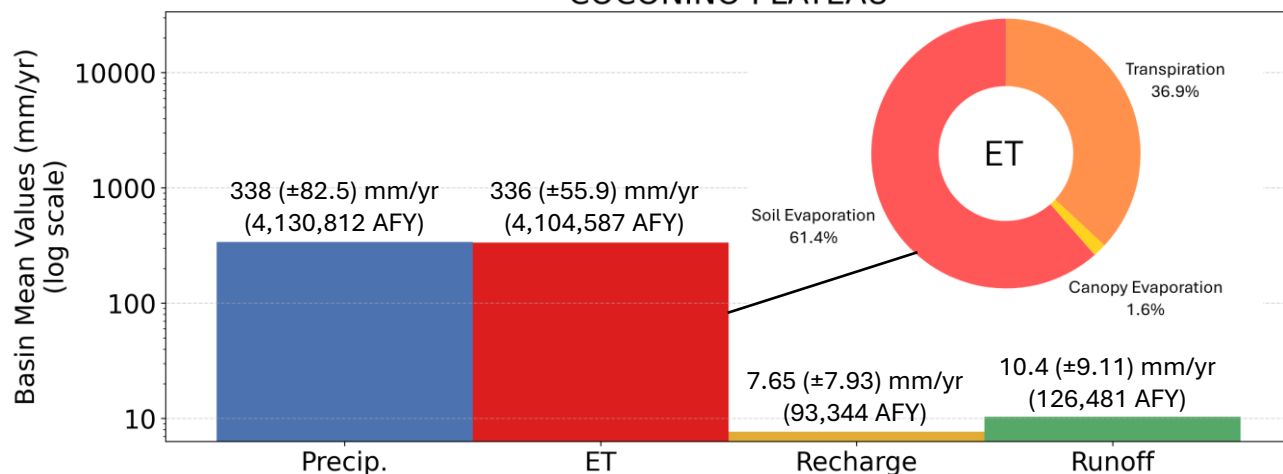
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.51** (Moderate)

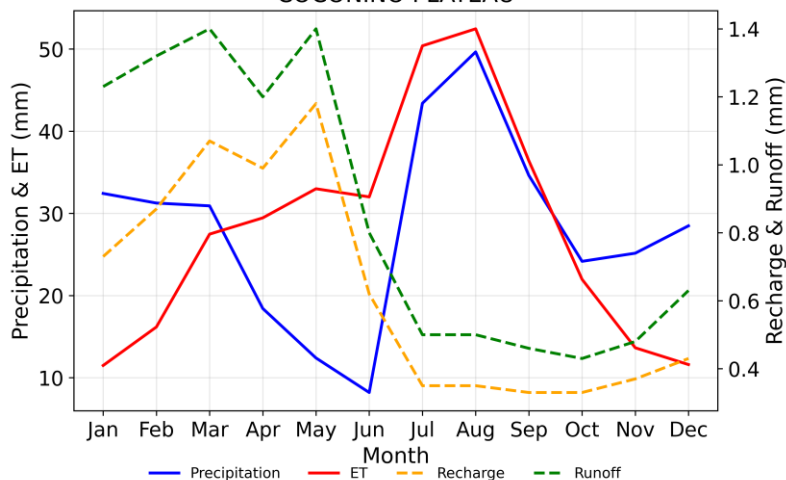


## Mean Annual Hydrologic Cycle Components (1980-2020) COCONINO PLATEAU



**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.<sup>6</sup> 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) COCONINO PLATEAU



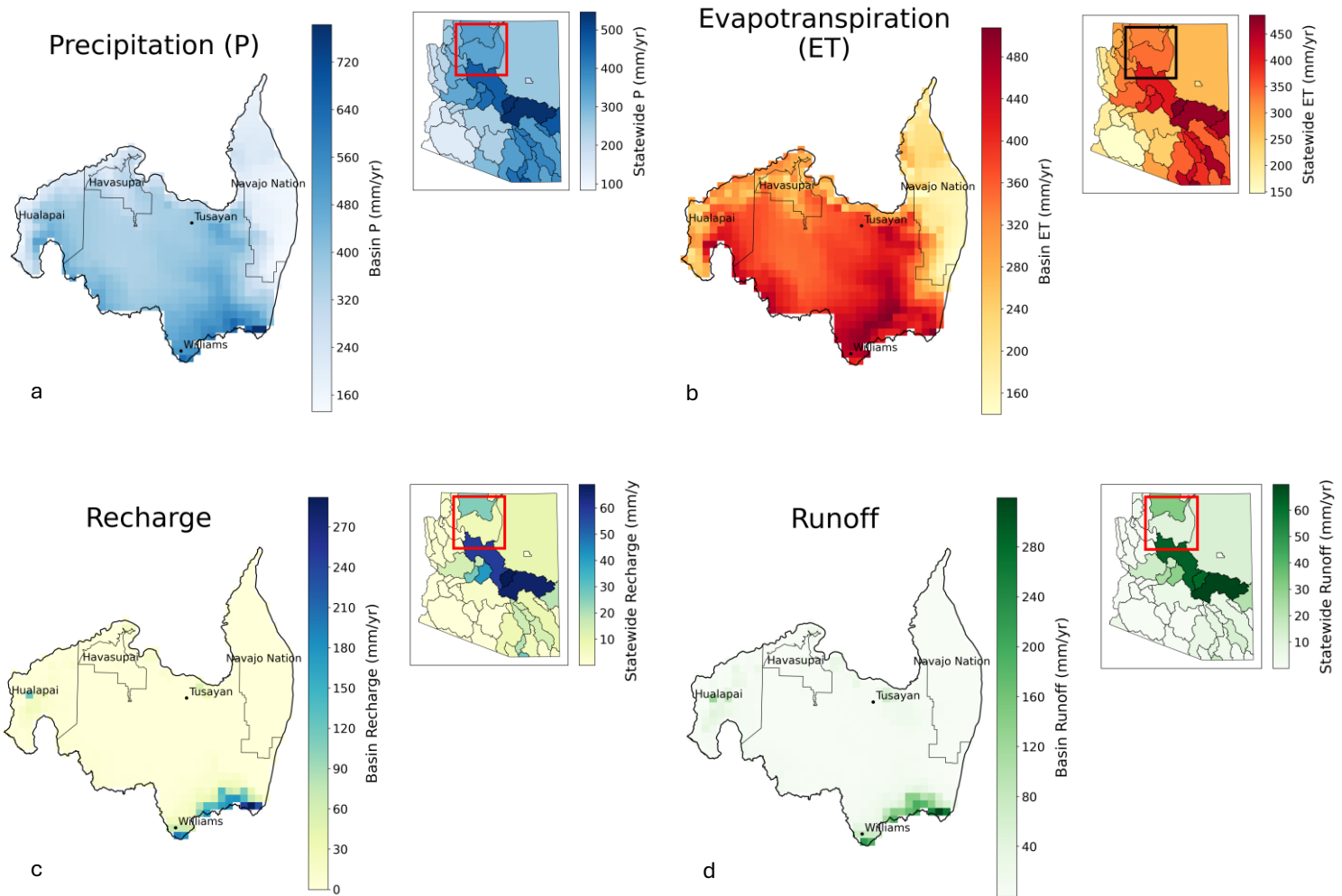
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On average, annual evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (7.65 mm) and runoff (10.4 mm). Seasonally, the Coconino Plateau is affected by the North American Monsoon during the summer months, and large frontal systems during the winter. ET exceeds P from March through September while P exceeds ET in the winter months. Soil evaporation makes up 61.4% of total ET in the basin, while transpiration comprises 36.9% and canopy evaporation accounts for the remainder (1.6%). Natural recharge and runoff peak in May as a result of springtime snowmelt.

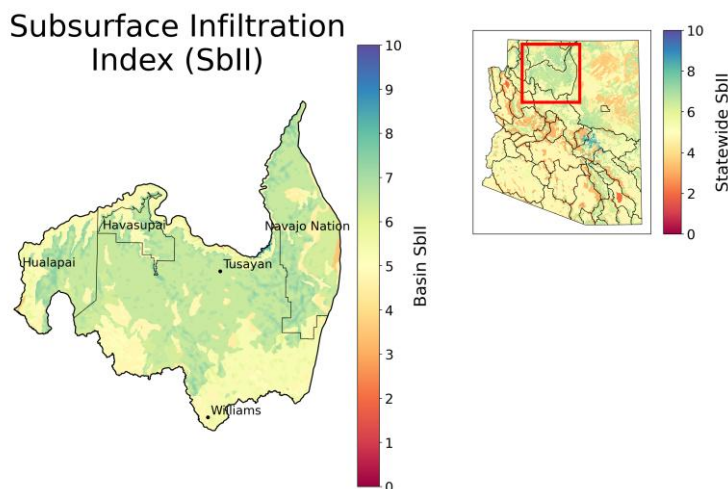
# Coconino Plateau



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

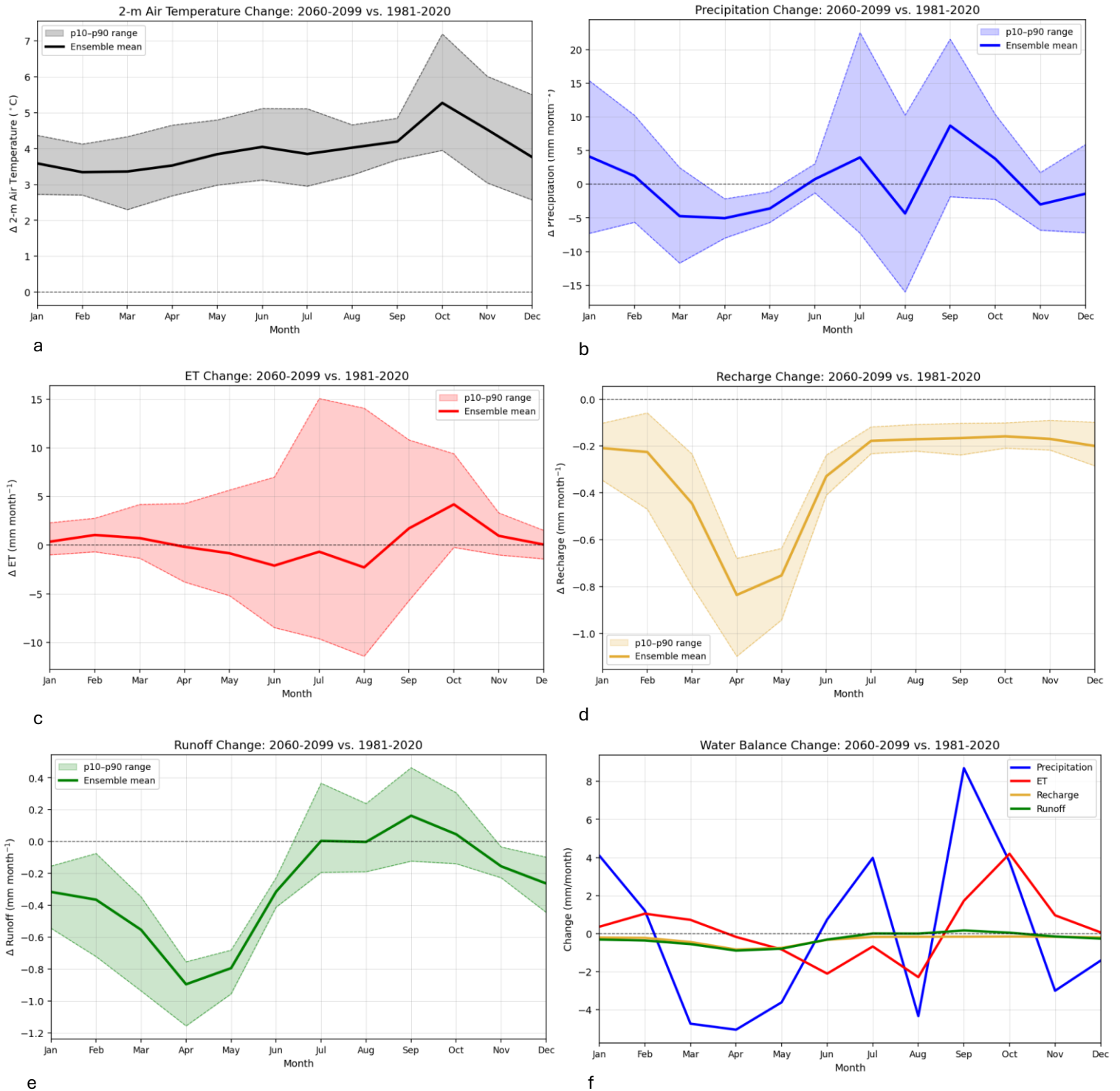


Natural recharge is greatest in the southeast portion of the Coconino Plateau basin, exceeding 200 mm/year in this region. Similarly, most of the runoff is generated near the San Francisco Peaks to the southeast. The majority of the basin has moderately high subsurface infiltration potential due to large regions with karst-type geology.

# Coconino Plateau



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Coconino Plateau show drier springs (15-28% drier March through May), and a drier August (8%), November (13%), and December (4%). September and October are projected to be 14-25% (3.8-8.8 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. Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (March-May) showing declines of 57-85% (-0.45 to -0.84 mm/month). Recharge projections are slightly negative (-0.01 mm) in July and August.\* Runoff is projected to decrease throughout most months of the year, with 56-83% (-0.55 to -0.90 mm/month) declines in the highest runoff months (March-May) and slight increases of 0.05-0.17 mm/month in September-October. Projected increases in temperature range from approximately 3.4 °C in February to 5.3 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 19% (4.2 mm) increase in evapotranspiration (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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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](https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/Federal_American_Indian_Reservations_v1/FeatureServer)
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# Detrital Valley Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 892 square miles

**Elevation**<sup>2</sup>: Range: 1,081-7,126 ft; Median: 2,866 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (93%), Open Water (2.8%), Barren Land (1.6%)

**Major surface watershed(s)**<sup>4</sup>: Detrital Wash, Lake Mead

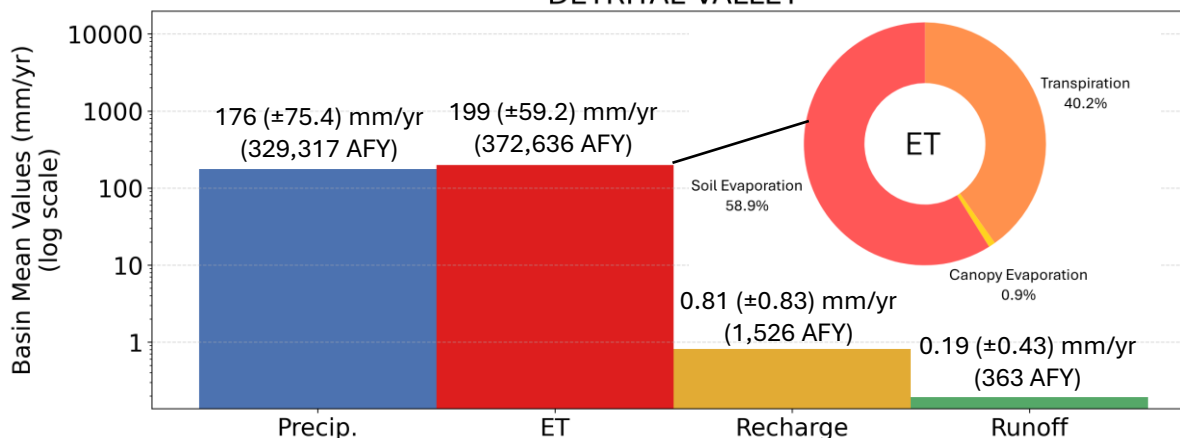
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.58** (High)

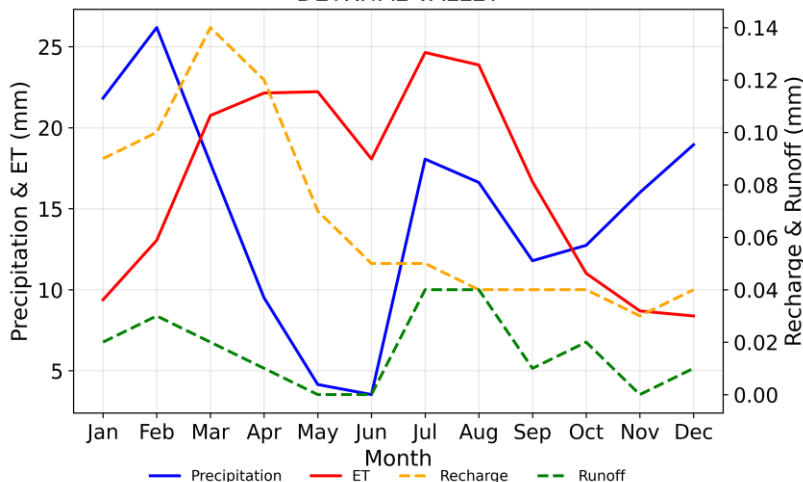


Mean Annual Hydrologic Cycle Components (1980-2020)  
DETRITAL VALLEY



**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.<sup>6</sup> 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)  
DETRITAL VALLEY



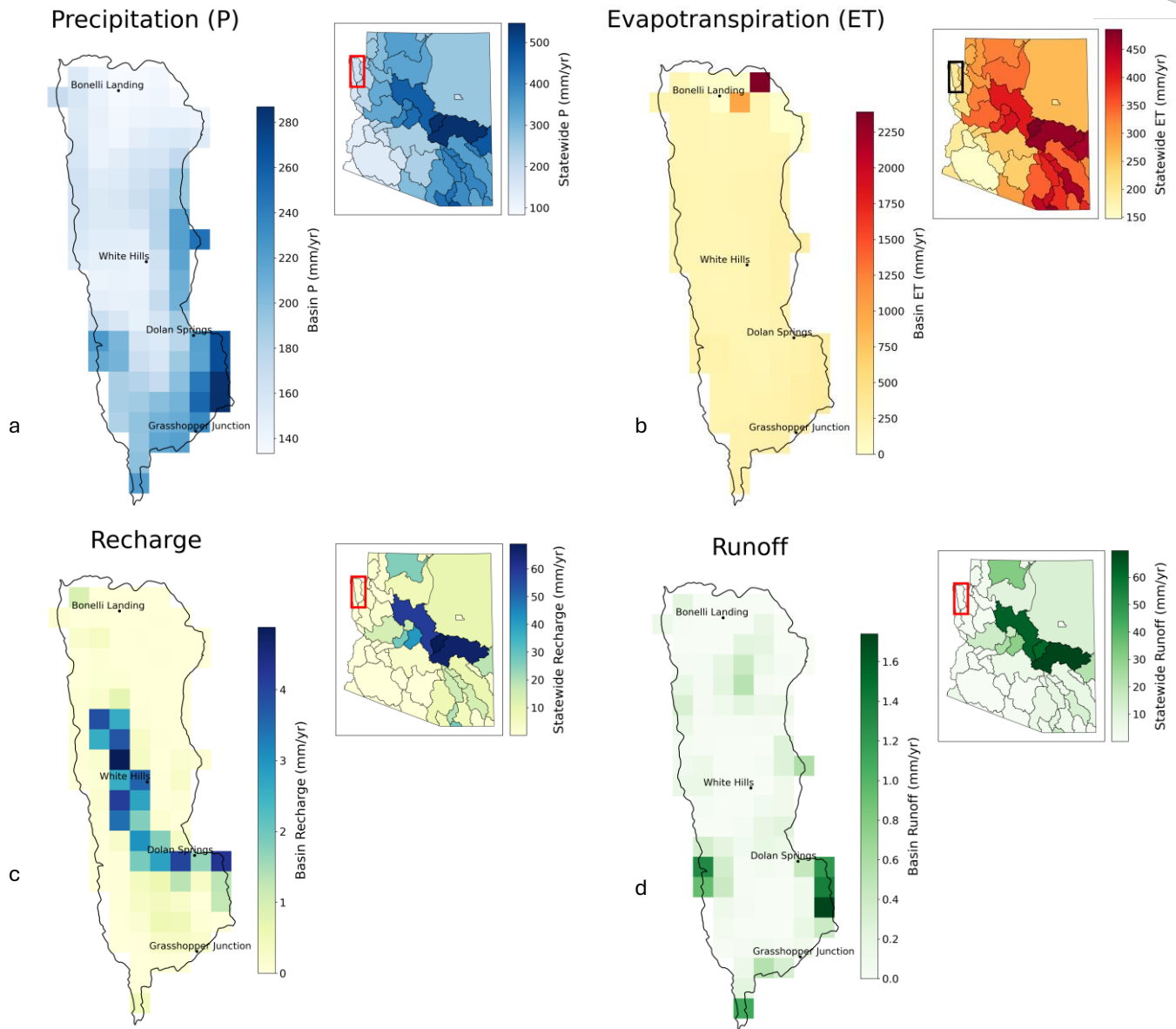
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Detrital Valley basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. On annual timescales, evapotranspiration (ET) is greater than P, with the greatest atmospheric losses occurring during the summer months. ET exceeds P from mid-February through mid-September. Soil evaporation makes up 58.9% of total ET in the basin, while transpiration comprises 40.2% and canopy evaporation accounts for the remainder (0.9%). Natural recharge (0.81 mm/yr) and runoff (0.19 mm/yr) are near zero on average across the basin.

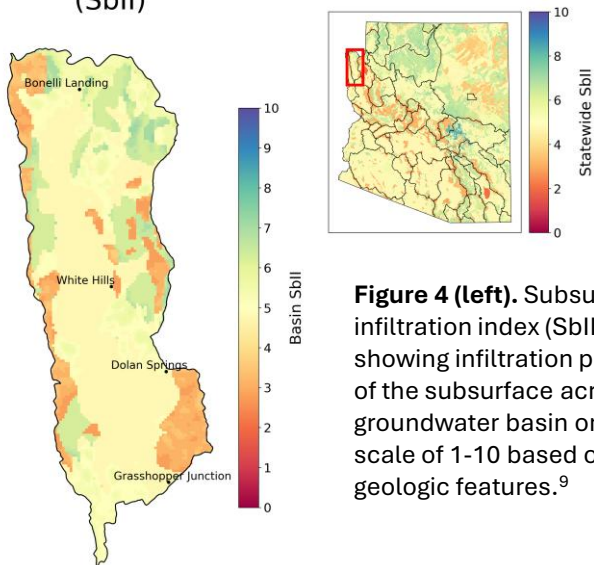
# Detrital Valley



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



## Subsurface Infiltration Index (SbII)

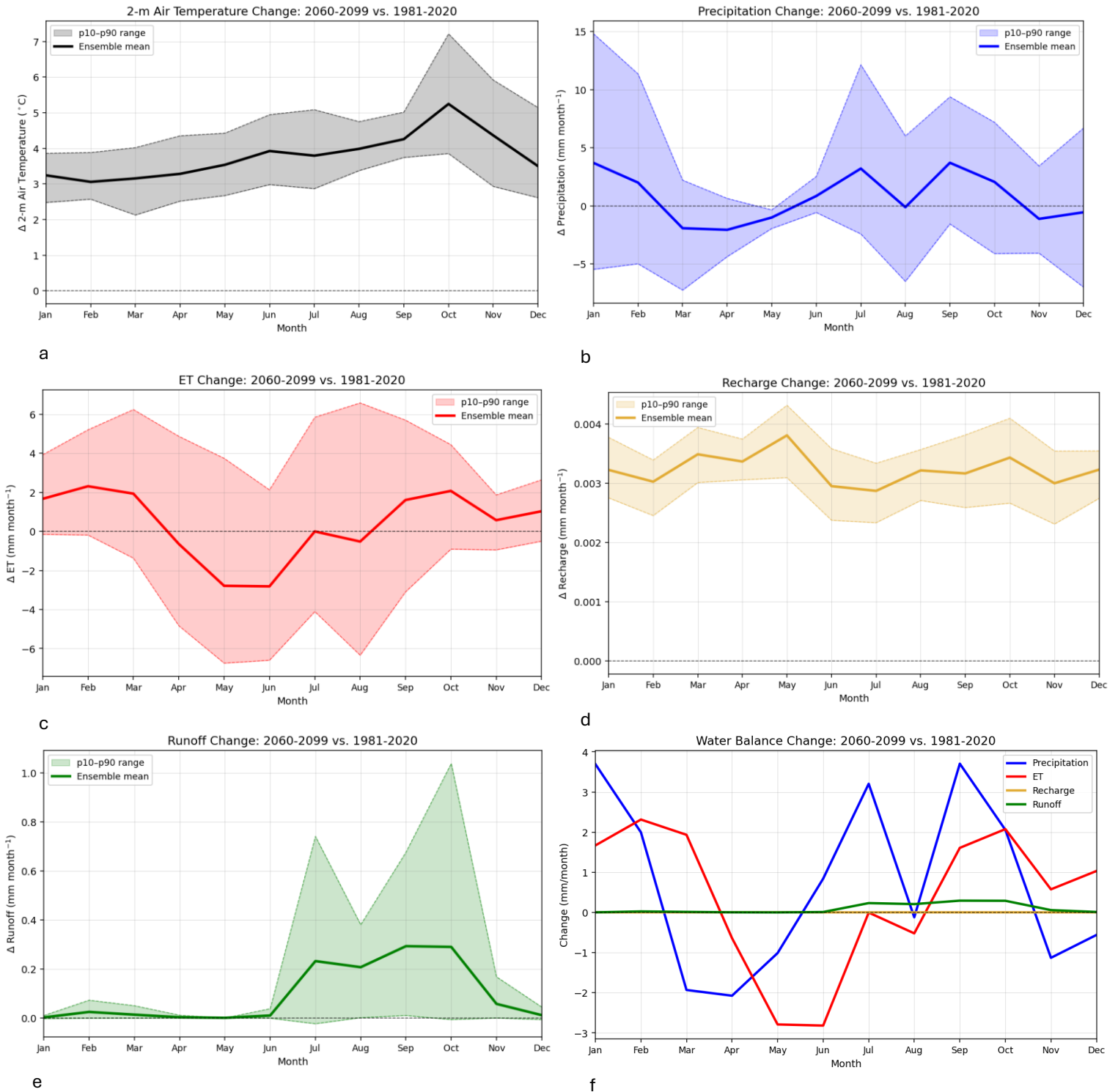


**Figure 4 (left).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

Precipitation (P) in the Detrital Valley basin is greatest at higher elevations to the southeast in the Mount Tipton Wilderness, where P exceeds 260 mm/yr on average. ET is highest over Lake Mead, where it exceeds 1,000 mm/yr on average. The greatest natural recharge (4 mm/yr) occurs along Detrital Wash. Surface runoff is minimal across the basin, with slightly higher values in the Mount Tipton Wilderness to the southeast. Overall, the basin has moderate infiltration potential with pockets of higher potential. Areas with higher potential result from the presence of moderately consolidated conglomerate that contains limestone, particularly in the northern portion 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Detrital Valley basin show drier springs (10-24% drier March through May) and a drier November (7%). September and October are projected to be 17-30% (2.1-3.7 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. Natural recharge is projected to remain near zero and slightly negative (approximately -0.005 mm/month) throughout the year.\* While runoff is projected to remain near zero for most of the year, minor increases of 0.21-0.30 mm/month are projected for 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 21% (2.1 mm) increase in evapotranspiration (ET) in October and a 18-19% (1.7-2.3 mm) increase in January-February 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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# Donnelly Wash Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 293 square miles

**Elevation<sup>2</sup>:** Range: 1,570-4,476 ft; Median: 2,872 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (98%), Grassland Herbaceous (0.84%), Woody Wetlands (0.78%)

**Major surface watershed(s)<sup>4</sup>:** Middle Gila River

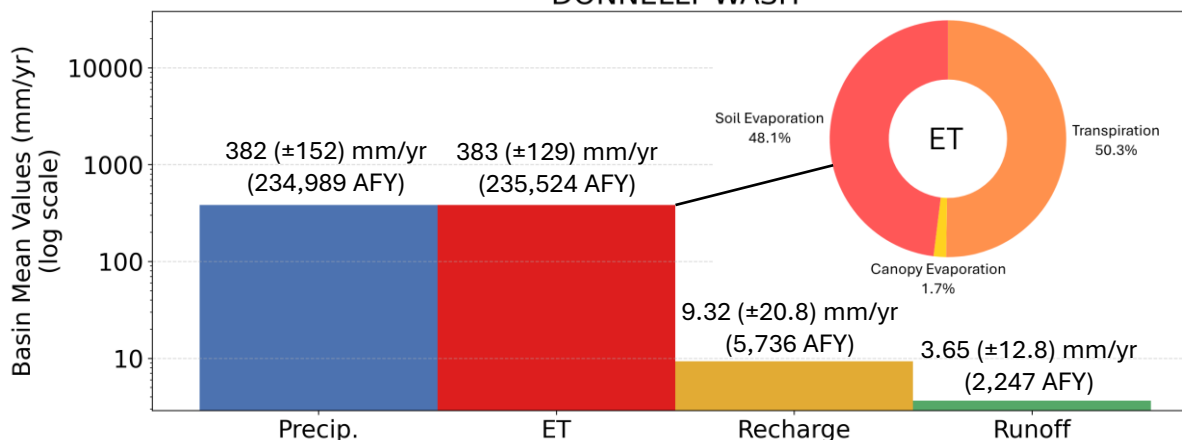
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.66** (Very High)

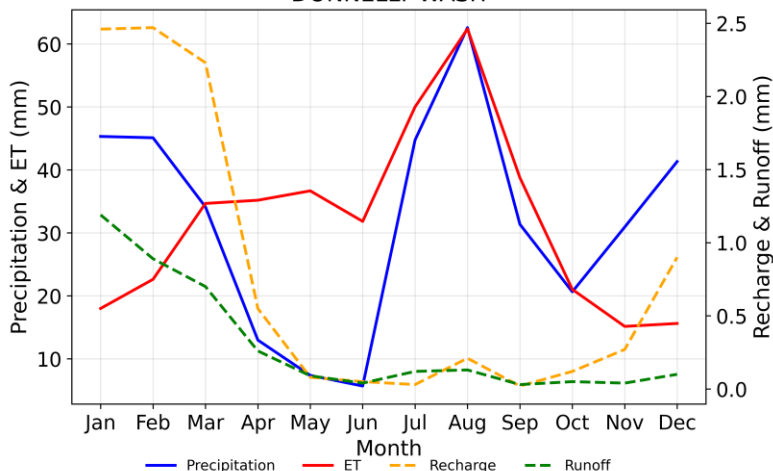


Mean Annual Hydrologic Cycle Components (1980-2020)  
DONNELLY WASH



**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.<sup>6</sup> 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



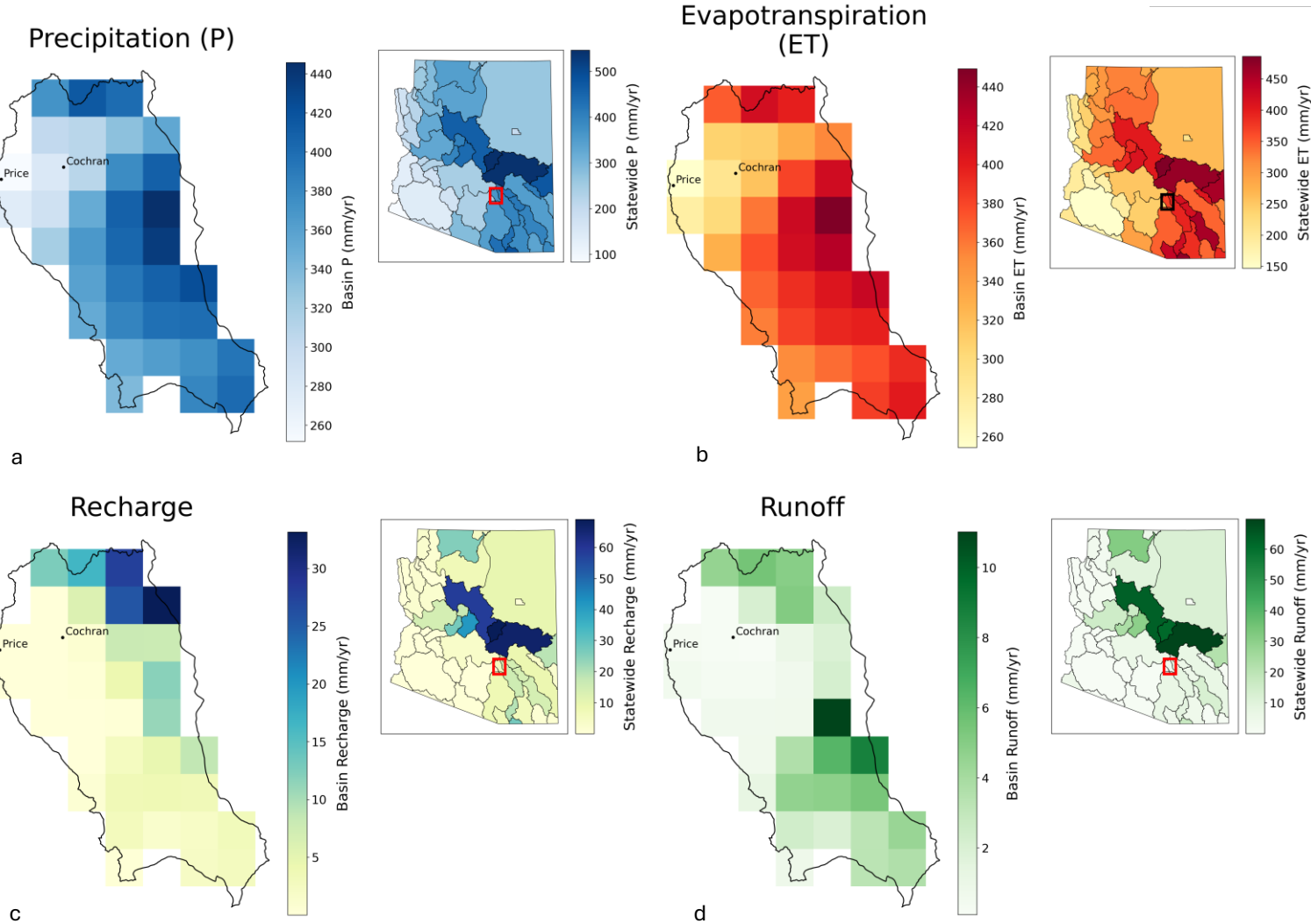
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

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.

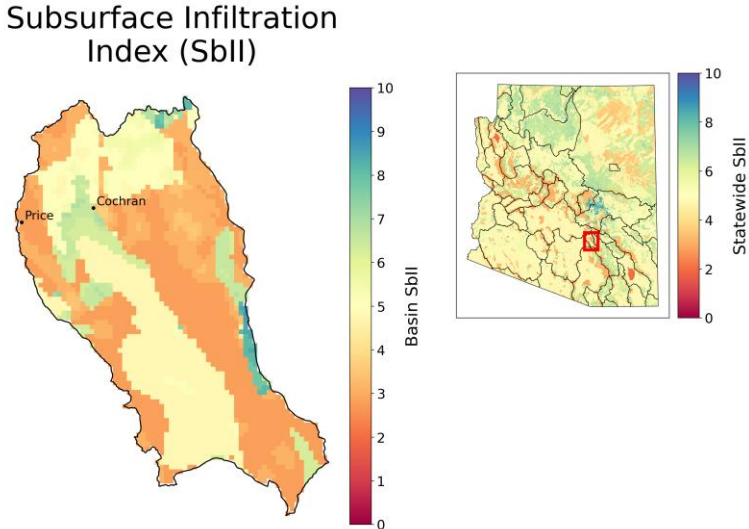
# Donnelly Wash



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



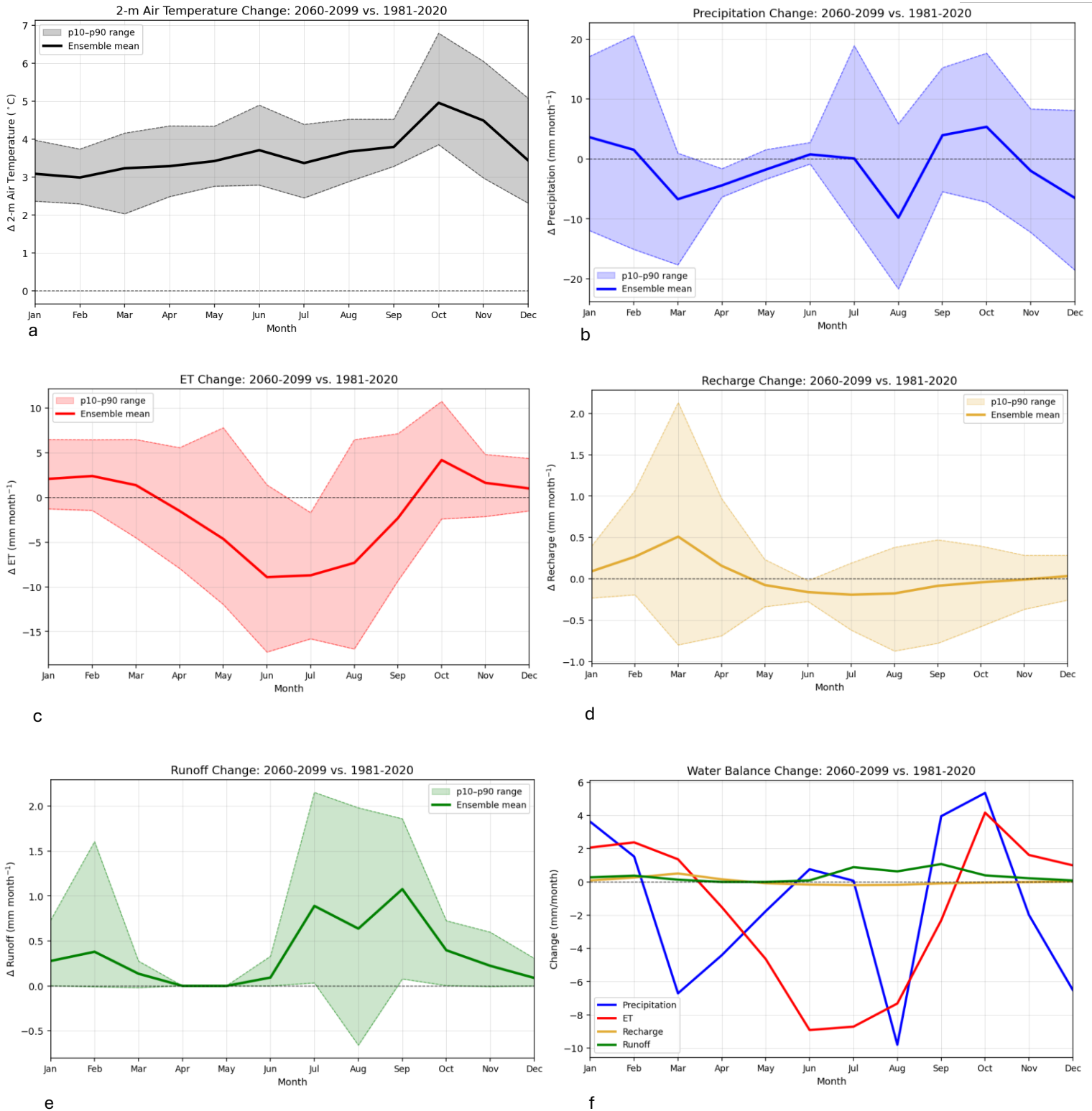
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> 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

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# Douglas AMA

## Groundwater Basin Profile



### Basin Summary Statistics

**Size<sup>1</sup>:** 949 square miles

**Elevation<sup>2</sup>:** Range: 3,894-7,364 ft; Median: 4,338 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (91%), Cultivated Crops (4.5%), Evergreen Forest (2.0%)

**Major surface watershed(s)<sup>4</sup>:** Whitewater Draw, Willcox Playa

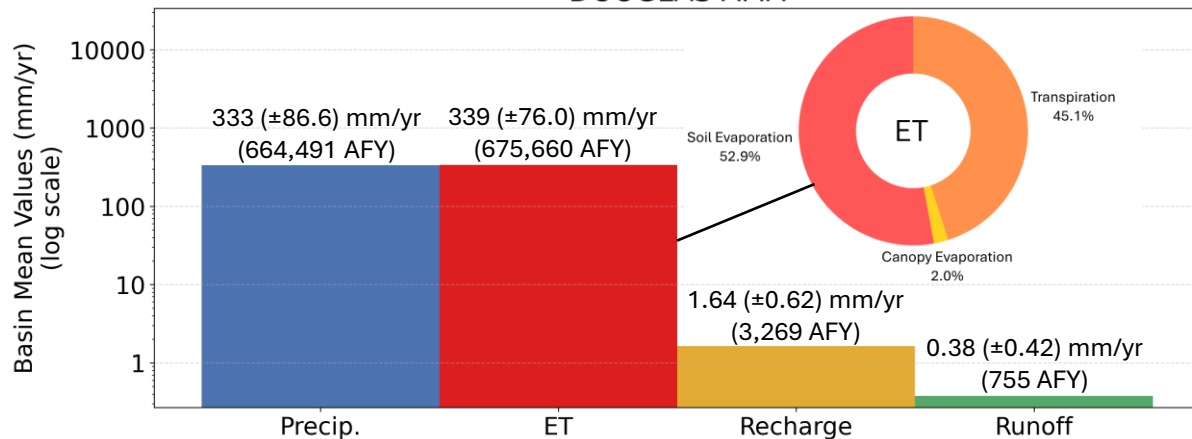
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.73** (Very High)

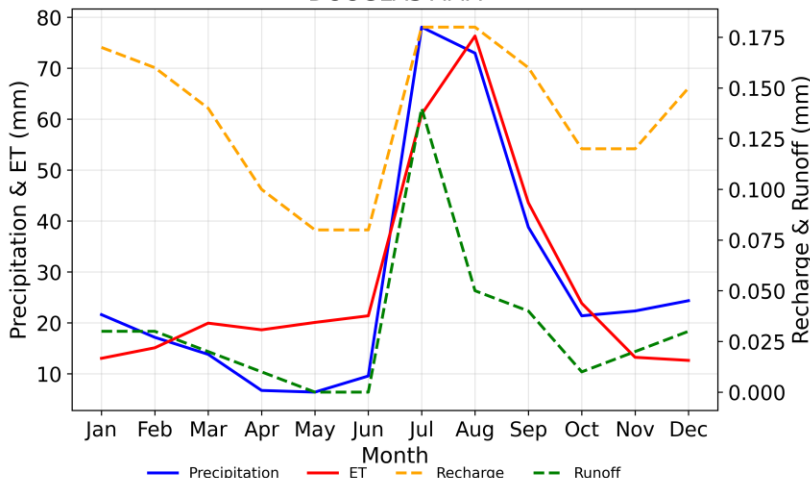


Mean Annual Hydrologic Cycle Components (1980-2020)  
DOUGLAS AMA



**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.<sup>6</sup> 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)  
DOUGLAS AMA



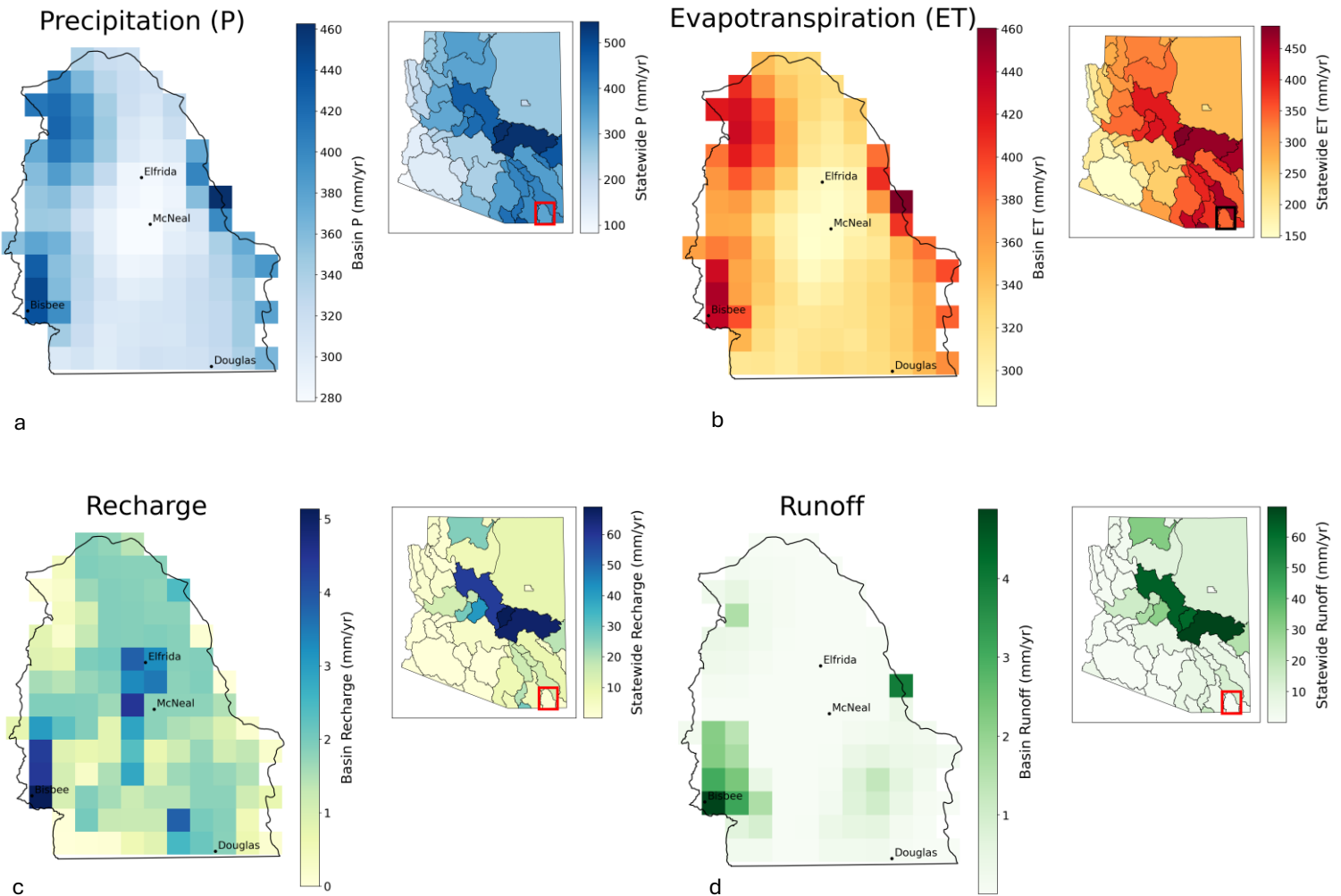
On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average across the Douglas AMA, resulting in near zero basin-wide averages for natural recharge (1.64 mm/yr) and runoff (0.38 mm/yr). Seasonally, P is affected by the North American Monsoon during the summer months. ET is greater 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%).

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

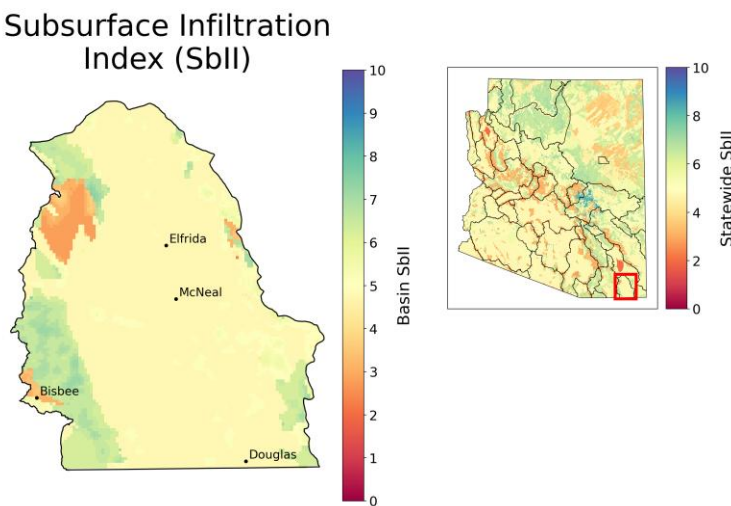
# Douglas AMA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



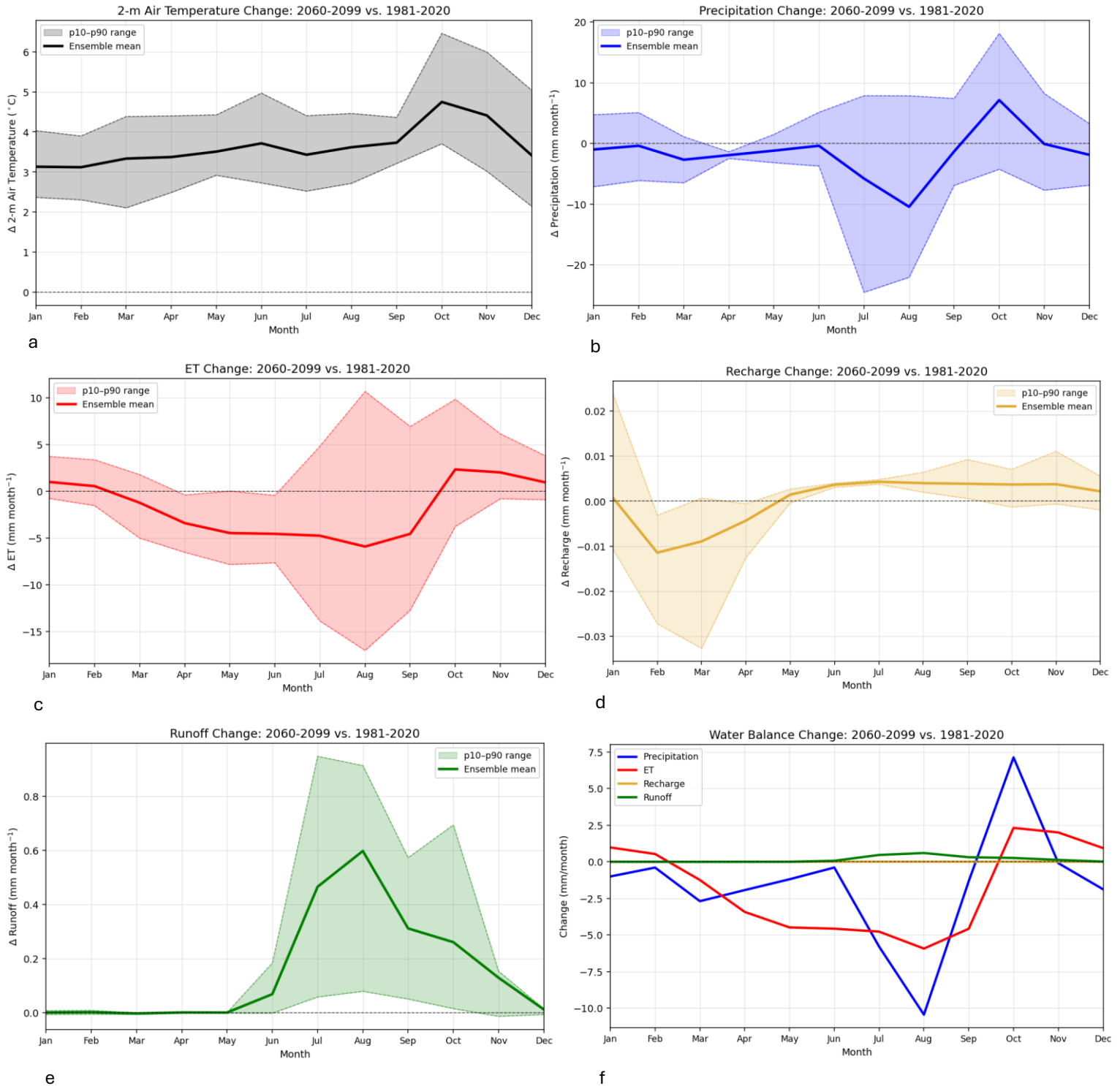
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



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 Drought 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 Droughts, and the Perilla Mountains east of Douglas.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



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.

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9. Lima, R., Springer, A., Sankey, T. (2026). Arizona Subsurface Infiltration Index v.2, HydroShare, <https://doi.org/10.4211/hs.abcd8aa1a793463ab33677ce9d46db58>
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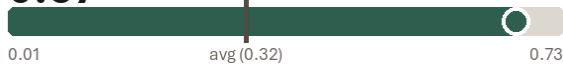
# Dripping Spring Wash Groundwater Basin Profile



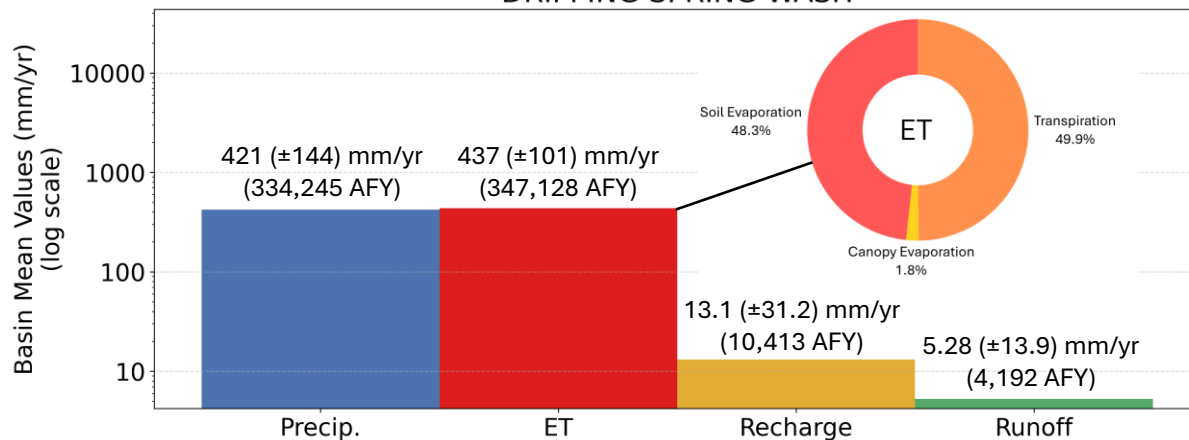
## Basin Summary Statistics

**Size<sup>1</sup>:** 378 square miles  
**Elevation<sup>2</sup>:** Range: 1,956-7,837 ft; Median: 3,502 ft  
**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (90%), Grassland Herbaceous (6.8%), Evergreen Forest (2.0%)  
**Major surface watershed(s)<sup>4</sup>:** Middle Gila River  
**Groundwater subbasins<sup>1</sup>:** None  
**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.67** (Very High)

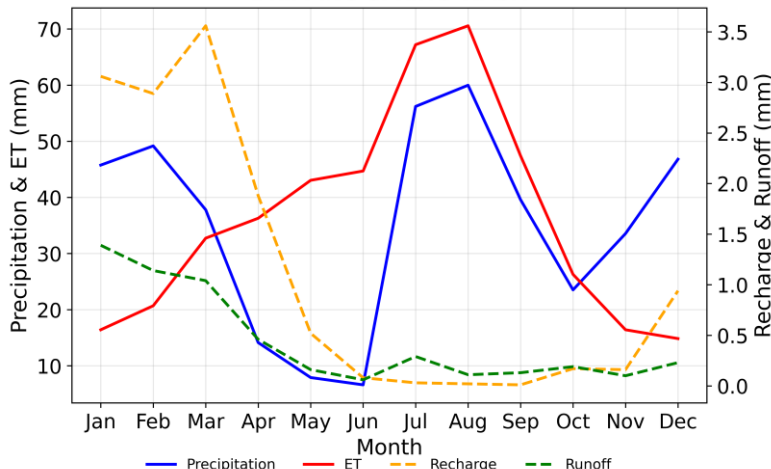


Mean Annual Hydrologic Cycle Components (1980-2020)  
DRIPPING SPRING WASH



**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.<sup>6</sup> 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)  
DRIPPING SPRING WASH



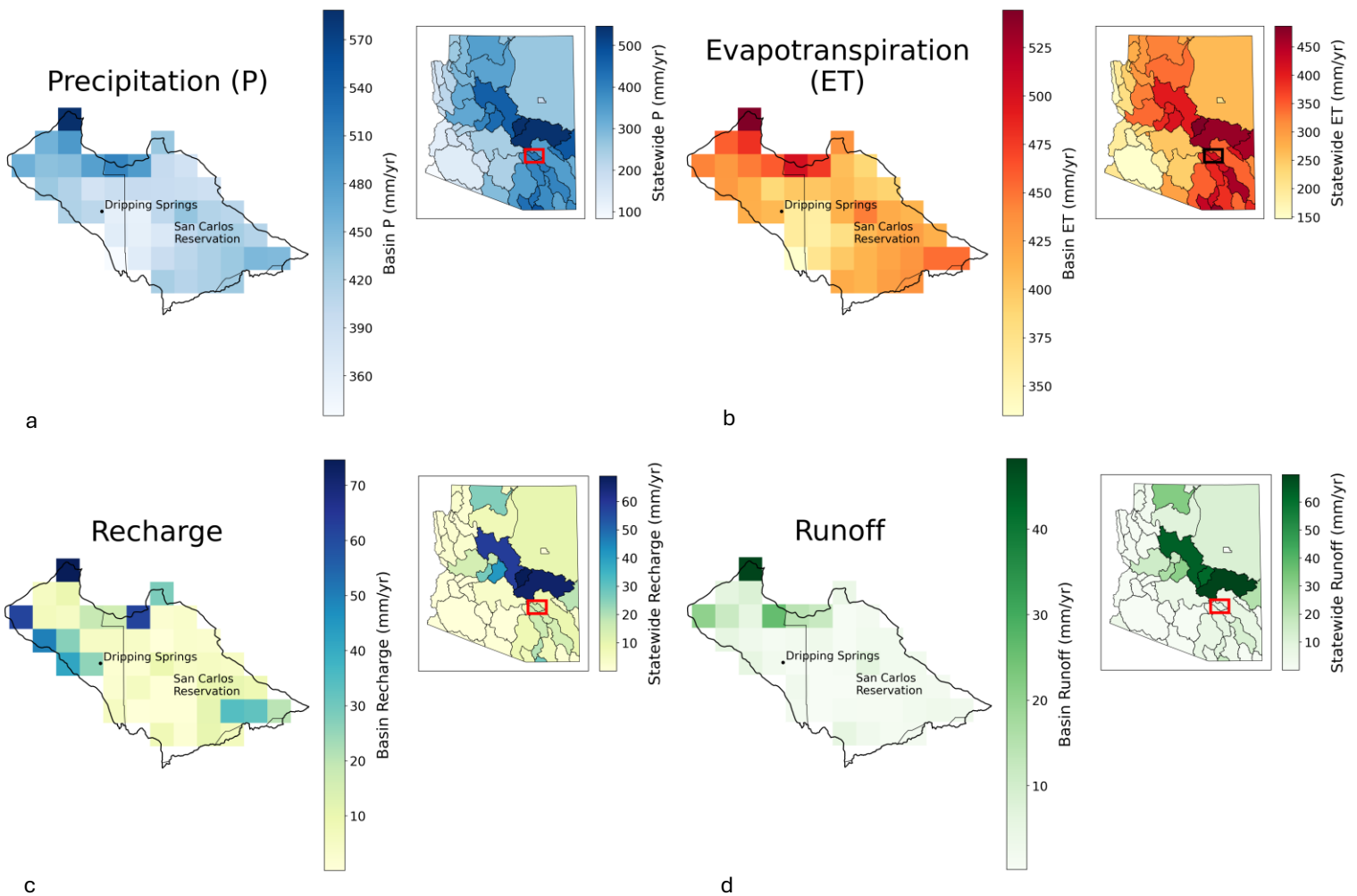
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is greater than precipitation (P) on average across the basin, resulting in moderately low averages for natural recharge (13.1 mm) and runoff (5.28 mm). ET is greater than P during the warmer months from March to October. Soil evaporation makes up 48.3% of total ET in the basin, while transpiration comprises 49.9% and canopy evaporation accounts for the remainder (1.8%). P in the Dripping Spring Wash basin is affected by the North American Monsoon during the summer months and large frontal systems in the winter. Natural recharge and runoff are highest January-March due to winter precipitation and relatively low atmospheric demand. Groundwater supplies an estimated 67% of total streamflow in the basin.

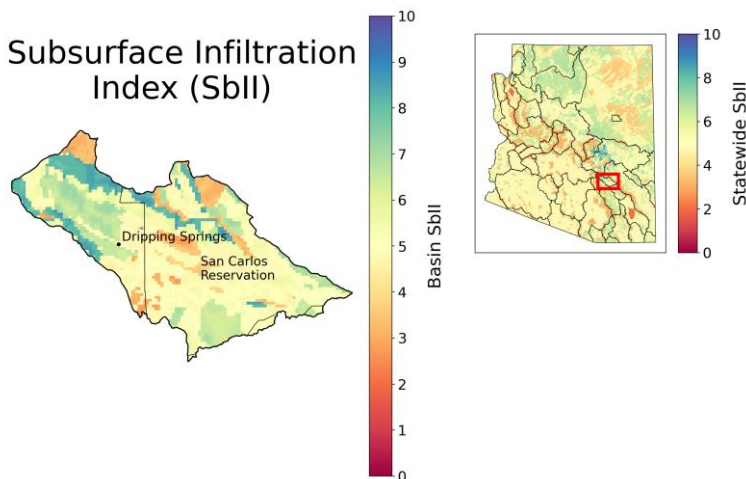
# Dripping Spring Wash



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



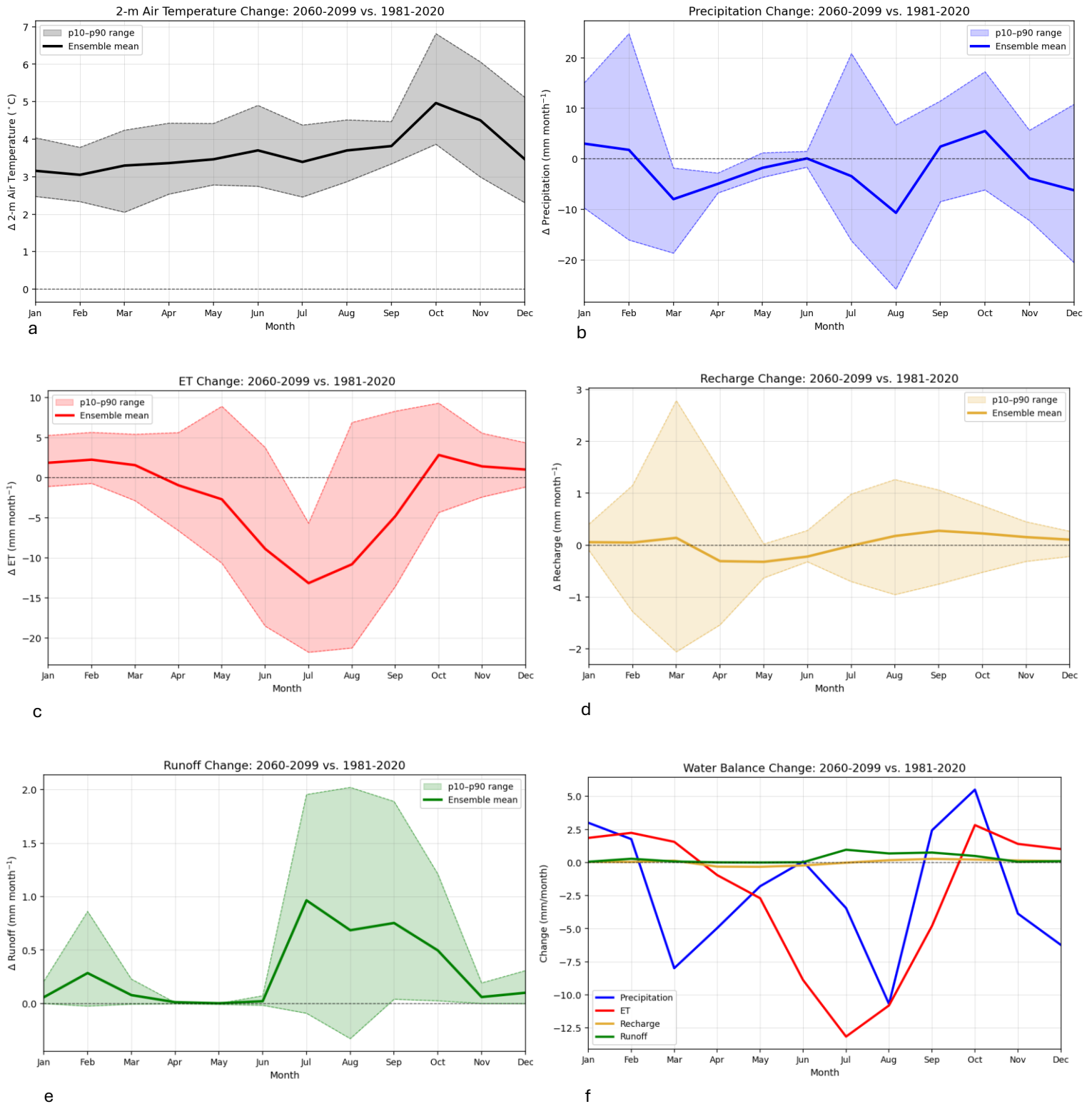
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation in the Dripping Spring Wash basin is highest in the Pinal Mountains in the northwestern portion of the basin. This region receives over 530 mm/yr of precipitation on average. The Pinal Mountains also have the highest evapotranspiration (~500 mm/yr), natural recharge (~60 mm/yr), and runoff (~40 mm/yr) in the basin. Subsurface infiltration potential varies across the basin with pockets of high infiltration potential from the presence of karst-type geology in the Pinal Mountains to the northwest and the Dripping Spring Mountains to the southwest.

# Dripping Spring Wash

## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.

# Dripping Spring Wash



Climate change projections across the Dripping Spring Wash basin show drier springs (14-34% drier March through May) and a drier July-August (6-18%) and November-December (13%). September and October are projected to be 6-21% (2.3-5.6 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. Natural recharge is projected to remain low and slightly negative (-0.09 to -1.1 mm/month) from June through January.\* While remaining below 1.2 mm/month, runoff is projected to increase by 0.51-0.98 mm/month from July to October by the end of the century. Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 11% (2.7 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability in May-August leads to projected declines in ET (7-22% or -2.7 to -13 mm/month) during the warmer 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

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# Duncan Valley Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 550 square miles

**Elevation<sup>2</sup>:** Range: 3,279-7,471 ft; Median: 4,237 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (94%), Evergreen Forest (2.1%), Grassland Herbaceous (1.8%)

**Major surface watershed(s)<sup>4</sup>:** Upper Gila - Mangas

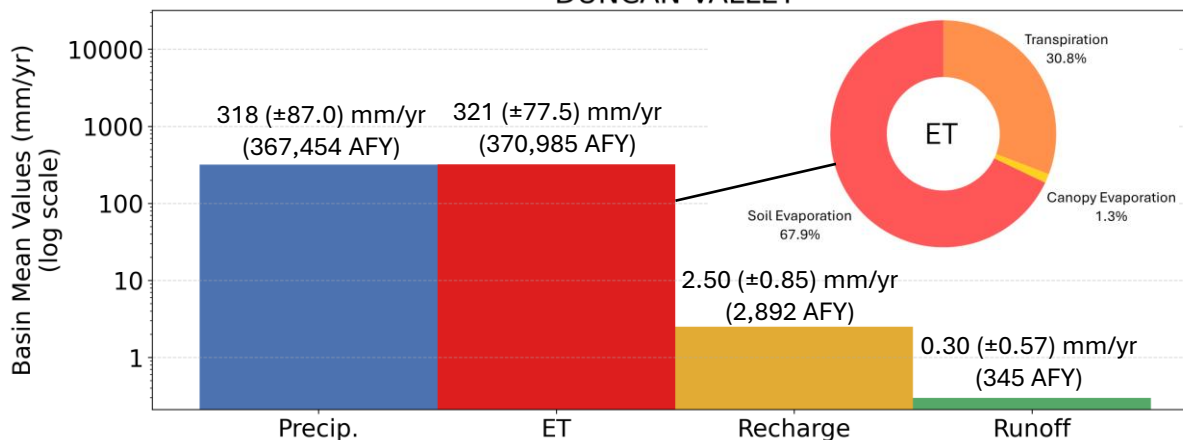
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.65** (High)

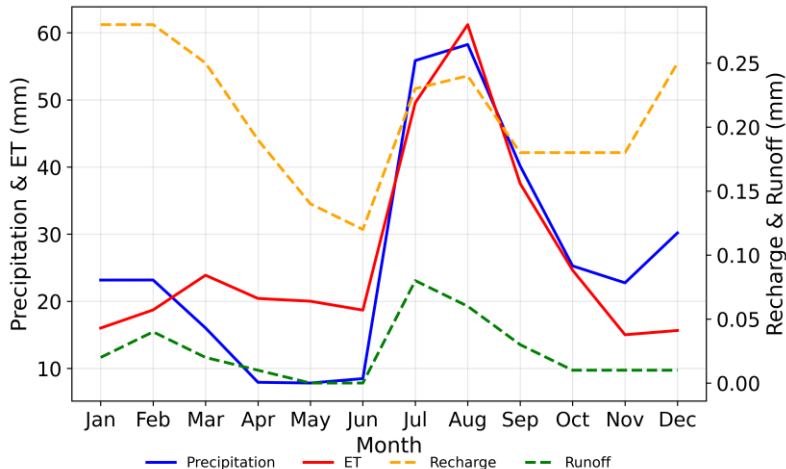


## Mean Annual Hydrologic Cycle Components (1980-2020) DUNCAN VALLEY



**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.<sup>6</sup> 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) DUNCAN VALLEY



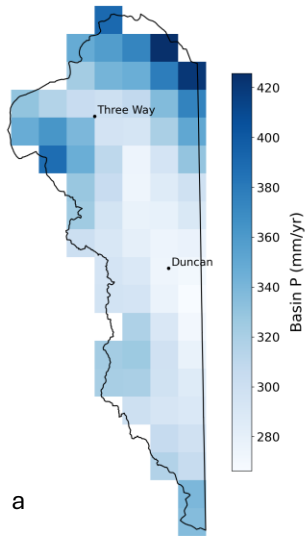
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) on average across the basin, resulting in low averages for natural recharge (2.50 mm) and runoff (0.30 mm). P in the Duncan Valley basin is affected by the North American Monsoon during the summer months. ET is greater than P from March to June and tracks with P from July to October. Soil evaporation makes up 67.9% of total ET in the basin, while transpiration comprises 30.8% and canopy evaporation accounts for the remainder (1.3%).

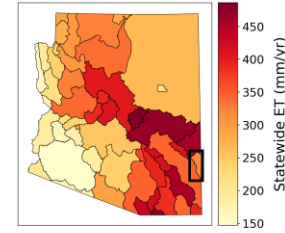
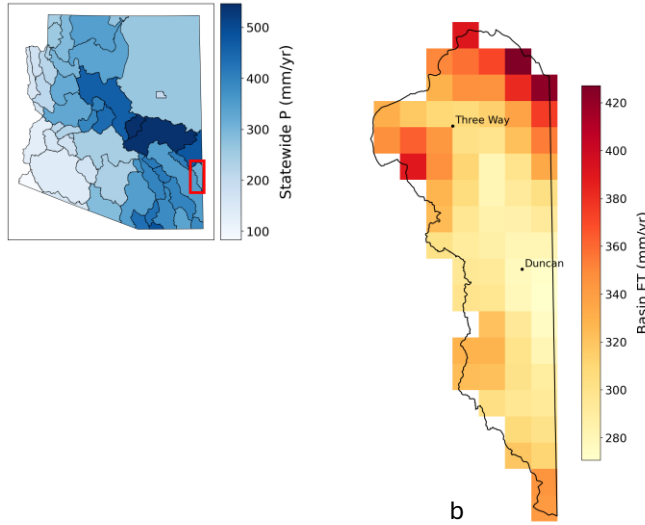
# Duncan Valley



## Precipitation (P)

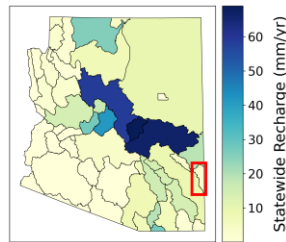
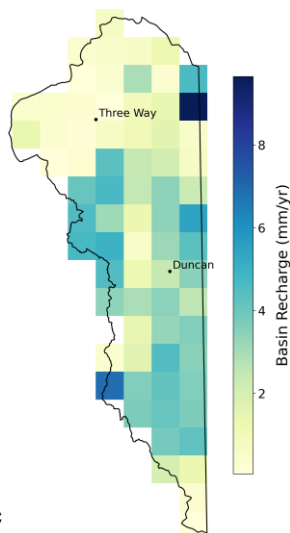


## Evapotranspiration (ET)

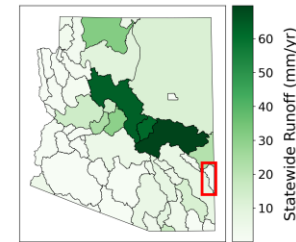
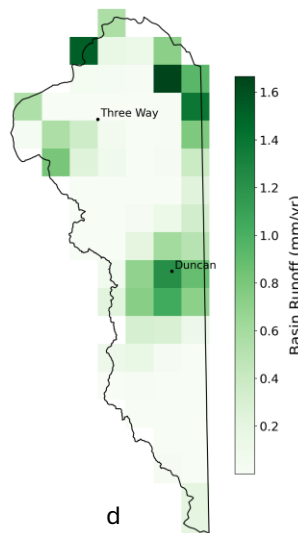


**Figure 3 (left).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are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

## Recharge

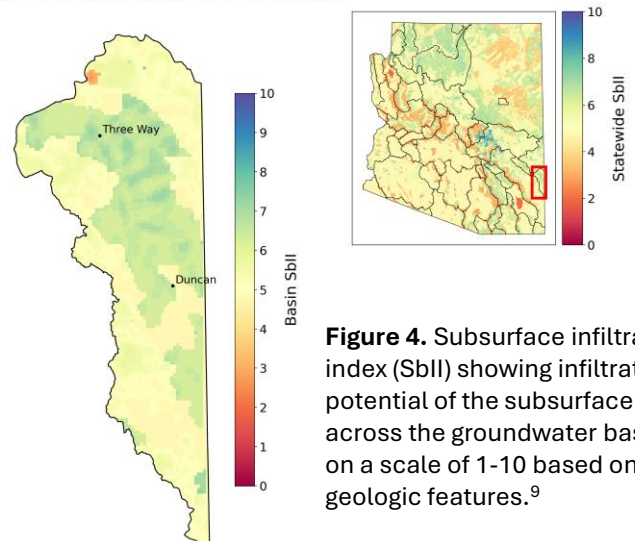


## Runoff



## Subsurface Infiltration Index (SbII)

Precipitation in the Duncan Valley basin is highest in mountainous region to the northeast. This region receives over 400 mm/yr of precipitation on average. Evapotranspiration (ET) is also highest in this region (~400 mm/yr). Natural recharge ranges from 2-4 mm/yr across much of the basin, with slightly higher values (8 mm/yr) at the higher elevations. Runoff is minimal across the basin, but is highest near the mountains to the north (~1.5 mm/yr). Subsurface infiltration potential is generally moderate to high across the basin, particularly in the Gila River valley due to the presence of moderately consolidated conglomerate containing limestone.

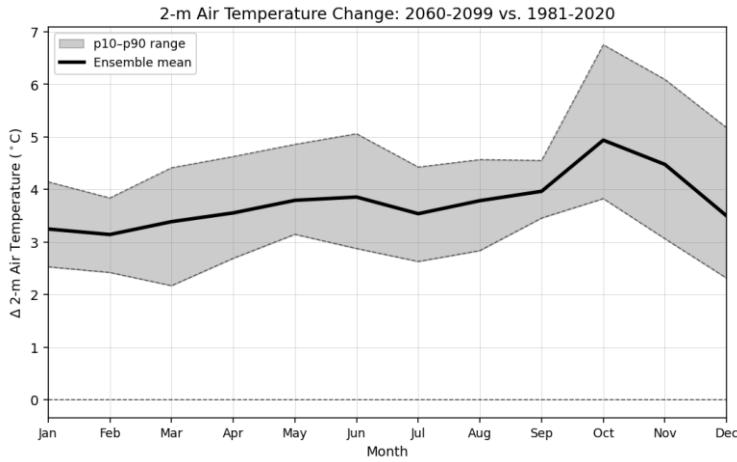


**Figure 4.** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

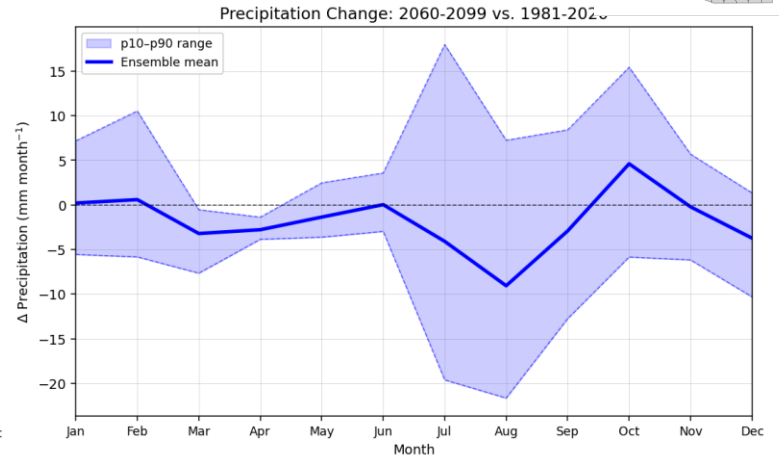
# Duncan Valley



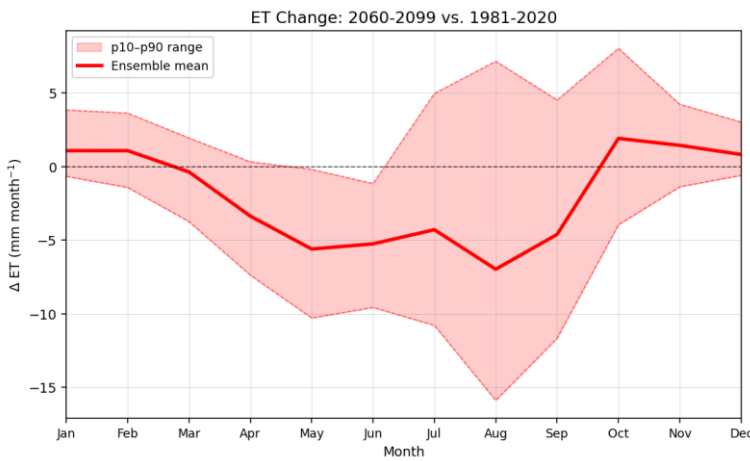
## Climate Change Projections: Changes in Temperature, Precipitation, ET, Recharge, and Runoff (2060-2099 vs. 1981-2020)



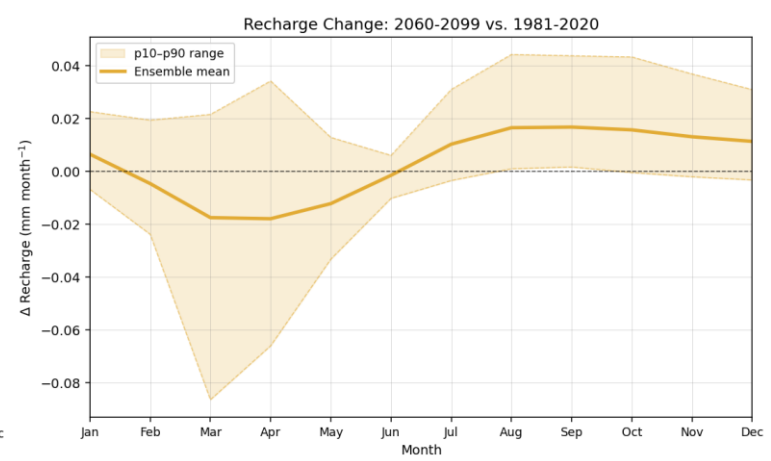
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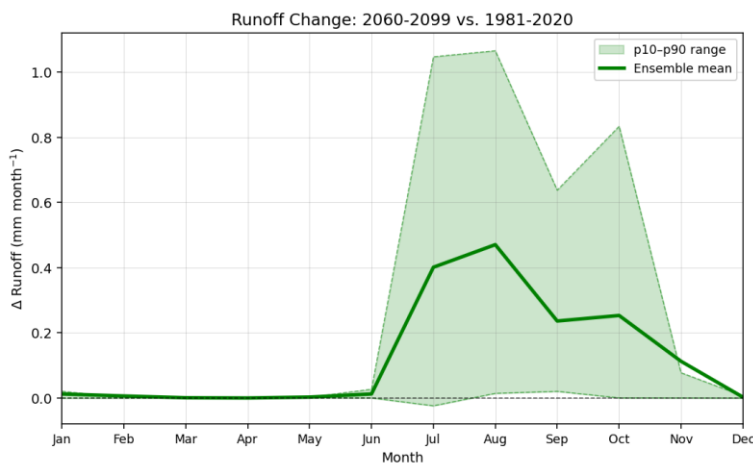
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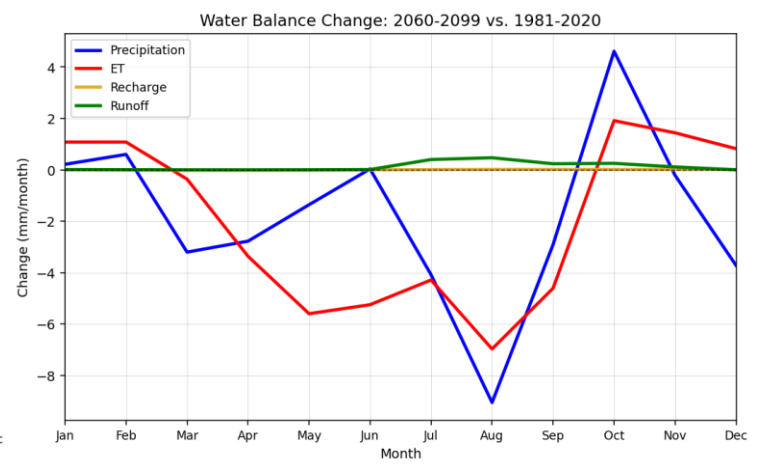
c



d



e



f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Duncan Valley basin show less precipitation throughout much of the year, with the exception of October, which shows an 8% (4.7 mm) increase in precipitation. The greatest declines in precipitation are projected for March-May (16-40% drier), July-September (7-15%), and December (12%). Recharge is projected to remain near zero throughout the year and slightly negative June through February (-0.01 to -0.02 mm/month).<sup>\*</sup> While remaining below 0.6 mm/month, runoff is projected to increase by 0.12-0.46 mm/month from July to November by the end of the century. Projected increases in temperature range from approximately 3.2 °C in February to 5.0 °C in October. Less water availability from April to September leads to projected declines (9-25% or -3.4 to -7.0 mm/month) in evapotranspiration (ET) during the warmer months, while higher temperatures and greater precipitation are consistent with a projected 7% (1.8 mm) increase in ET in October compared to the baseline period.

<sup>\*</sup>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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# Gila Bend Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 1,284 square miles

**Elevation<sup>2</sup>:** Range: 535-3,914 ft; Median: 1,102 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (86%), Cultivated Crops (7.0%), Grassland Herbaceous (2.6%)

**Major surface watershed(s)<sup>4</sup>:** Lower Gila – Painted Rock Reservoir

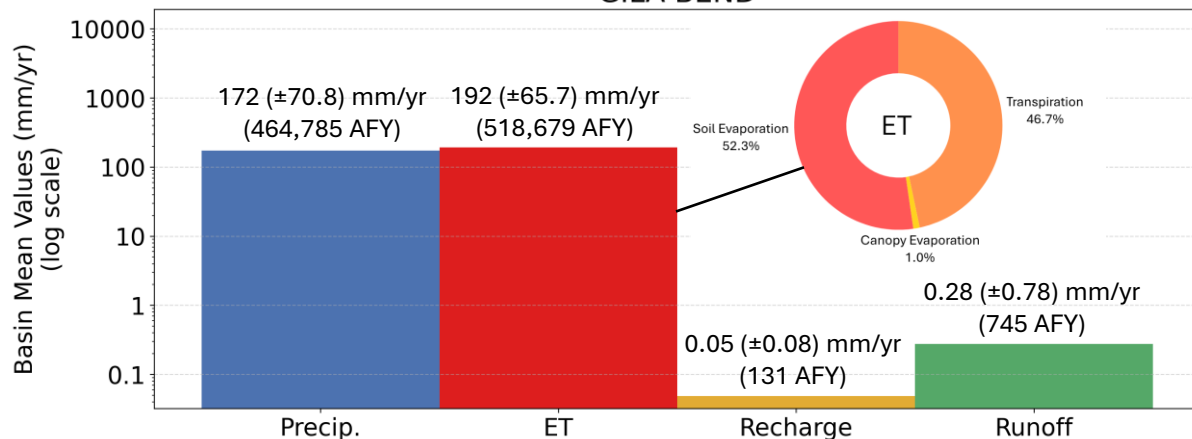
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.32 (Low)**

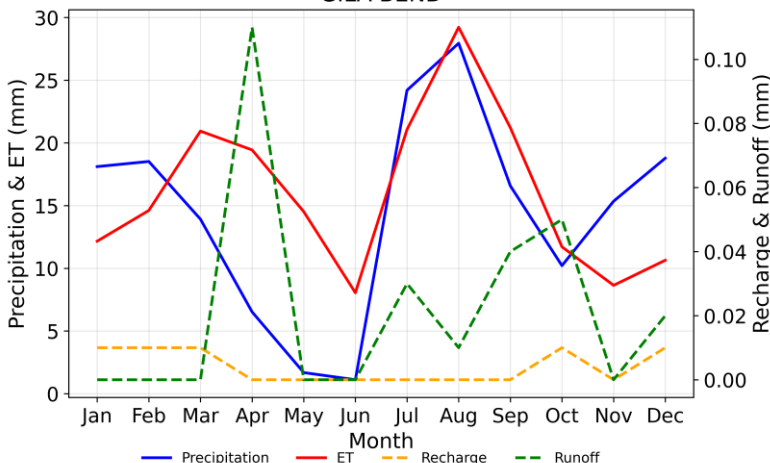


Mean Annual Hydrologic Cycle Components (1980-2020)  
GILA BEND



**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.<sup>6</sup> 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)  
GILA BEND



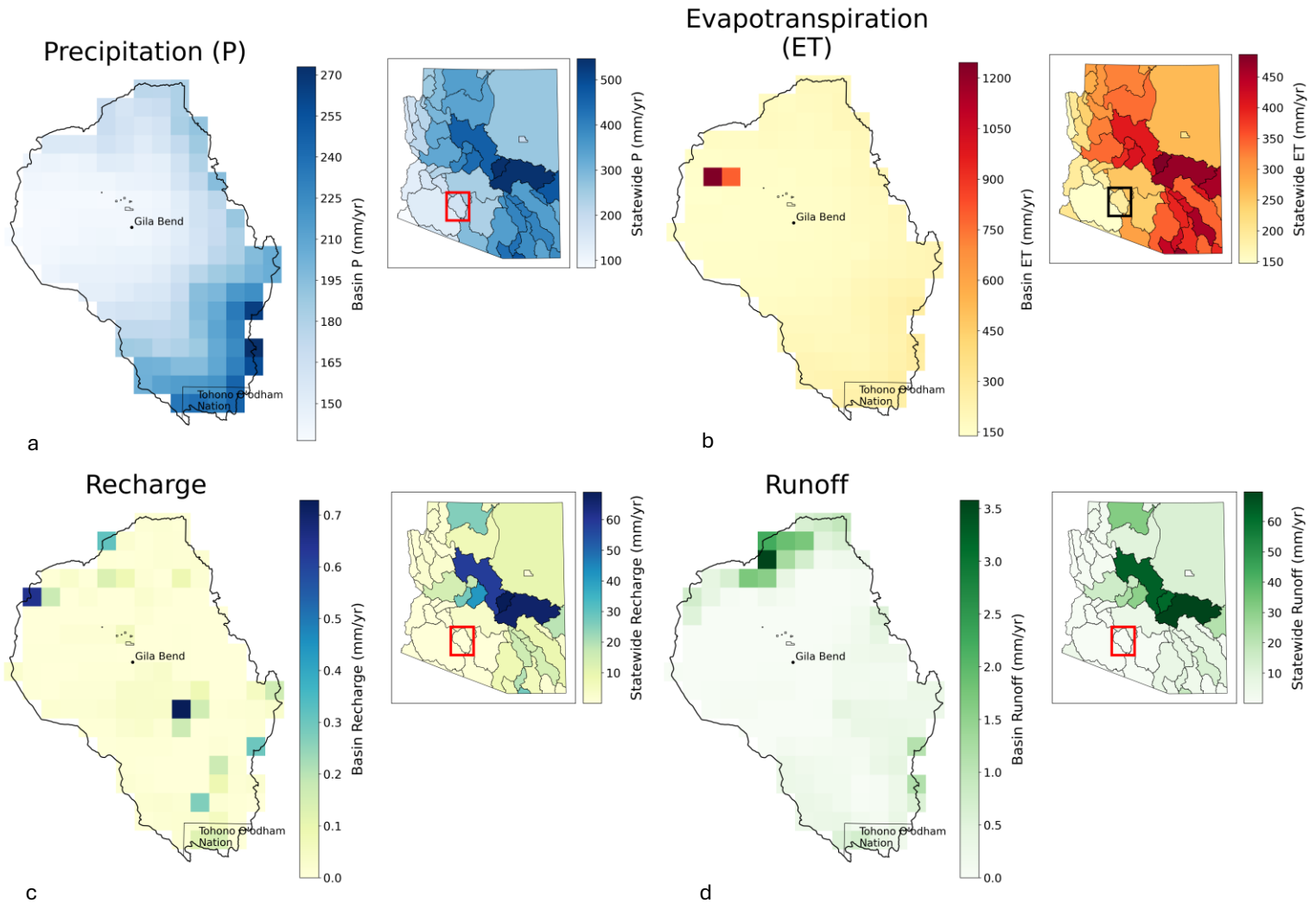
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is greater than precipitation (P) on average across the basin, resulting in near zero averages for natural recharge (0.05 mm) and runoff (0.28 mm). P in the Gila Bend 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 mid-February to June and tracks with P from June to October due to enhanced water availability from the North American Monsoon. Soil evaporation makes up 52.3% of total ET in the basin, while transpiration comprises 46.7% and canopy evaporation accounts for the remainder (1.0%).

# Gila Bend

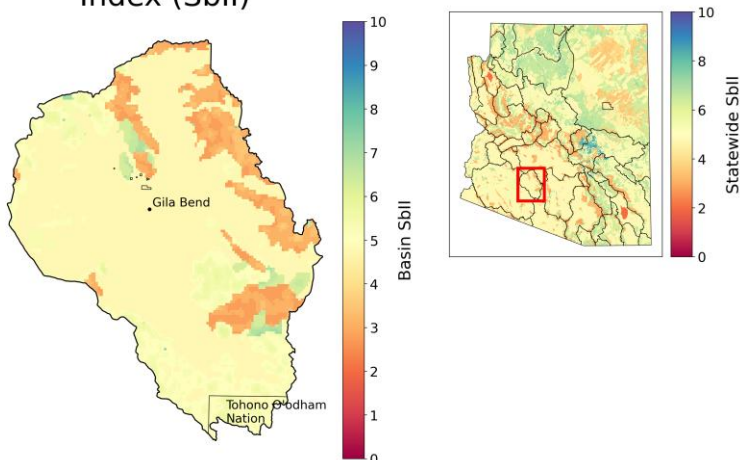


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

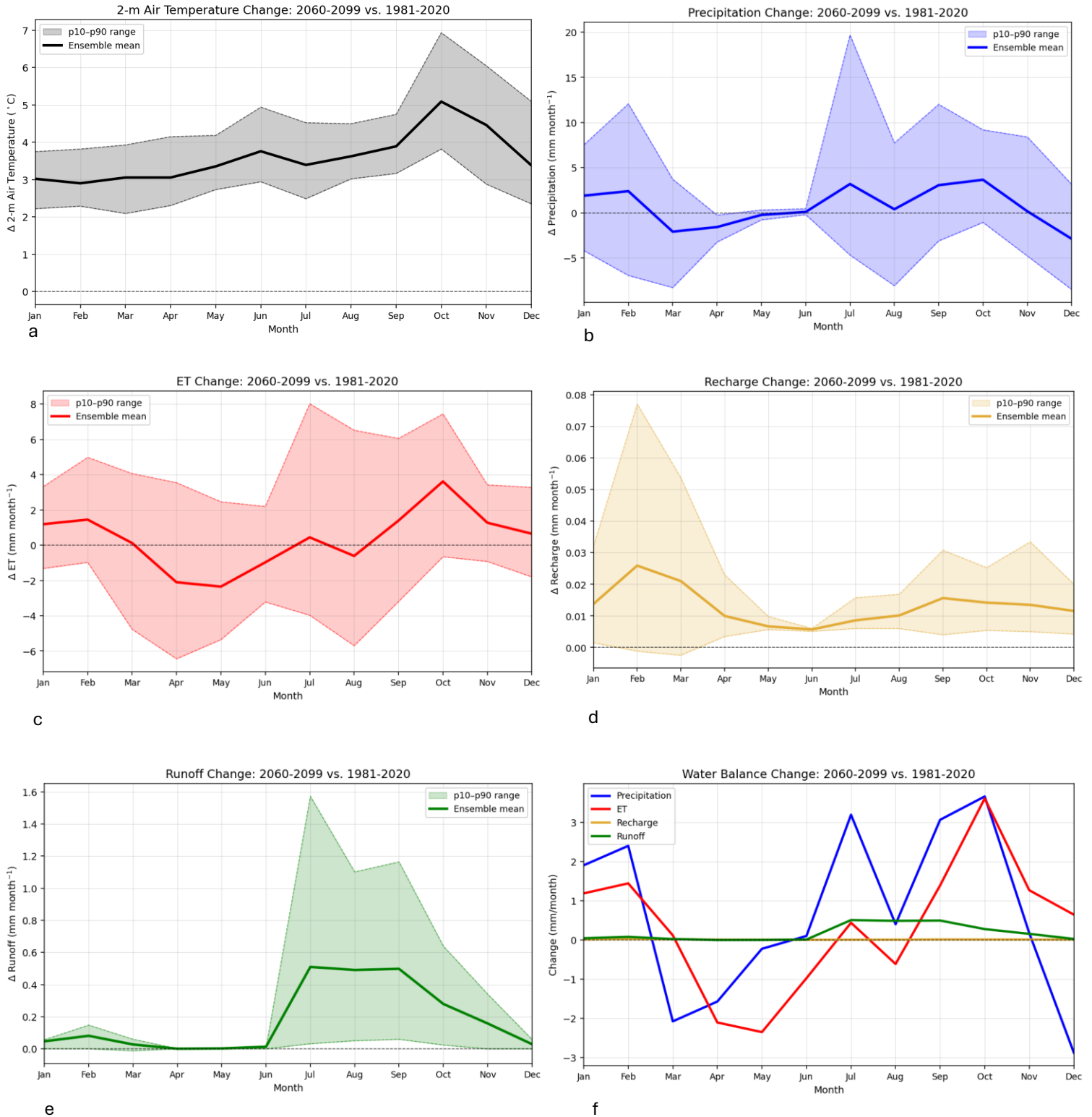
## Subsurface Infiltration Index (SbII)



Precipitation in the Gila Bend basin is highest in the Saucedo Mountains to the south and the Sand Tank Mountains to the southeast. These regions receive over 250 mm/yr of precipitation on average. Evapotranspiration (ET) is highest (~1,000 mm/yr) over the Painted Rock Reservoir northwest of Gila Bend. ET averages ~260 mm/yr in the mountainous regions of the basin. Natural recharge and runoff are near zero across the basin, with slightly higher runoff values (2-3 mm/yr) in the Woolsey Peak Wilderness to the north. Subsurface infiltration potential is generally low to moderate across the basin, with pockets of higher infiltration potential due to karst-type geology north of Gila Bend and in the southeast portion of the basin near the Sand Tank Mountains.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Gila Bend basin show drier springs (13-33% drier March through May) and a drier December (14%). January-February (11-12%), July (13%) and September-October (18-32%) are projected to be wetter on average. This increase in precipitation in September and October (3.0-3.8 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity by the end of the century. Natural recharge is projected to remain near zero and slightly negative (-0.01 mm/month) throughout the year.\* While remaining below 0.6 mm/month, runoff is projected to increase by 0.16-0.51 mm/month from July to November by the end of the century. Projected increases in temperature range from approximately 2.9 °C in February to 5.1 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 30% (3.6 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability in April-May leads to projected declines in ET (12-20% or -2.2 to -2.4 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

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# Grand Wash Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 959 square miles

**Elevation**<sup>2</sup>: Range: 1,095-7,715 ft; Median: 4,256 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (73%), Grassland Herbaceous (14%), Evergreen Forest (12%)

**Major surface watershed(s)**<sup>4</sup>: Grand Wash

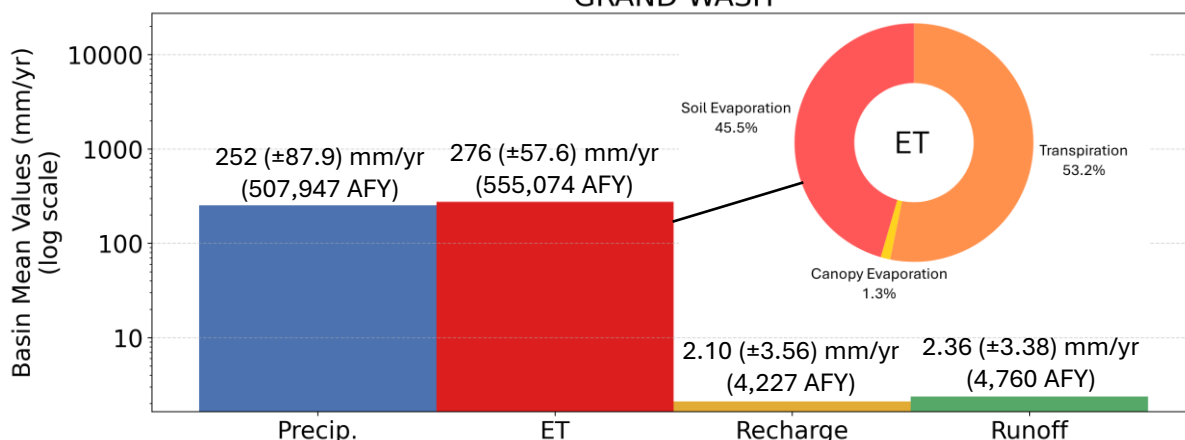
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.46** (Moderate)

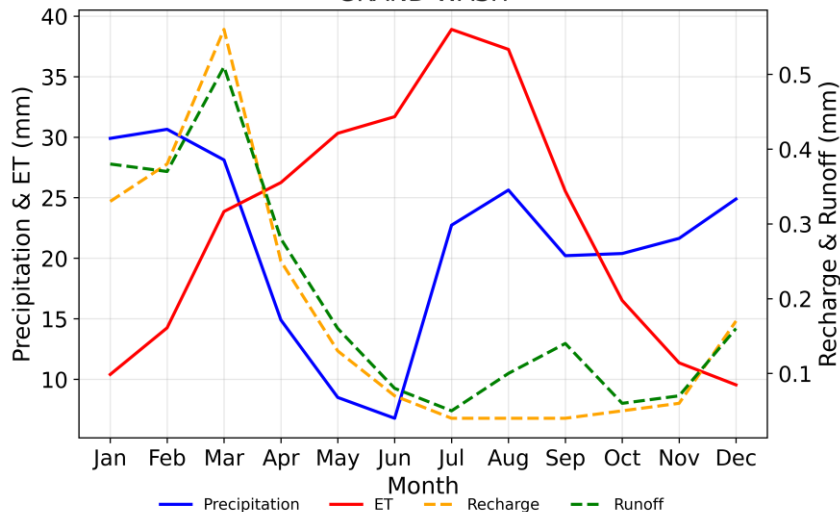


## Mean Annual Hydrologic Cycle Components (1980-2020) GRAND WASH



**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.<sup>6</sup> 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) GRAND WASH



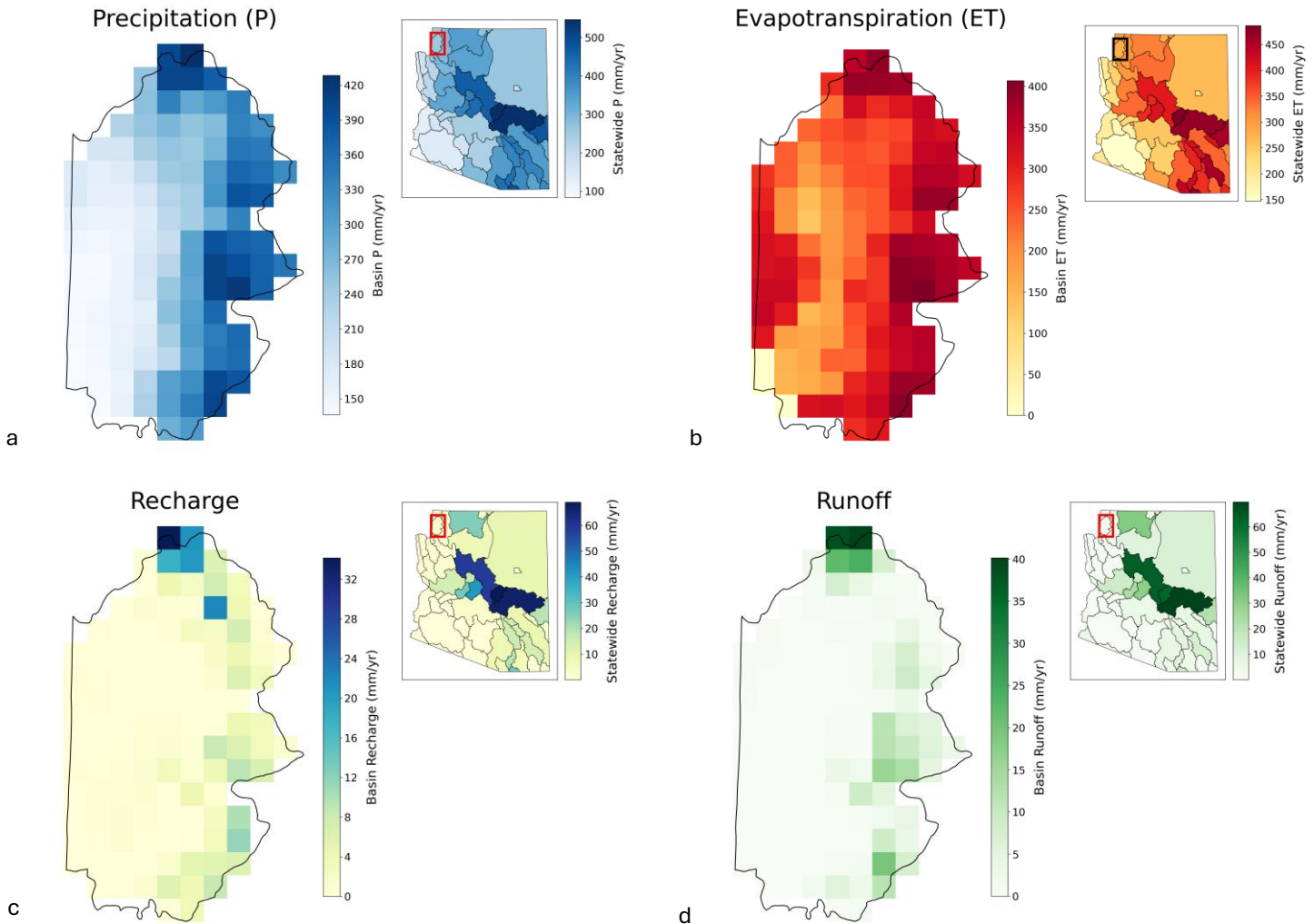
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

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.

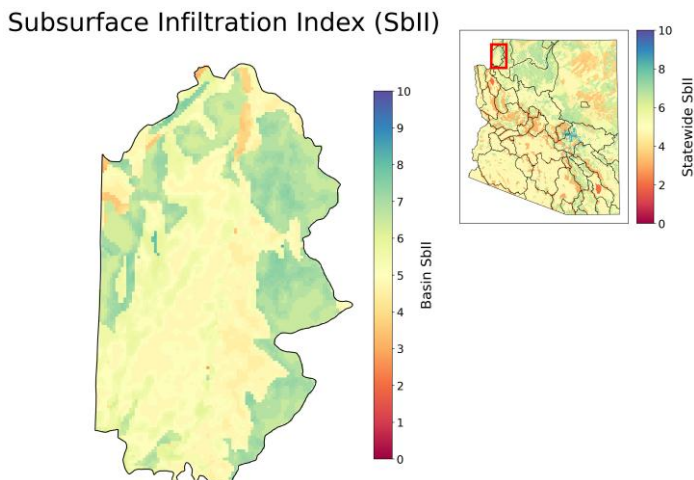
# Grand Wash



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



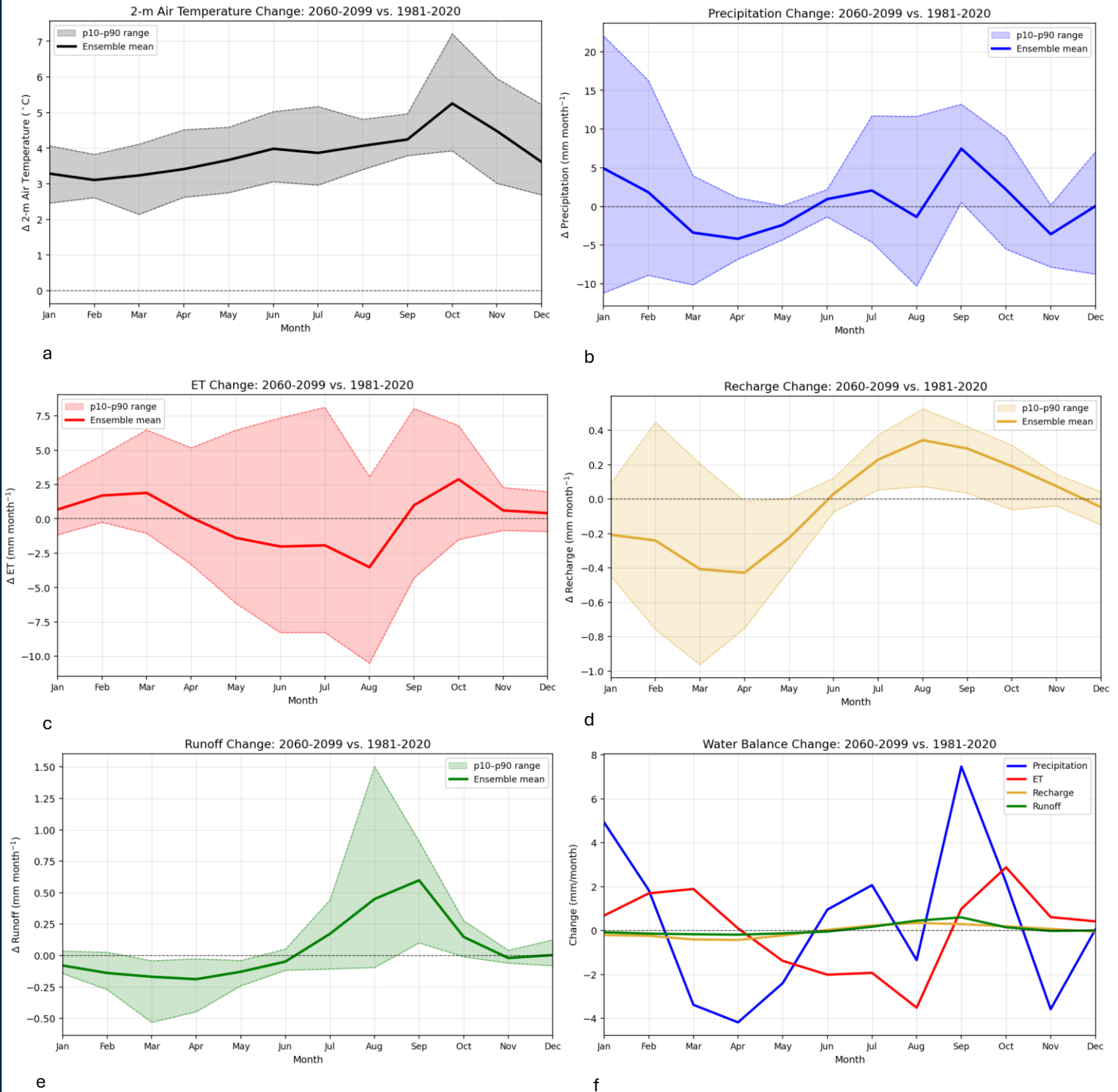
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



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.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



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).<sup>\*</sup> 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).

<sup>\*</sup>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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# Harquahala INA Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 766 square miles

**Elevation<sup>2</sup>:** Range: 927-5,676 ft; Median: 1,424 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (92%), Cultivated Crops (5.6%), Barren Land (0.66%)

**Major surface watershed(s)<sup>4</sup>:** Centennial Wash, Bouse Wash

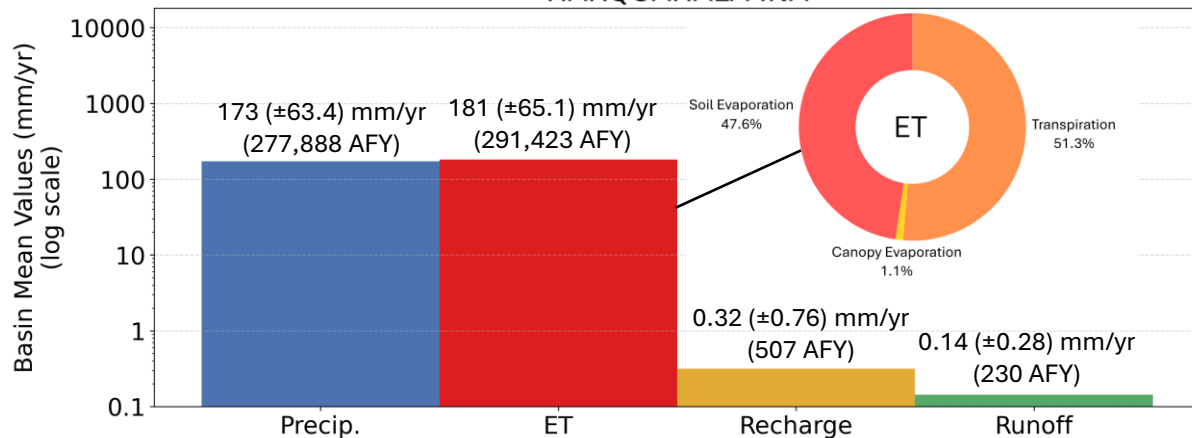
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.03** (Very Low)

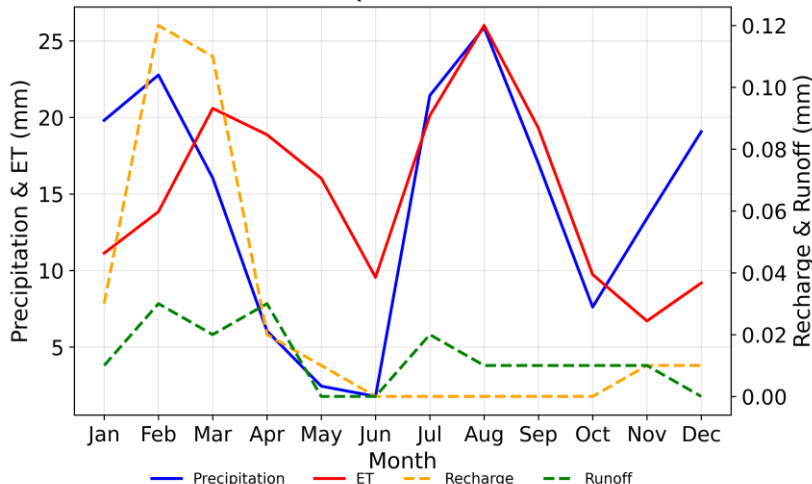


Mean Annual Hydrologic Cycle Components (1980-2020)  
HARQUAHALA INA



**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.<sup>6</sup> 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)  
HARQUAHALA INA



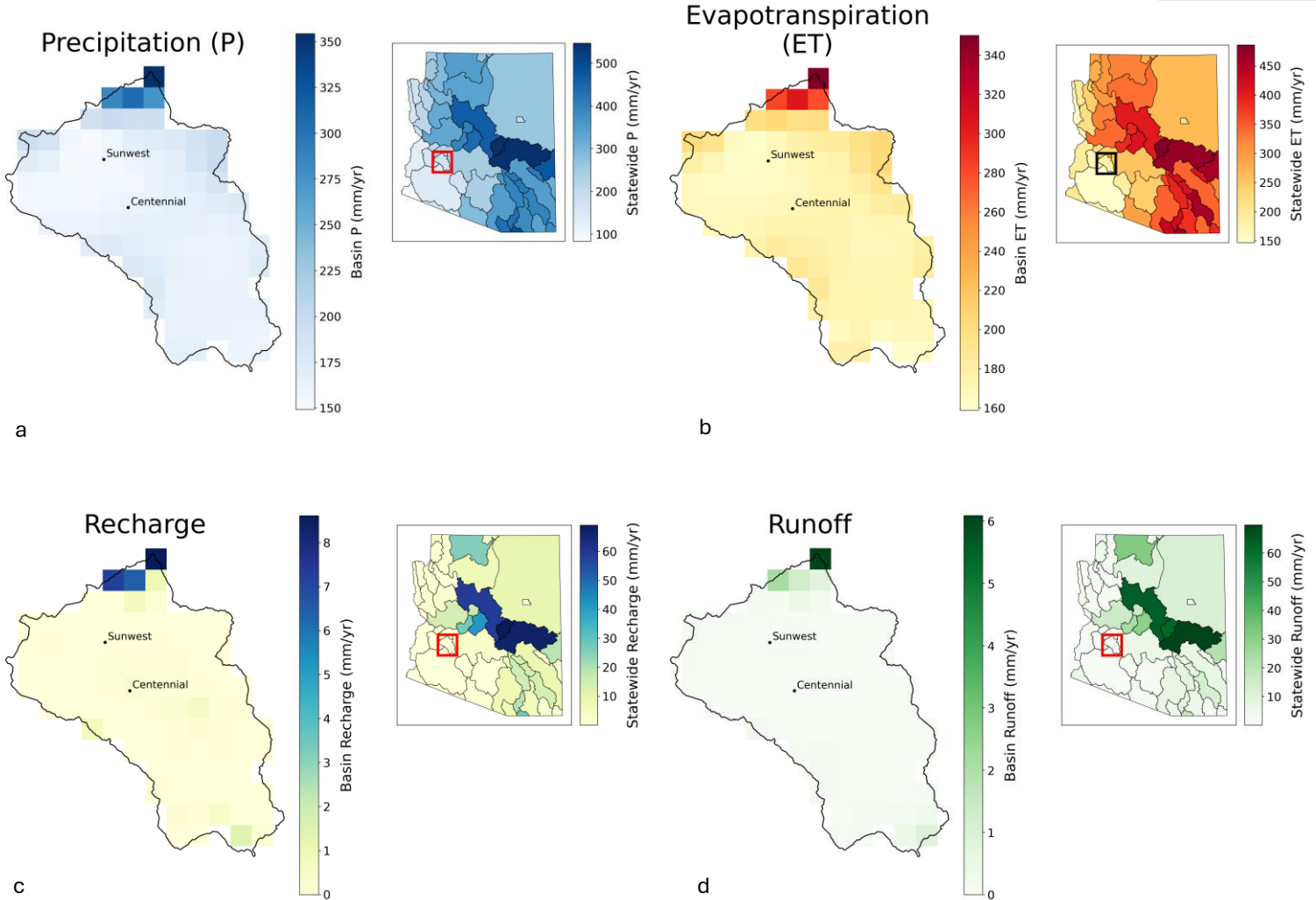
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the Harquahala INA. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P from March to June and tracks closely with P from June through October. Soil evaporation makes up 47.6% of total ET, while transpiration comprises 51.3% and canopy evaporation accounts for the remainder (1.1%).

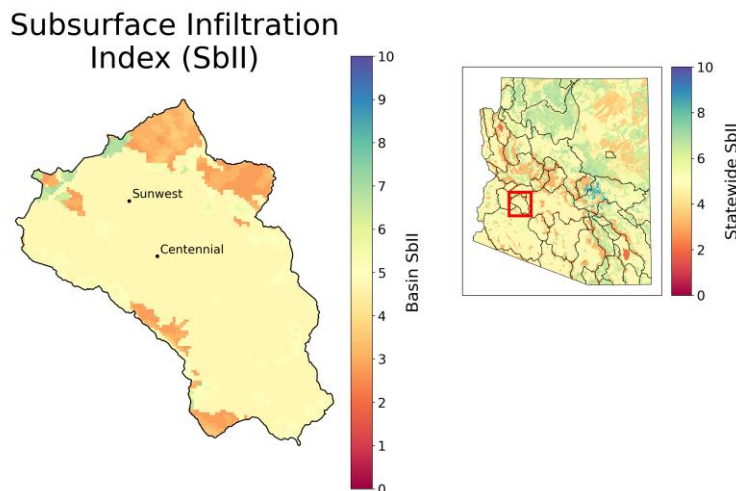
# Harquahala INA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

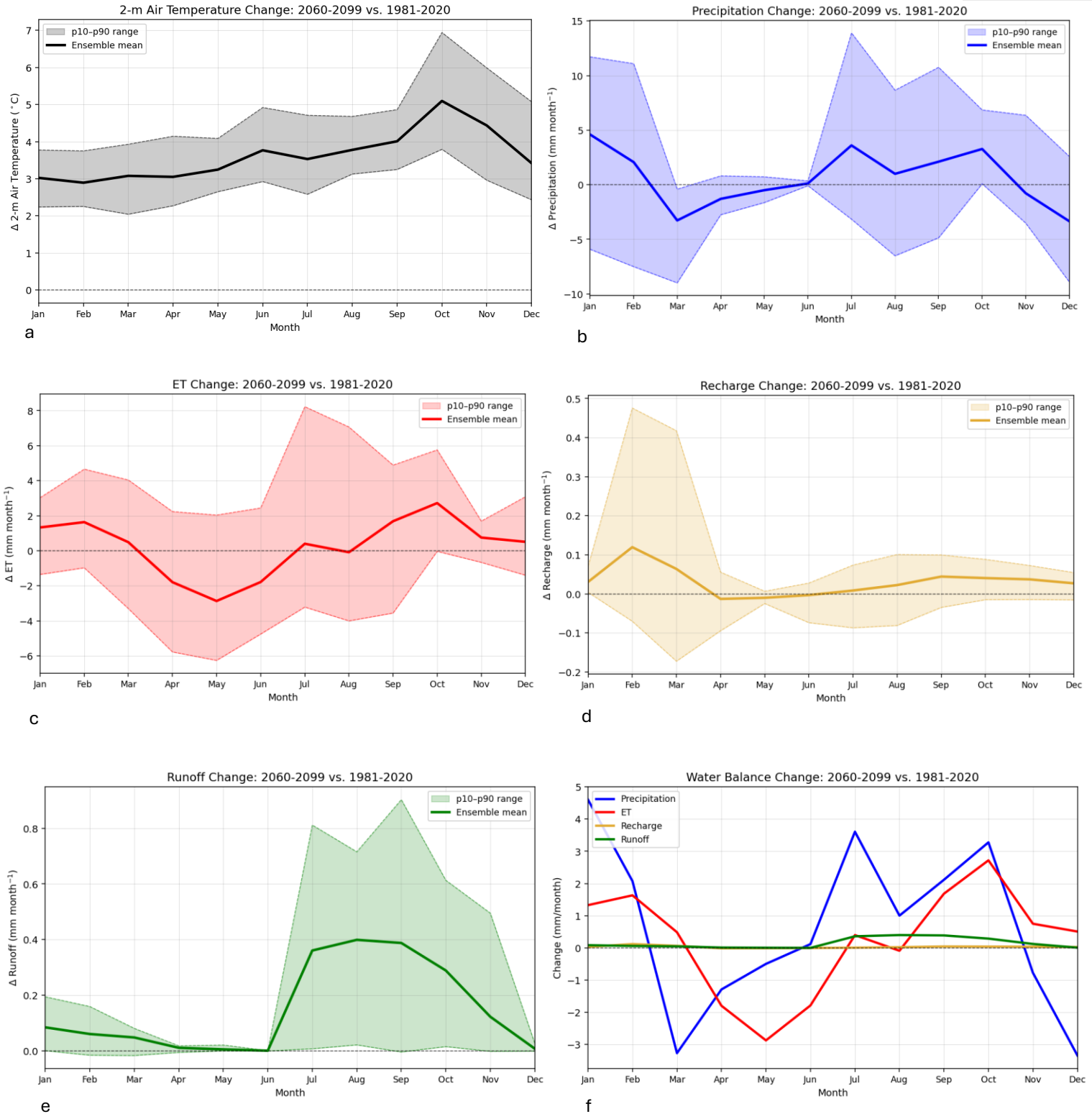


Precipitation (P) in the Harquahala INA is greatest in the Harquahala Mountains in the northernmost part of the basin. Both P and evapotranspiration (ET) can exceed 325 mm/yr on average in this region. Natural recharge and runoff are also highest in this region, exceeding 6 mm/yr and 5 mm/yr, respectively. The Harquahala INA generally has moderate infiltration potential with areas of higher potential in regions with karst-type geology in the Harquahala Mountains.

# Harquahala INA



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Harquahala INA show drier springs (18-27% drier March through May) and a drier November-December (6-17%). January-February (7-24%) and June-October (4-36%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.1-3.3 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (approximately -0.01 to -0.07 mm/month) from May through December.\* While runoff is projected to remain below 0.5 mm/month, minor increases of 0.13-0.41 mm/month are projected for July-November. Projected increases in temperature range from approximately 2.9 °C in February to 5.1 °C in October. Less precipitation in April and May leads to a projected 10-19% (-1.9 to -2.9 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 25% (2.7 mm) increase in ET in October, a 13% (1.3 mm) increase in January, and a 11% (1.6 mm) increase in February 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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# Hualapai Valley INA Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 1,213 square miles

**Elevation<sup>2</sup>:** Range: 1,081-7,971 ft; Median: 3,364 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (91%), Evergreen Forest (3.3%), Barren Land (1.7%)

**Major surface watershed(s)<sup>4</sup>:** Truxton Wash/Red Lake, Colorado River

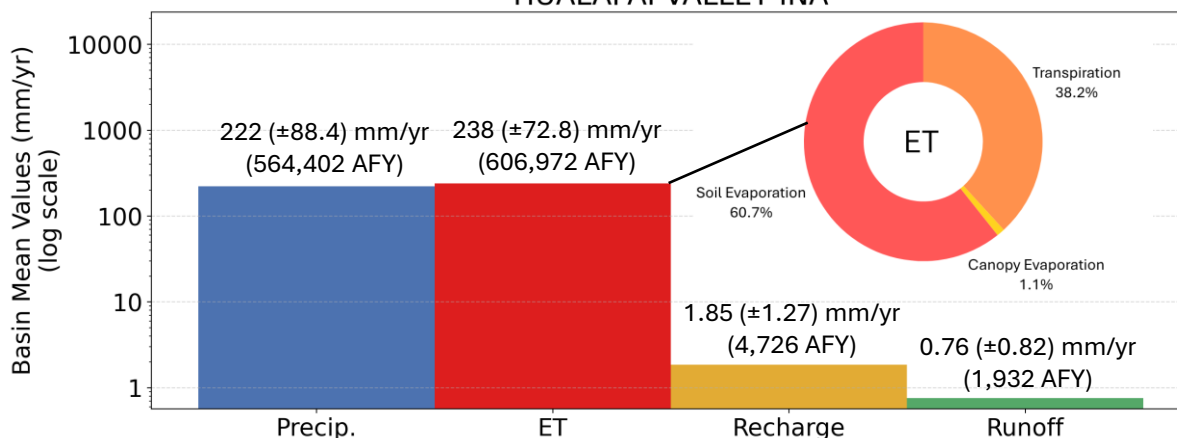
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.73** (Very High)

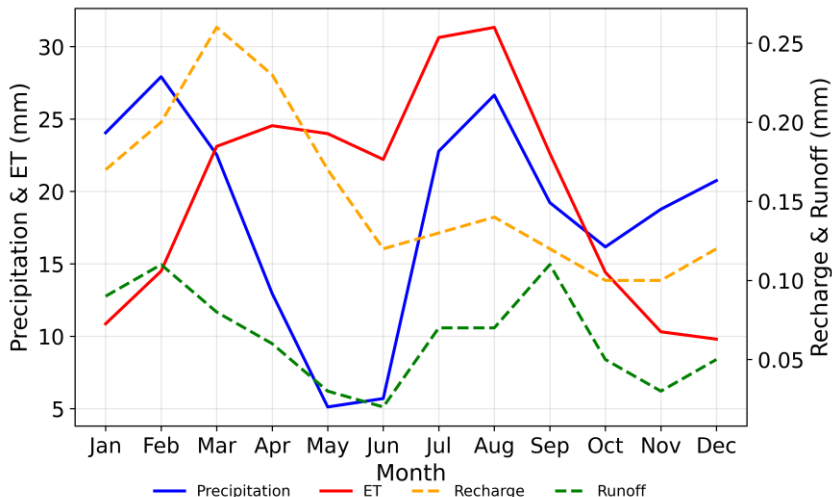


Mean Annual Hydrologic Cycle Components (1980-2020)  
HUALAPAI VALLEY INA



**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.<sup>6</sup> 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)  
HUALAPAI VALLEY INA



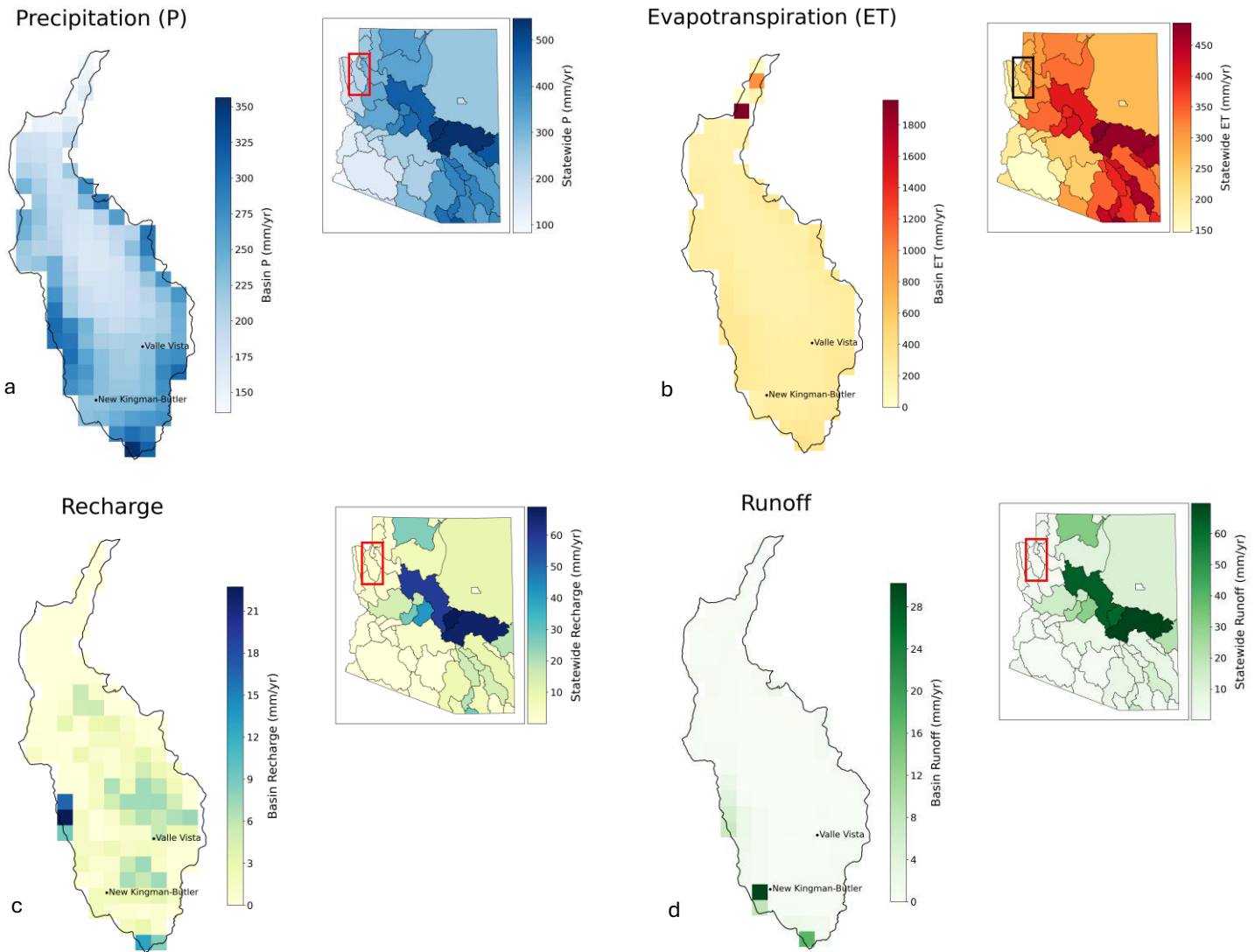
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average in the Hualapai Valley INA, resulting in low basin-wide averages for natural recharge (1.85 mm) and runoff (0.76 mm). ET is greater than P from March through mid-September. Soil evaporation makes up 60.7% of total ET in the basin, while transpiration comprises 38.2% and canopy evaporation accounts for the remainder (1.1%). P exceeds ET during the late fall and winter months when there is lower atmospheric demand.

# Hualapai Valley INA

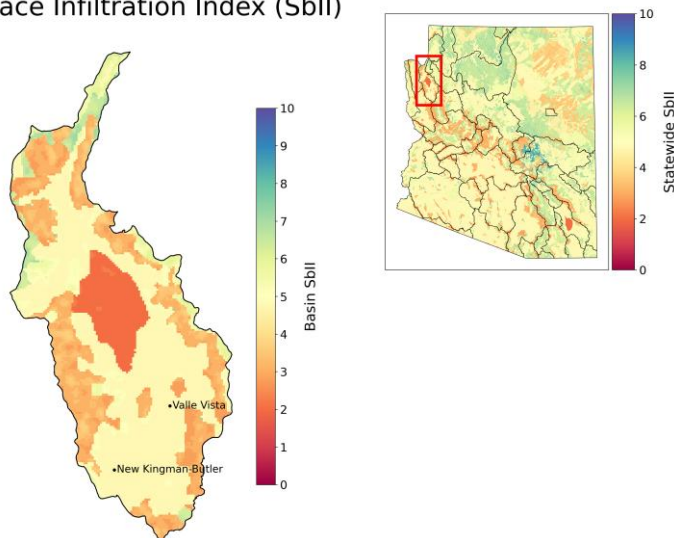


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

## Subsurface Infiltration Index (SbII)

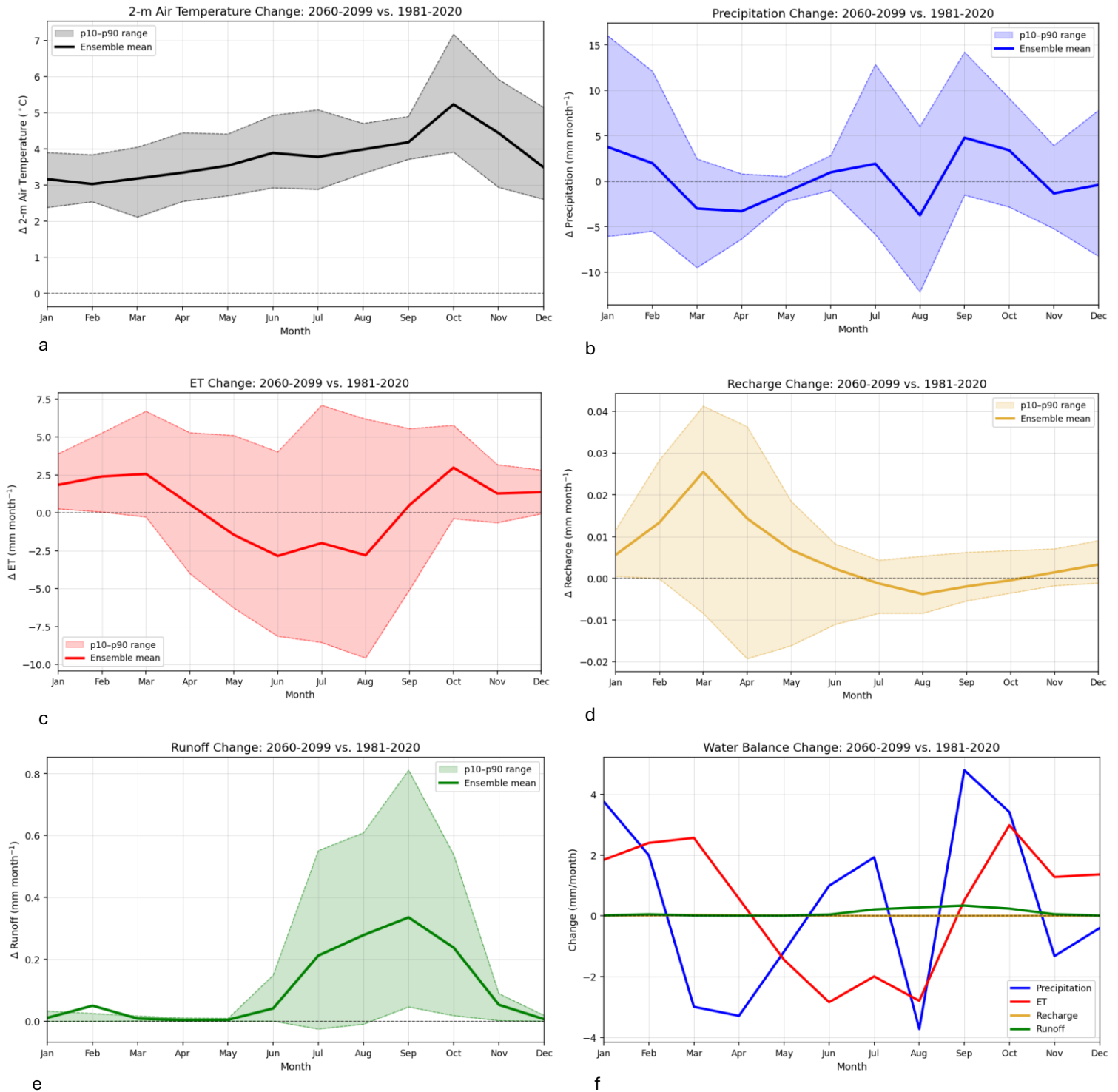


The Hualapai Valley INA is ringed by mountains to the west, south, and east, where P can exceed 350 mm/yr. ET is highest over the open water of the Colorado River in the northern portion of the basin (>1,000 mm/yr). Runoff and natural recharge are minimal across the basin, with the highest values (~30 mm/yr and 20 mm/yr, respectively) occurring at the mountain front of the Cerbat Mountains. Infiltration potential varies across the basin; however, the Red Lake Playa is highlighted as an area of particularly low infiltration potential due to the presence of low permeability, fine-grained sediment. The northern tip of the basin has higher infiltration potential due to karst-type geology.

# Hualapai Valley INA



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Hualapai Valley INA show drier springs (12-26% drier March through May) and a drier August (13%) and November (8%). September and October are projected to be 21-26% (3.5-4.8 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. Natural recharge remains near zero and slightly negative (approximately -0.04 mm/month) throughout the year.\* While remaining below 0.4 mm/month, runoff is projected to increase by 0.22 to 0.34 mm/month from July to October by the end of the century. 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 15% increase in evapotranspiration (ET) in January (1.9 mm) and October (3.0 mm) 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.

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7. AZGeo City Points shapefile. Retrieved from AZGeo Data Hub: <https://azgeo-open-data-agic.hub.arcgis.com/datasets/azgeo::city-points/about>
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9. Lima, R., Springer, A., Sankey, T. (2026). Arizona Subsurface Infiltration Index v.2, HydroShare, <https://doi.org/10.4211/hs.abcd8aa1a793463ab33677ce9d46db58>
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# Joseph City INA Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 180 square miles

**Elevation<sup>2</sup>:** Range: 4,912-5,497 ft; Median: 5,112 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (87%), Grassland Herbaceous (7.2%), Woody Wetlands (2.1%)

**Major surface watershed(s)<sup>4</sup>:** Middle Little Colorado, Chevelon Canyon

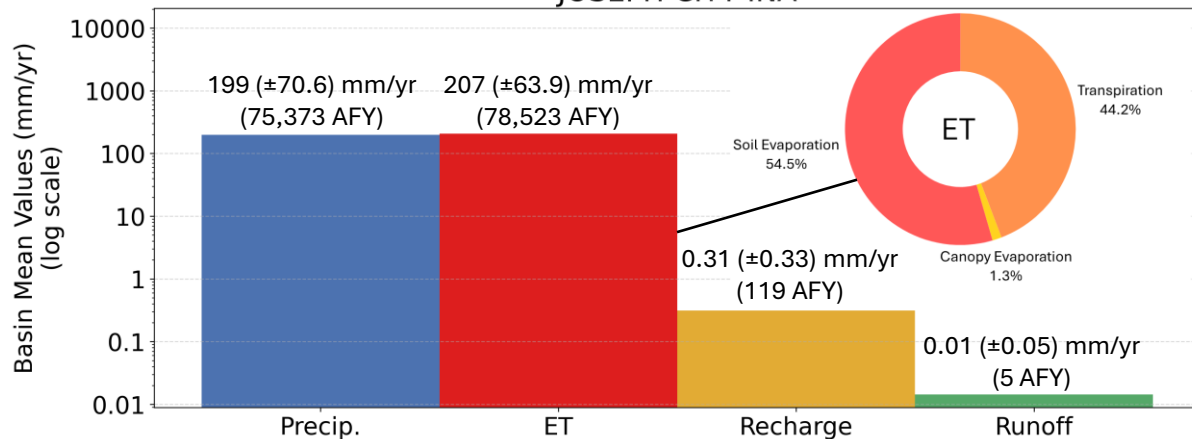
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.55** (High)

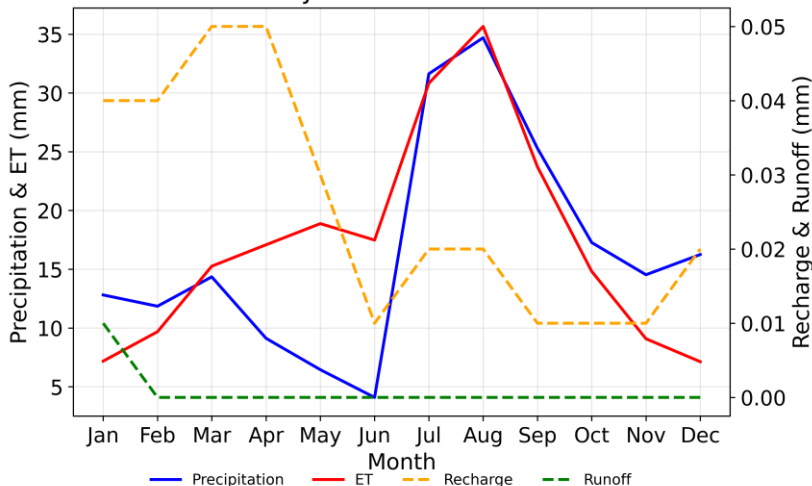


Mean Annual Hydrologic Cycle Components (1980-2020)  
JOSEPH CITY INA



**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.<sup>6</sup> 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)  
JOSEPH CITY INA



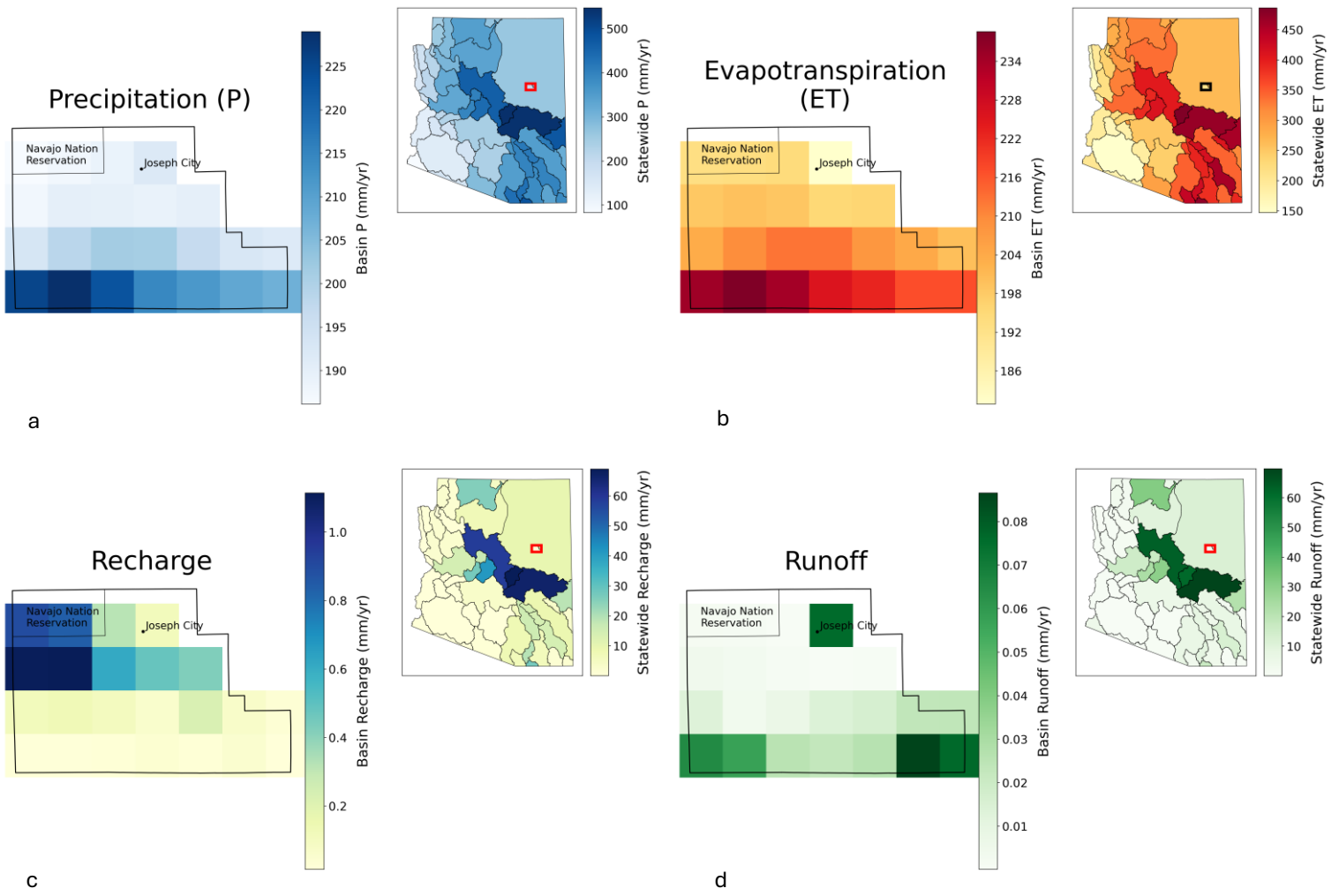
On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average across the Joseph City INA, resulting in near zero basin-wide averages for natural recharge (0.31 mm/yr) and runoff (0.01 mm/yr). Seasonally, P is affected by the North American Monsoon during the summer months. ET is greater than P from March to June and tracks with P from June to October. Soil evaporation makes up 54.5% of total ET in the basin, while transpiration comprises 44.2% and canopy evaporation accounts for the remainder (1.3%).

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

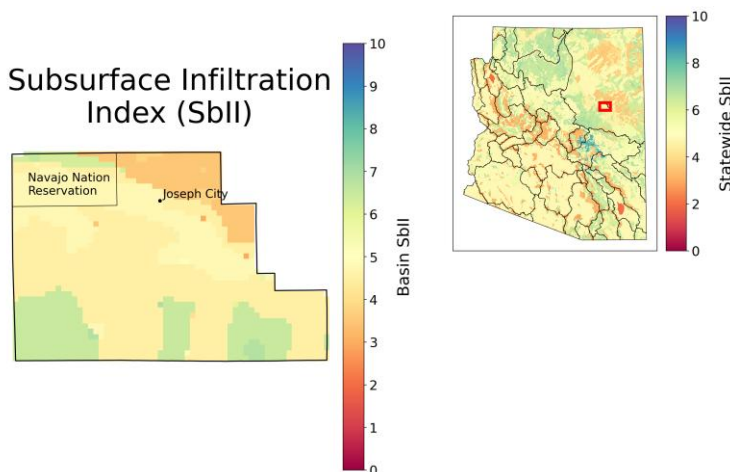
# Joseph City INA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



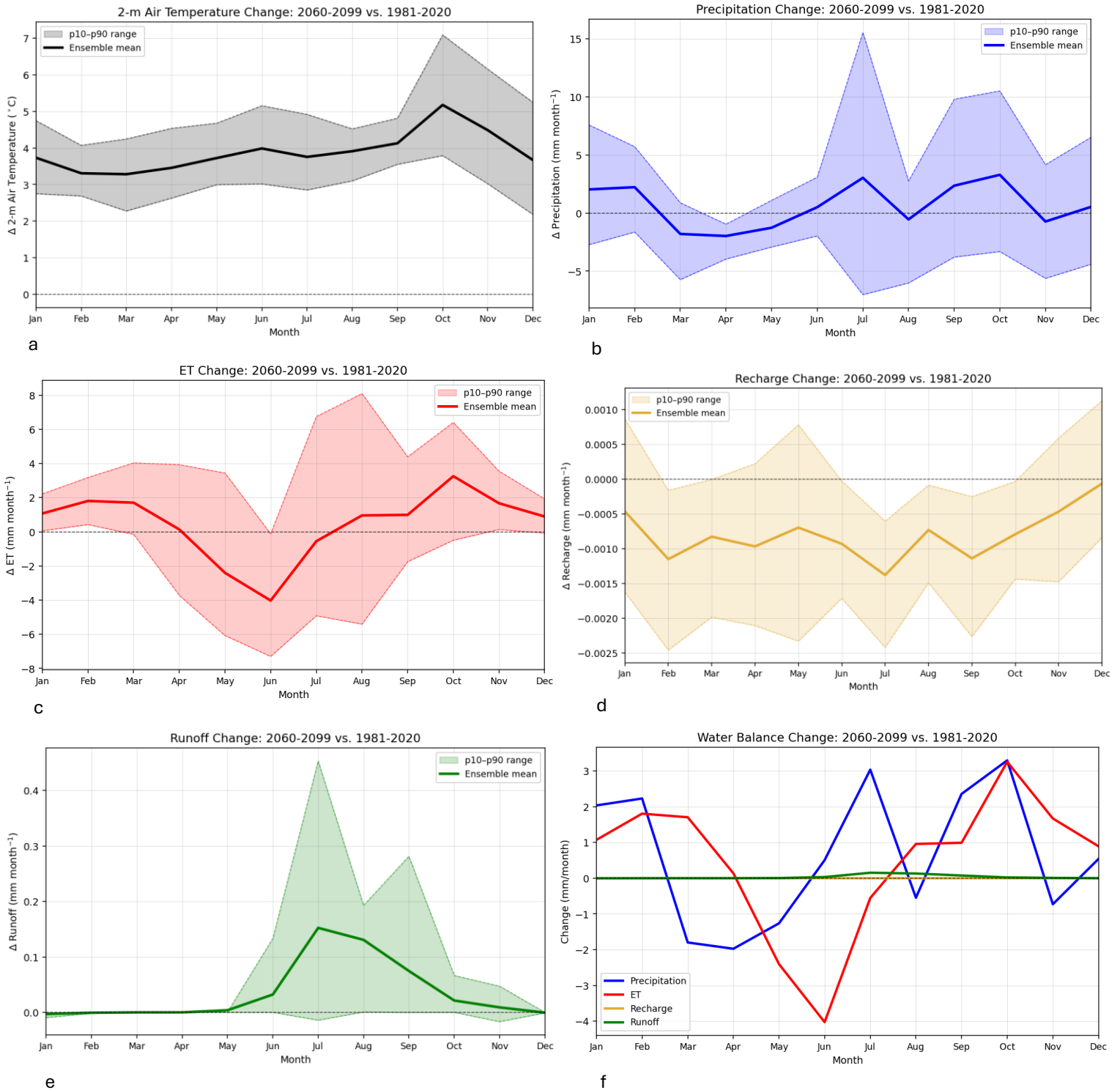
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Joseph City INA is greatest at higher elevations in the southern portion of the INA. This region receives ~220 mm/yr of P on average. Evapotranspiration (ET) is also highest in these higher-elevation areas (~230 mm/yr). Natural recharge and runoff are both minimal across the INA, although natural recharge is slightly higher near the Little Colorado River (~1 mm/yr). Subsurface infiltration potential is generally moderate across the basin with higher infiltration potential in the limestone geology of the Kaibab and Toroweap Formations in the southern portion of the INA.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Joseph City INA show drier springs (12-27% drier March through May), and a drier August (1%) and November (5%). January-February (16-20% wetter), July (9%), and September-October (9-19%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.2-3.4 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero throughout the year. While remaining below 0.17 mm/month, runoff is projected to increase by 0.02-0.16 mm/month from June to October by the end of the century. Projected increases in temperature range from approximately 3.3 °C in March to 5.2 °C in October. Less water availability from March to May leads to projected declines of 11-23% (-2.4 to -4.1 mm/month) in evapotranspiration (ET) in May-June, while higher temperatures and greater precipitation are consistent with a projected 20-21% (1.6-3.2 mm/month) increase in ET in October-November and a 16-21% (1.1-1.8 mm/month) increase in January-February compared to the baseline period.

## References

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# Kanab Plateau Groundwater Basin Profile



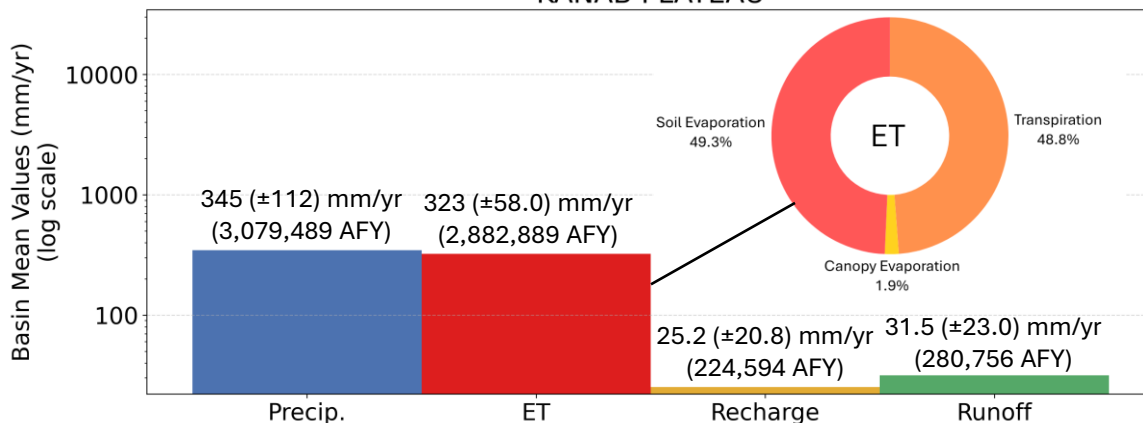
## Basin Summary Statistics

**Size**<sup>1</sup>: 4,247 square miles  
**Elevation**<sup>2</sup>: Range: 1,608-9,209 ft; Median: 5,410 ft  
**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (75%), Evergreen Forest (21%), Barren Land (1.2%)  
**Major surface watershed(s)**<sup>4</sup>: Kanab Creek, Colorado River  
**Groundwater subbasins**<sup>1</sup>: None  
**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.41** (Moderate)

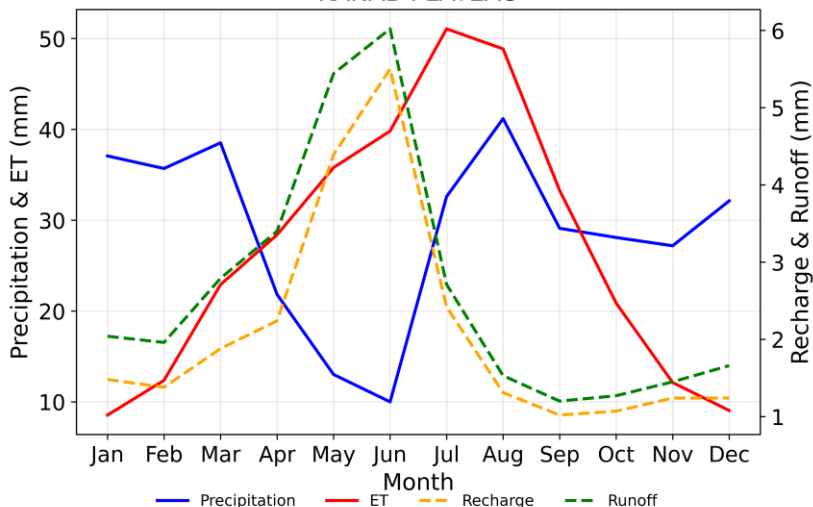


Mean Annual Hydrologic Cycle Components (1980-2020)  
KANAB PLATEAU



**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.<sup>6</sup> 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)  
KANAB PLATEAU



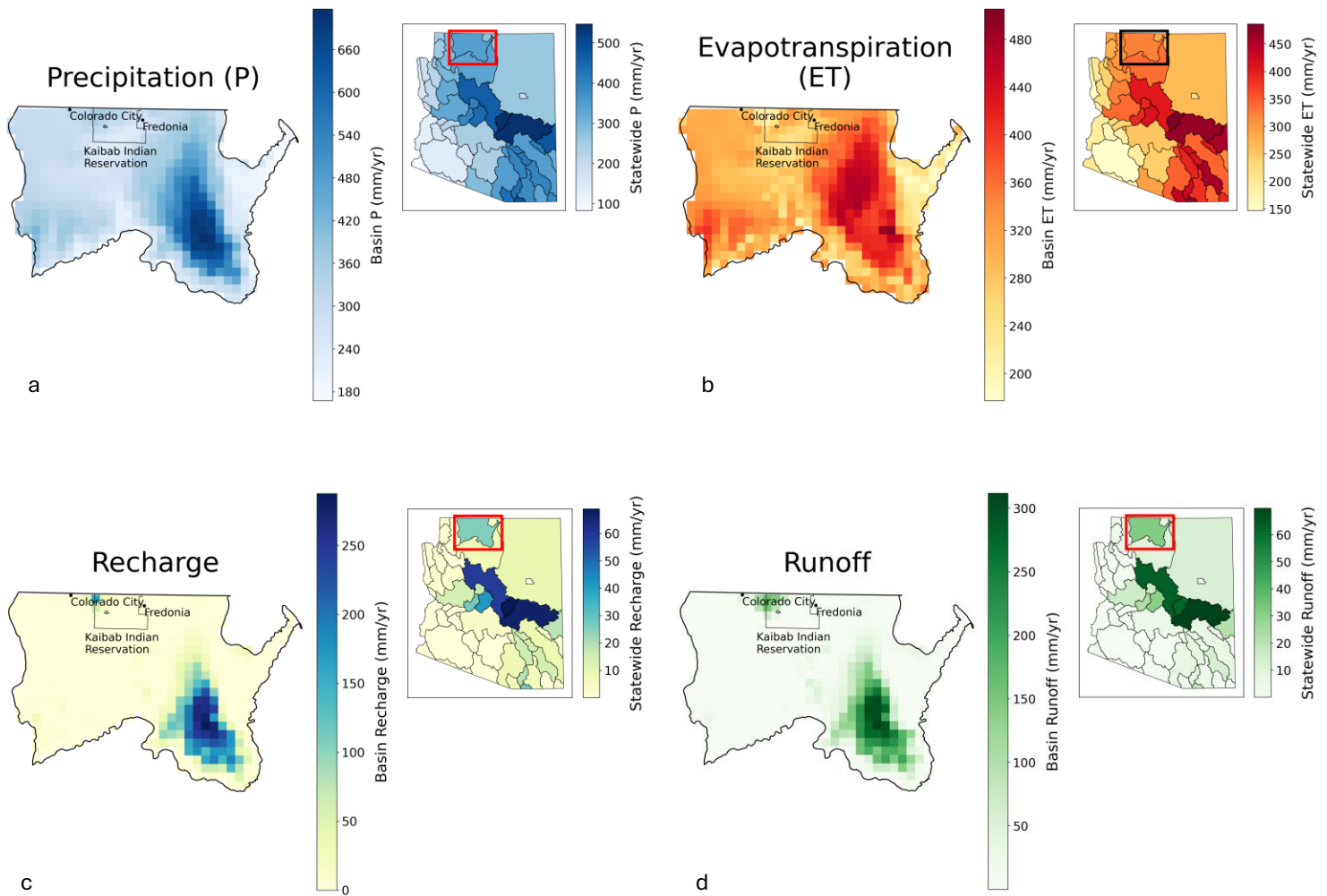
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Kanab Plateau 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. Soil evaporation makes up 49.3% of total ET in the basin, while transpiration comprises 48.8% and canopy evaporation accounts for the remainder (1.9%). Natural recharge (25.2 mm/yr) and runoff (31.5 mm/yr) peak in June due to springtime snowmelt. Groundwater is estimated to supply 41% of total streamflow in the Kanab Plateau.

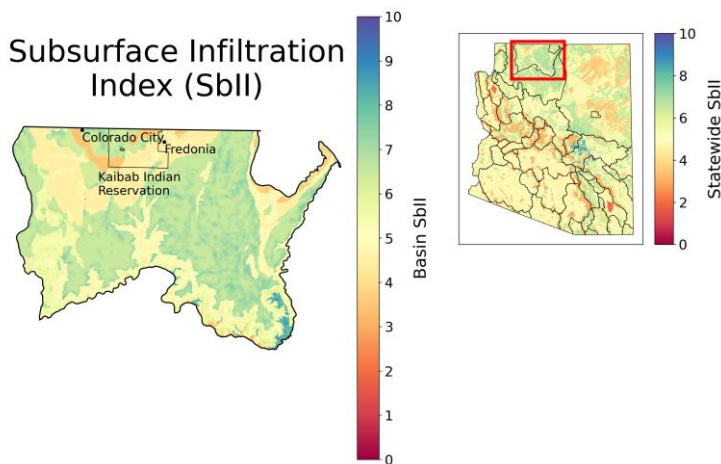
# Kanab Plateau



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



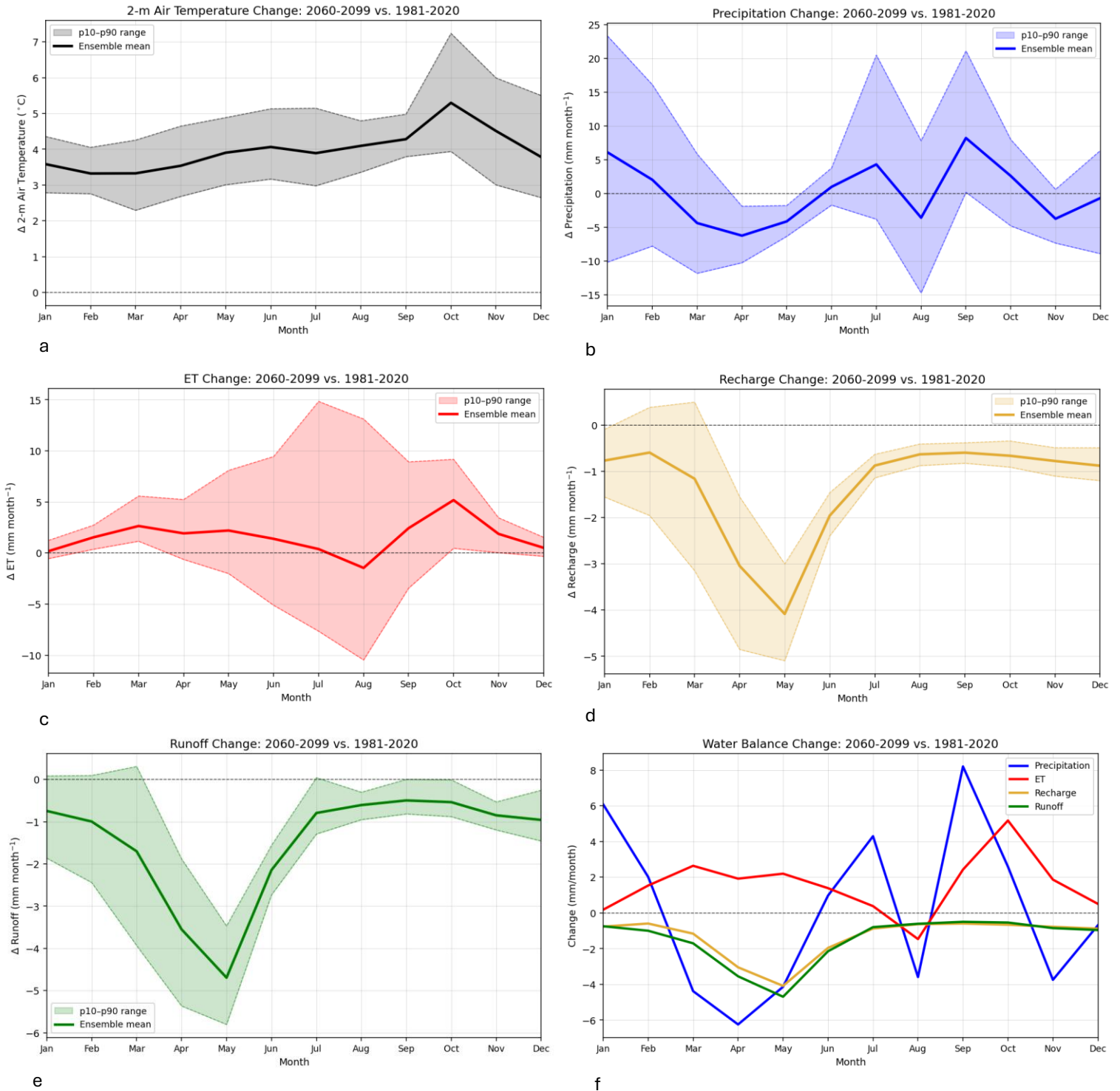
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Kanab Plateau is greatest in southeast portion of the basin near the North Rim of the Grand Canyon, where P exceeds 680 mm/yr on average. ET (~480 mm/yr), natural recharge (~260 mm/yr) and runoff (~280 mm/yr) are also highest in this region. The basin has relatively high infiltration potential due to the presence of karst-type geology and faults.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Kanab Plateau show drier springs (11-29% drier March through May), and a drier August (8%) and November (15%). September and October are projected to be 9-29% (2.7-8.2 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. Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (March-June) showing declines of 31-76% (-1.2 to -4.1 mm/month). Similarly, runoff is expected to decline in all months of the year, with declines of 36-75% in March-June (-1.7 to -4.7 mm/month). Projected increases in temperature range from approximately 3.3 °C in March to 5.3 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 26% (5.2 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 (3% or -1.3 mm).

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# Lake Havasu Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 252 square miles

**Elevation**<sup>2</sup>: Range: 450-5,075 ft; Median: 1,191 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (81%), Developed – Medium Intensity (7.8%), Open Water (5.1%)

**Major surface watershed(s)**<sup>4</sup>: Havasu-Mohave Lakes (Colorado River)

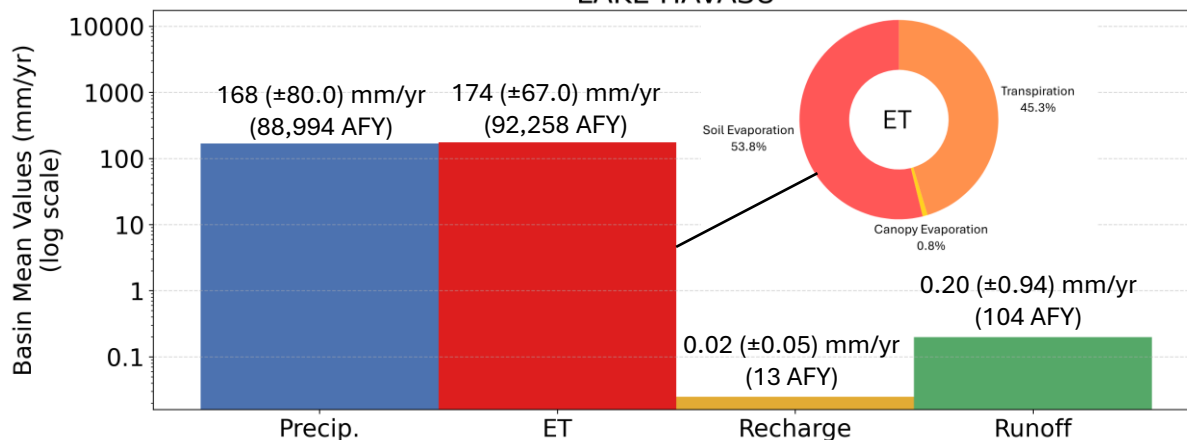
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.47** (Moderate)

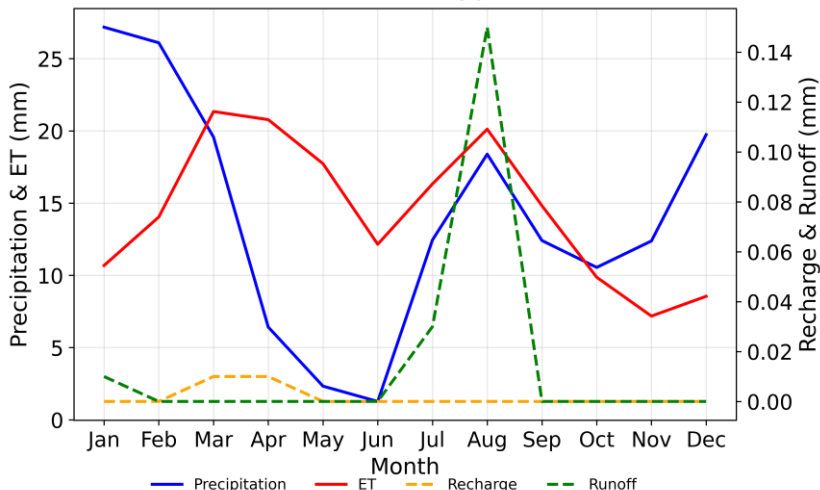


Mean Annual Hydrologic Cycle Components (1980-2020)  
LAKE HAVASU



**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.<sup>6</sup> 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)  
LAKE HAVASU



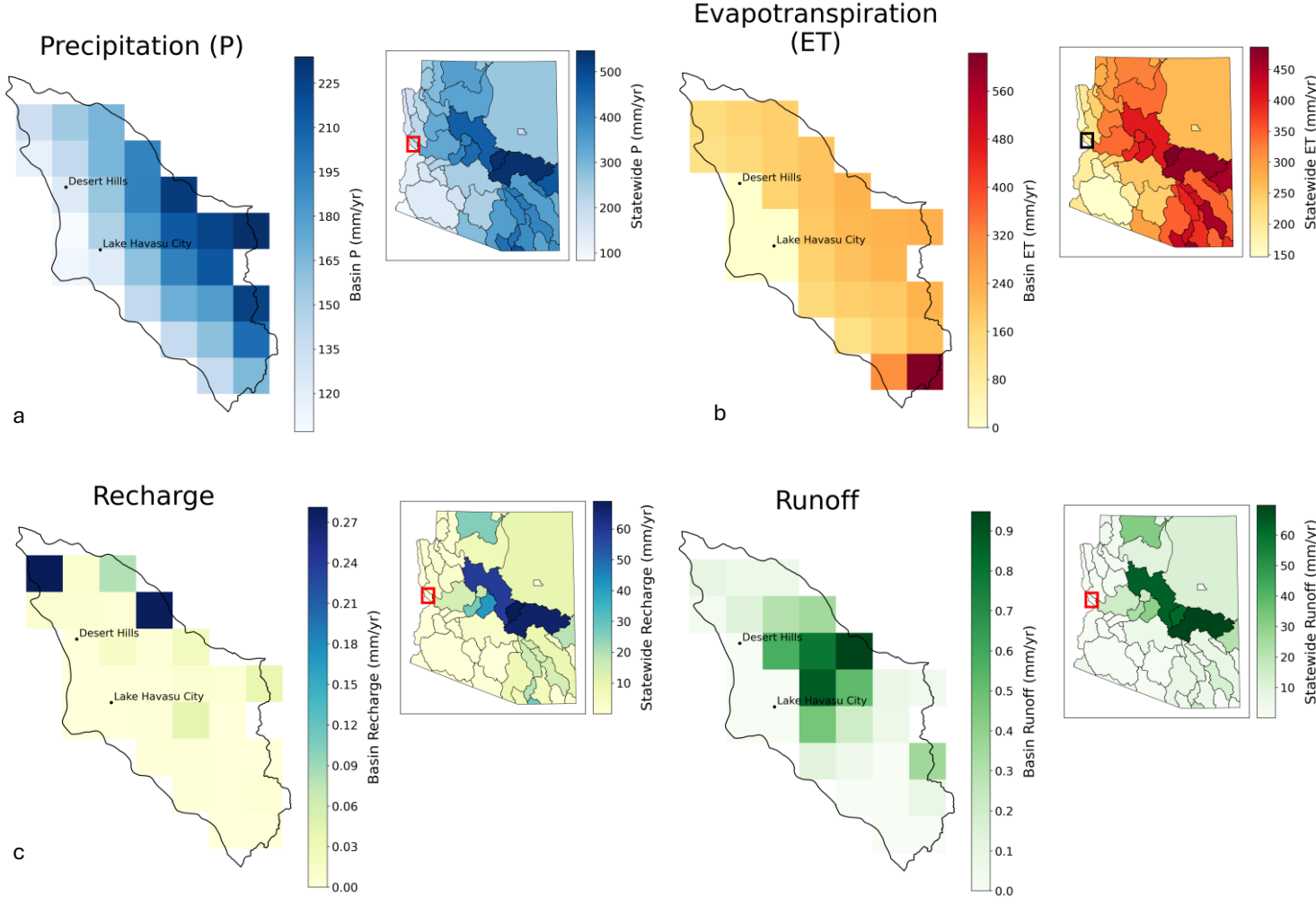
On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the Lake Havasu basin. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P during the warmer months from March to October. Soil evaporation makes up 53.8% of total ET, while transpiration comprises 45.3% and canopy evaporation accounts for the remainder (0.8%).

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

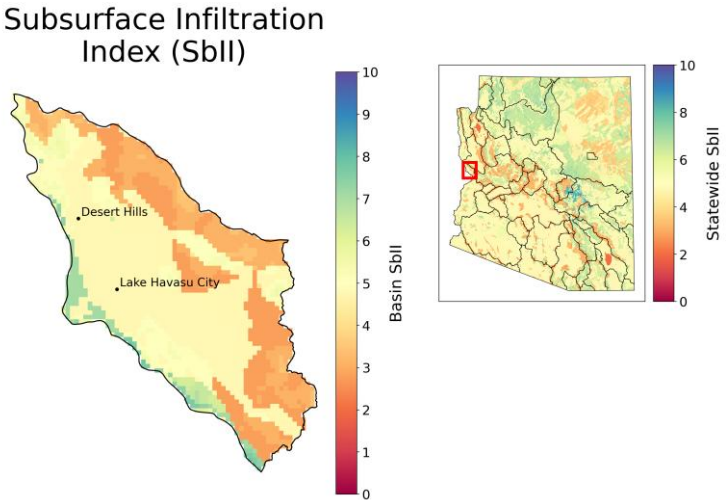
# Lake Havasu



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



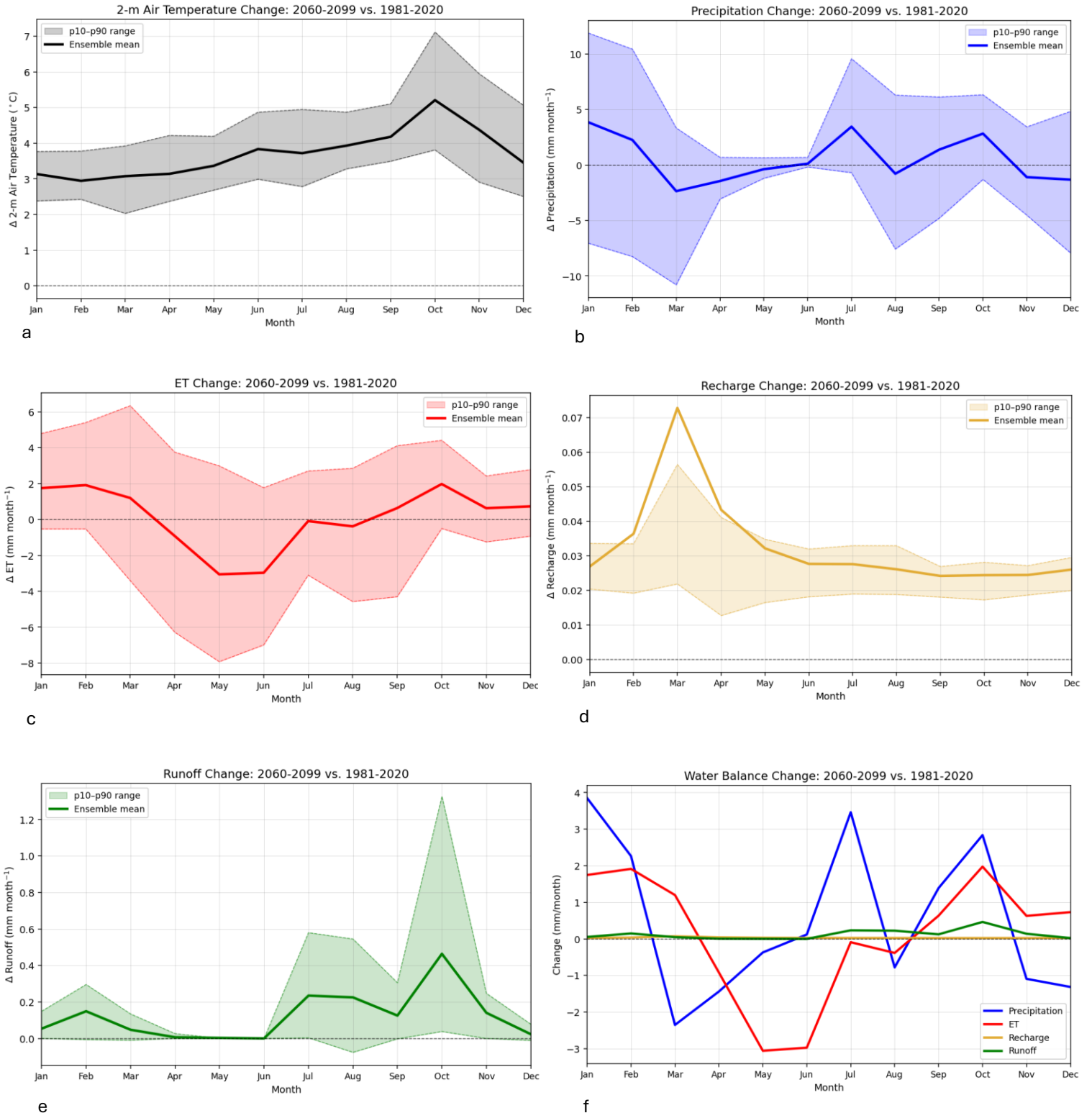
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Lake Havasu basin is greatest in the Mohave Mountains east of Lake Havasu City where it can exceed 220 mm/yr on average. Evapotranspiration (ET) is highest in the southern tip of the basin (~500 mm/yr). Natural recharge and runoff are near zero throughout the basin. Infiltration potential varies across the basin, with the least potential in the metamorphic rocks of the Mohave Mountains and the highest potential in the bed of the Colorado 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Lake Havasu basin show drier springs (11-26% drier March through May) and a drier August (4%), November (10%), and December (6%). July, September, and October are projected to be 10-29% (1.3-3.6 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. Natural recharge is projected to remain near zero, with slightly negative projections in January-February and from May through December (-0.01 to -0.02 mm/month)\*. While runoff is projected to remain below 0.7 mm/month, minor increases of 0.12-0.48 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.0 °C in February to 5.3 °C in October. Less precipitation leads to a projected 4-26% (-1.0 to -3.1 mm/month) decrease in evapotranspiration (ET) April-June, while higher temperatures and greater water availability lead to a projected 20% (2.0 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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# Lake Mohave Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 980 square miles

**Elevation**<sup>2</sup>: Range: 454-5,455 ft; Median: 1,524 ft

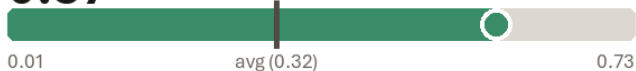
**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (87%), Open Water (3.7%), Cultivated Crops (2.4%)

**Major surface watershed(s)**<sup>4</sup>: Colorado River

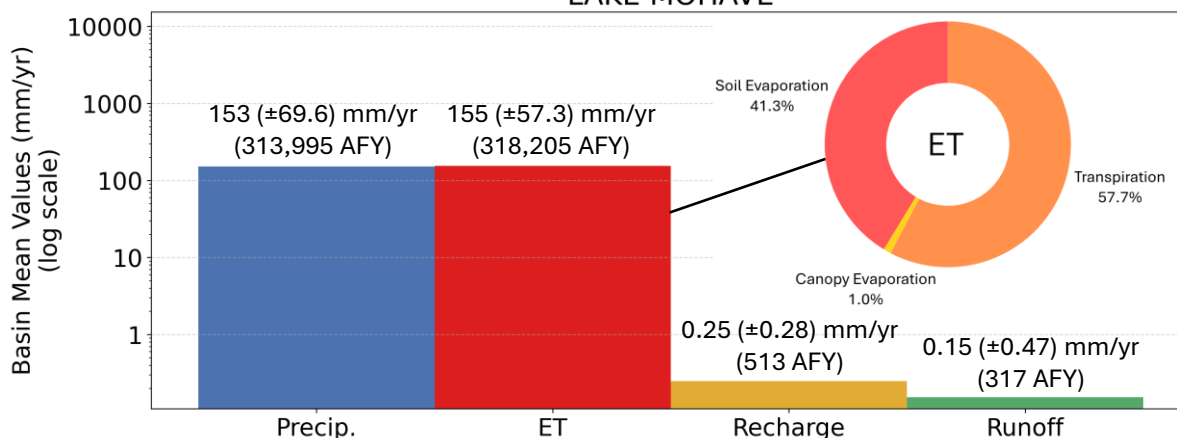
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.57** (High)

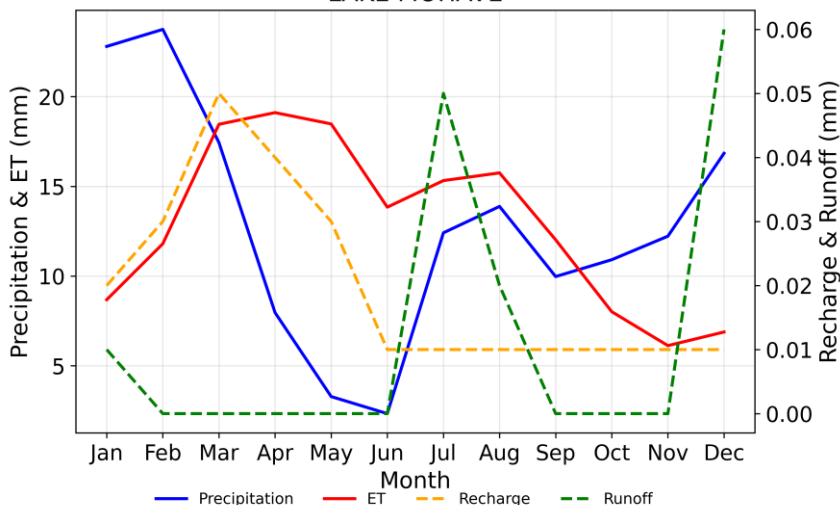


## Mean Annual Hydrologic Cycle Components (1980-2020) LAKE MOHAVE



**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.<sup>6</sup> 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.

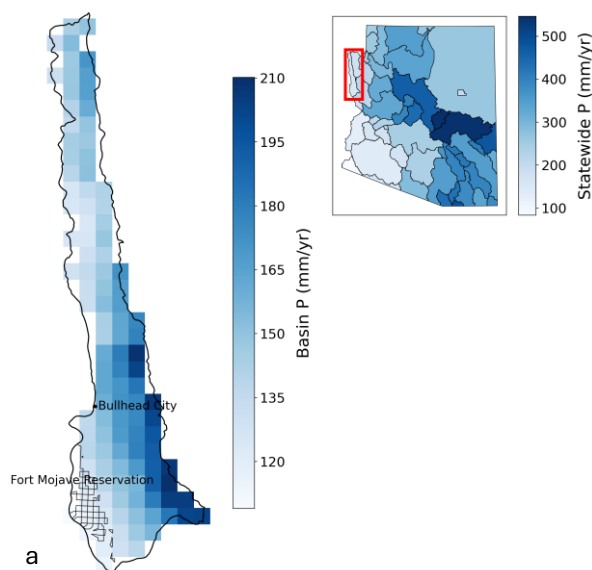
## Mean Monthly Hydrologic Cycle Components (1980-2020) LAKE MOHAVE



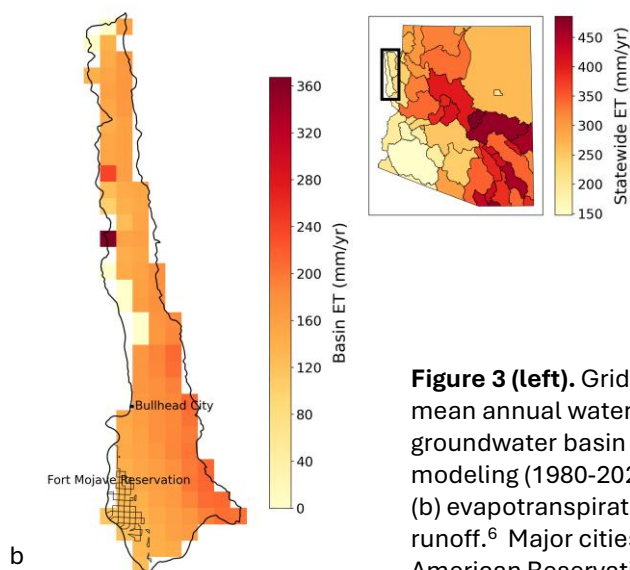
On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) on average in the Lake Mohave basin, resulting in basin-wide averages near zero for natural recharge (0.25 mm) and runoff (0.15 mm). ET is greater than P from mid-March through mid-September. Soil evaporation makes up 41.3% of total ET in the basin, while transpiration comprises 57.7% and canopy evaporation accounts for the remainder (1.0%). P exceeds ET during the late fall and winter months when there is lower atmospheric demand.

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

### Precipitation (P)



### Evapotranspiration (ET)

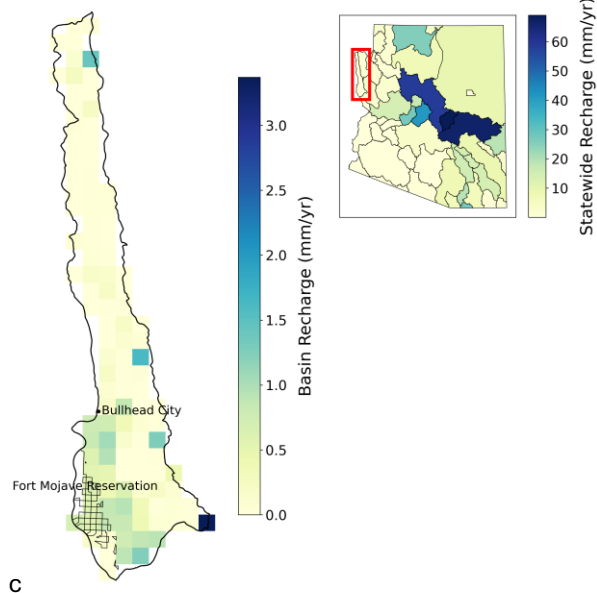


### Lake Mohave

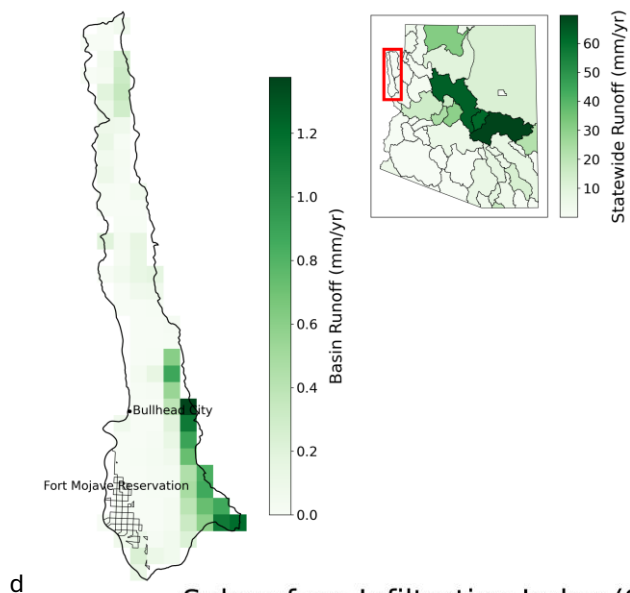


**Figure 3 (left).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are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

### Recharge



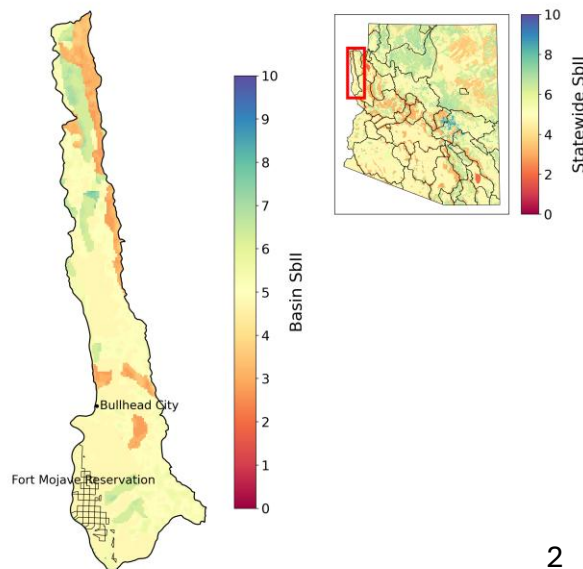
### Runoff



### Subsurface Infiltration Index (SbII)

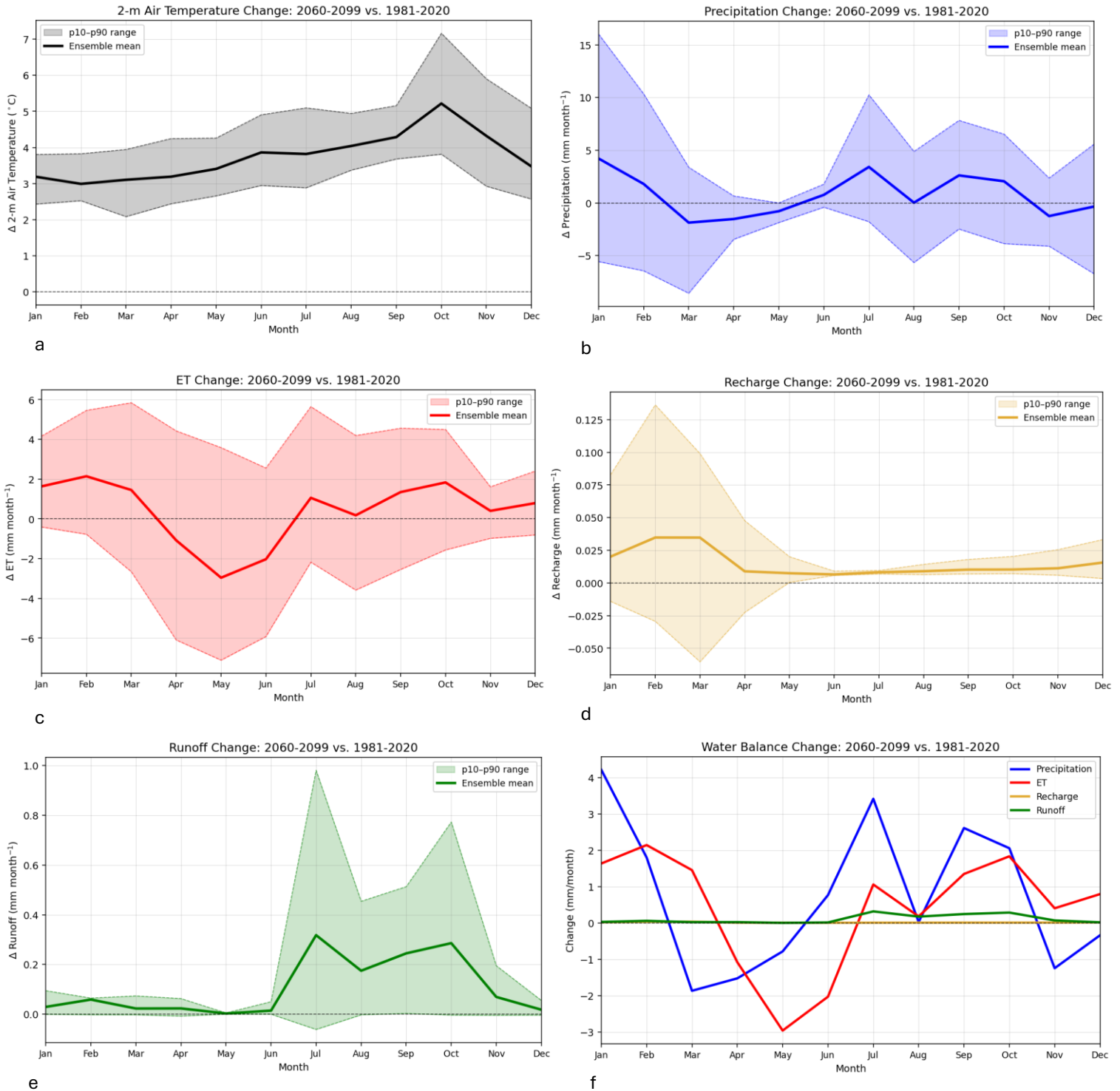
P in the Lake Mohave basin is greatest in the Black Mountains in the southeast portion of the basin. ET is highest over the open water of Lake Mohave. Runoff and natural recharge are minimal across the basin, with the highest values (1 mm/yr and 3 mm/yr, respectively) occurring at the mountain fronts of the Black Mountains. Infiltration potential varies across the basin, but is generally greater in the alluvial deposits in the northern regions of the basin and in the alluvial fans east of the Mohave Valley in the southern portion.

**Figure 4 (right).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>





## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Lake Mohave basin show drier springs (10-22% drier March through May) and a drier November (10%) and December (1%). September and October are projected to be 18-25% (2.1-2.6 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. Natural recharge remains near zero throughout the year and is projected to be slightly negative (approximately - 0.01 mm/month) from May-November.\* While remaining below 0.5 mm/month, runoff is projected to increase by 0.18-0.30 mm/month from July to October. Projected increases in temperature range from approximately 3.0 °C in February to 5.3 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 18% increase in evapotranspiration (ET) in January and a 21% increase 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

1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
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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](https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/Federal_American_Indian_Reservations_v1/FeatureServer)
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# Little Colorado River Plateau Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 26,520 square miles

**Elevation**<sup>2</sup>: Range: 3,048-12,341 ft; Median: 5,976 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (81%), Evergreen Forest (14%), Grassland Herbaceous (2.9%)

**Major surface watershed(s)**<sup>4</sup>: Little Colorado River (LCR), Chinle Wash, Moenkopi Wash, Dinnebito Wash, Oraibi Wash, Polacca Wash, Jadito Wash, Cottonwood Wash, among other LCR tributaries

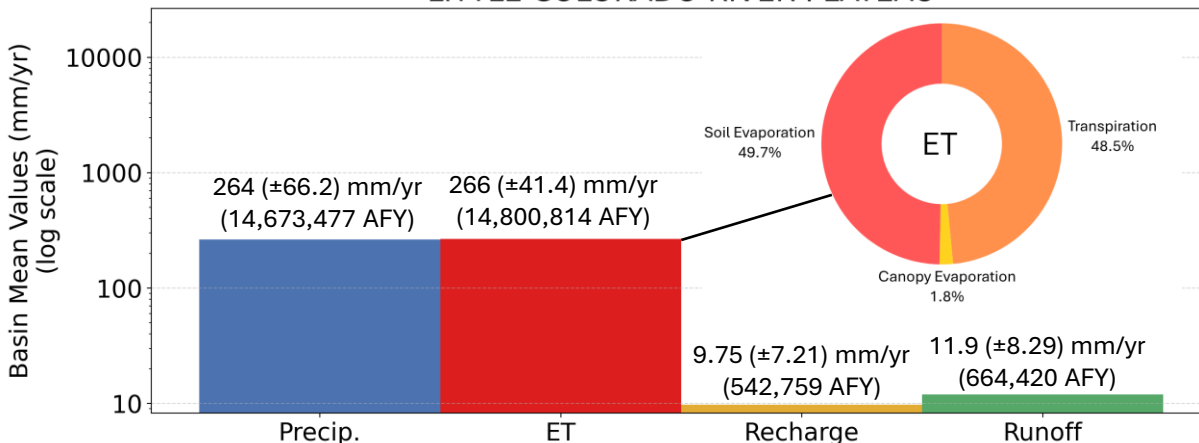
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.37** (Moderate)



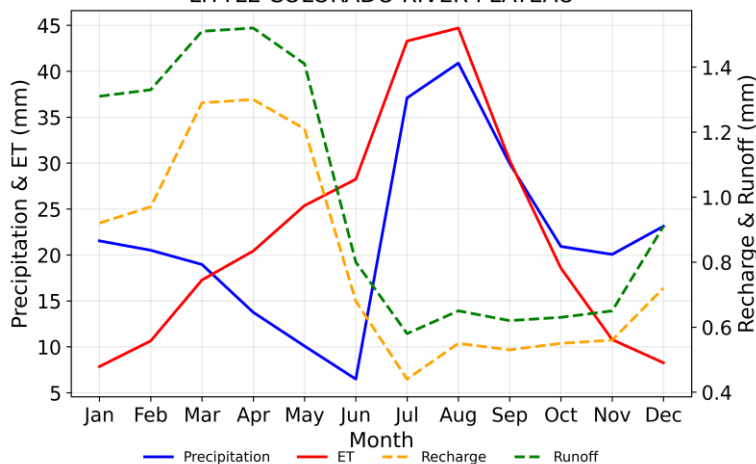
Mean Annual Hydrologic Cycle Components (1980-2020)  
LITTLE COLORADO RIVER PLATEAU



**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.<sup>6</sup> 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.

The Little Colorado River Plateau (LCRP) is the largest groundwater basin in the state, covering 26,520 square miles. On average, annual evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in relatively low basin-wide annual averages for natural recharge (9.75 mm) and runoff (11.9 mm). Soil evaporation makes up 49.7% of total ET in the basin, while transpiration comprises 48.5% and canopy evaporation accounts for the remainder (1.8%). Seasonally, the LCRP is affected by the North American Monsoon during the summer months. ET exceeds P from March through September while P exceeds ET in the winter months. Natural recharge and runoff peak in April as a result of springtime snowmelt.

Mean Monthly Hydrologic Cycle Components (1980-2020)  
LITTLE COLORADO RIVER PLATEAU

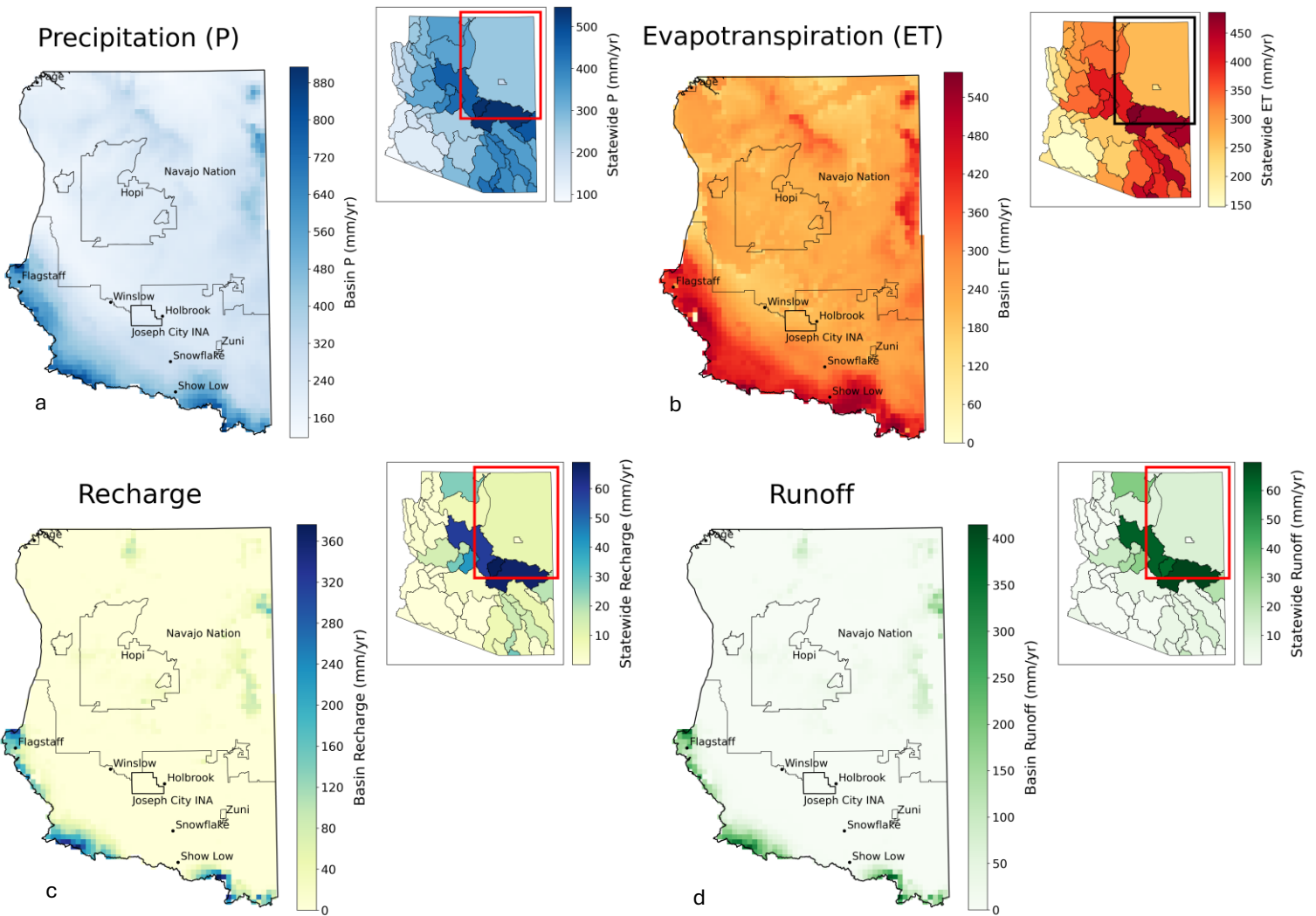


**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

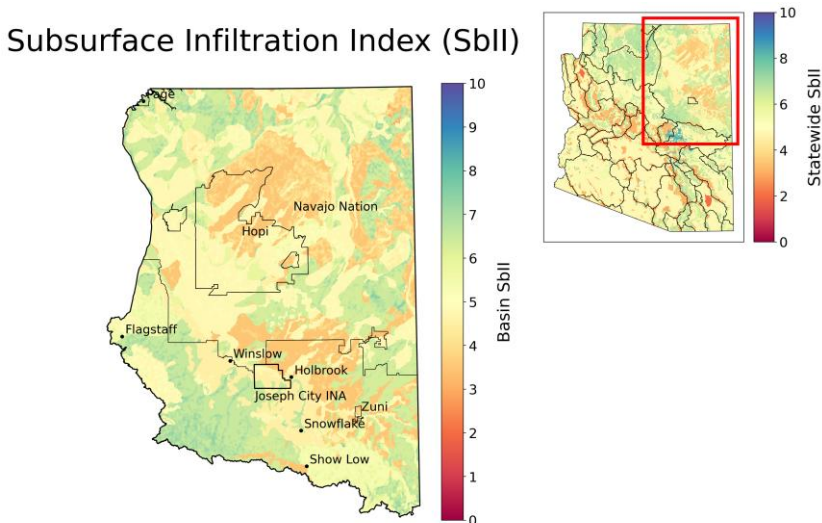
# Little Colorado River Plateau



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

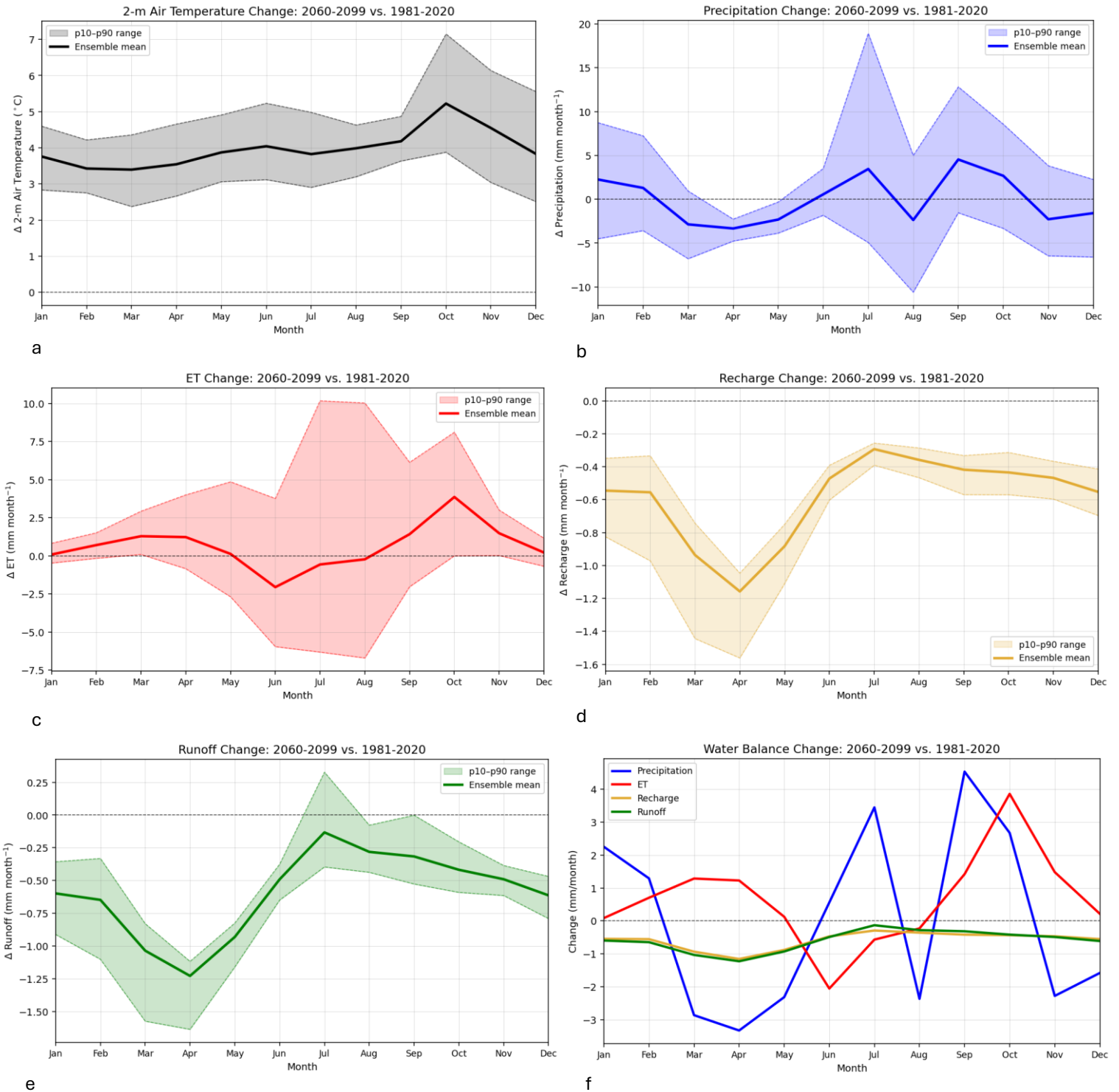


Most of the rain and snowfall in the Little Colorado River Plateau basin occurs along the Mogollon Rim in the southern portion of the basin where average annual precipitation can exceed 800 mm/year. Evapotranspiration, runoff, and natural recharge in the basin are also generally highest along the Rim due to greater water availability in that region. Much of the basin has moderately high subsurface infiltration potential due to presence of karst-type geology.

# Little Colorado River Plateau



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the LCRP show drier springs (14-27% drier March through May), and a drier August (5%), November (12%) and December (6%). January-February (7-11%), June-July (9-10%), and September-October (13-15%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.8-4.4 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (February-May) showing declines of 57-76% (-0.57 to -1.2 mm/month). Similarly, runoff is expected to decline in all months of the year, with declines of 55-72% (-0.66 to -1.2 mm/month) from February to May by the end of the century. Projected increases in temperature range from approximately 3.4 °C in March to 5.3 °C in October. Higher temperatures and greater water availability from precipitation lead to a 23% (3.9 mm) projected increase in evapotranspiration (ET) in October compared to the baseline period.

## References

1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
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# Lower Gila Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 7,309 square miles

**Elevation<sup>2</sup>:** Range: 158-4,681 ft; Median: 889 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (84%), Barren Land (8.1%), Grassland Herbaceous (5.2%)

**Major surface watershed(s)<sup>4</sup>:** Lower Gila River, San Cristobal Wash, Tenmile Wash

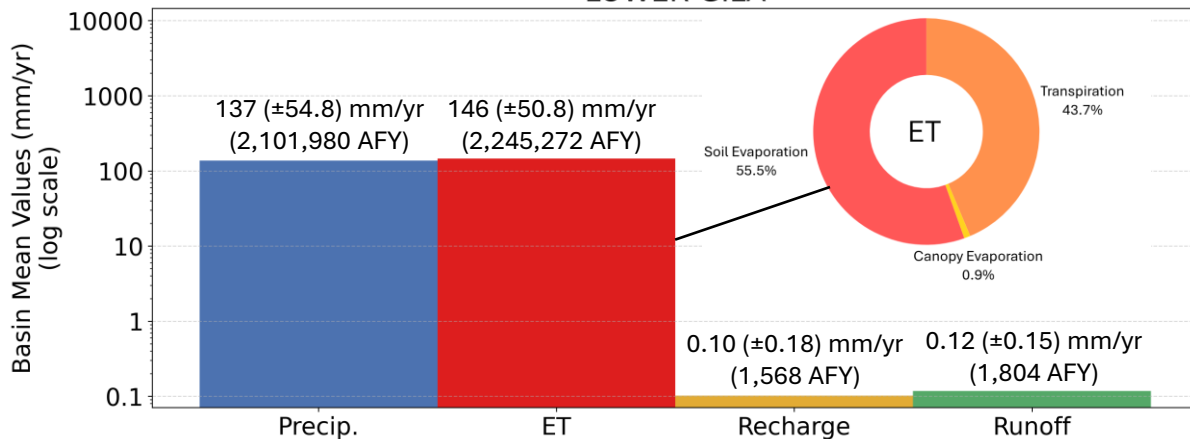
**Groundwater subbasins<sup>1</sup>:** Dendora Valley, Childs Valley, Wellton - Mohawk

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.02** (Very Low)

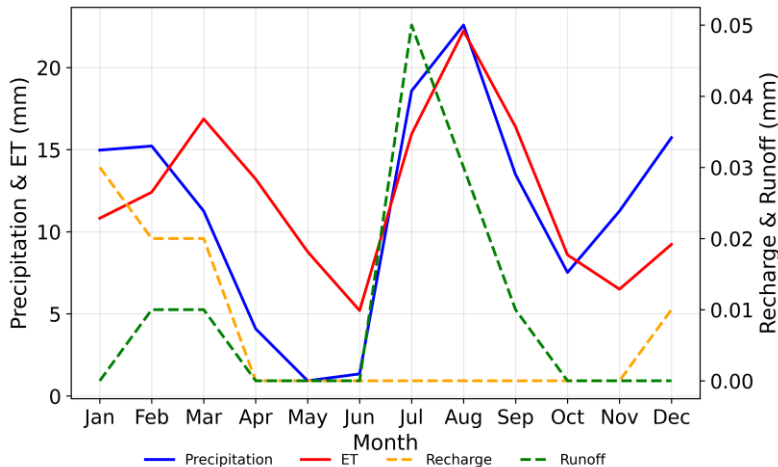


Mean Annual Hydrologic Cycle Components (1980-2020)  
LOWER GILA



**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.<sup>6</sup> 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)  
LOWER GILA



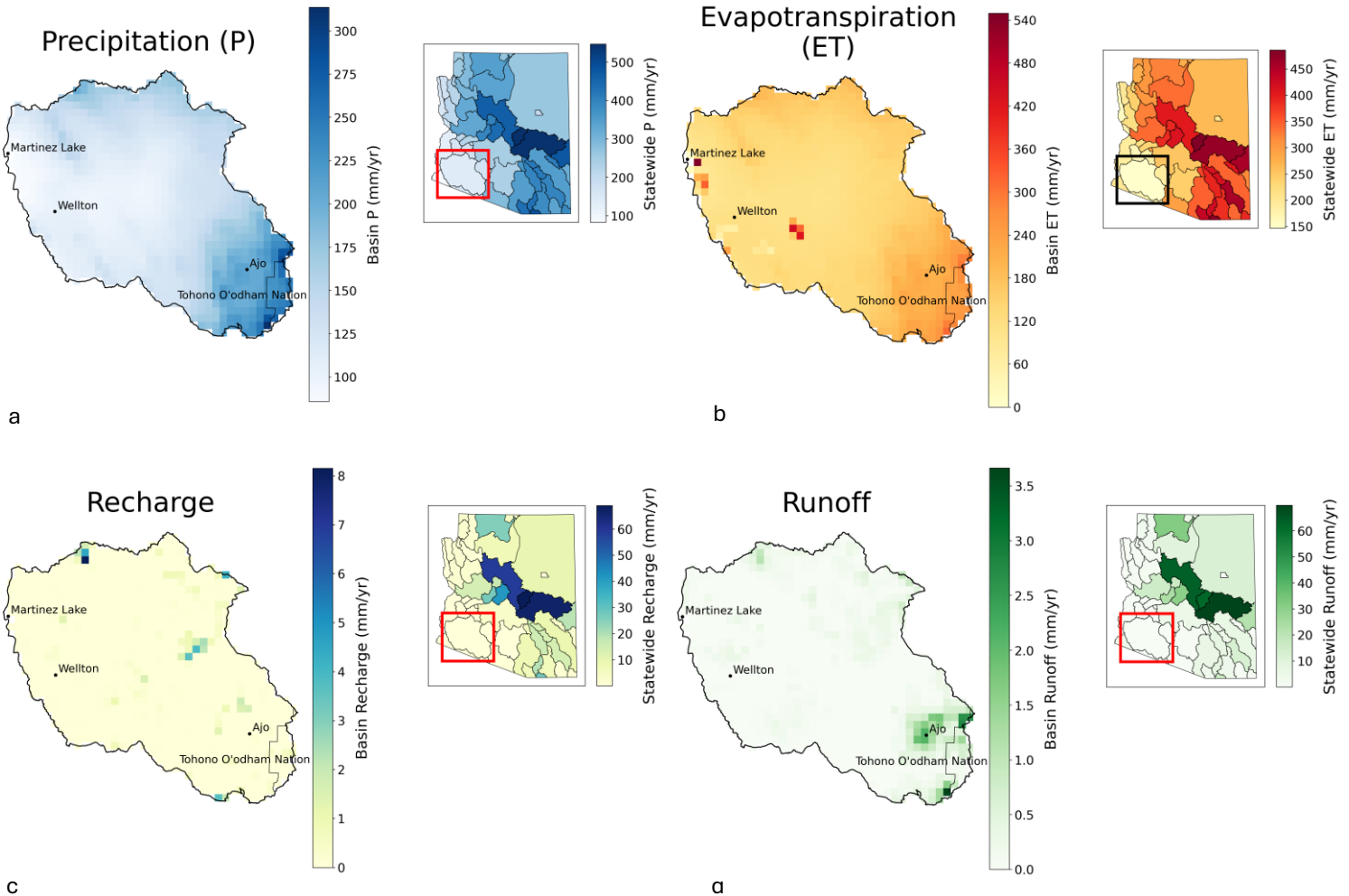
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the Lower Gila basin. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P from March to June and tracks closely with P from June through October. Soil evaporation makes up 55.5% of total ET, while transpiration comprises 43.7% and canopy evaporation accounts for the remainder (0.9%).

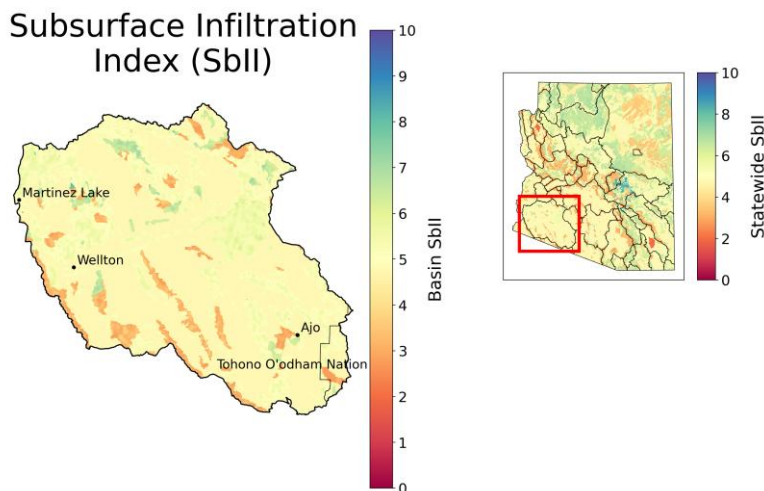
# Lower Gila



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

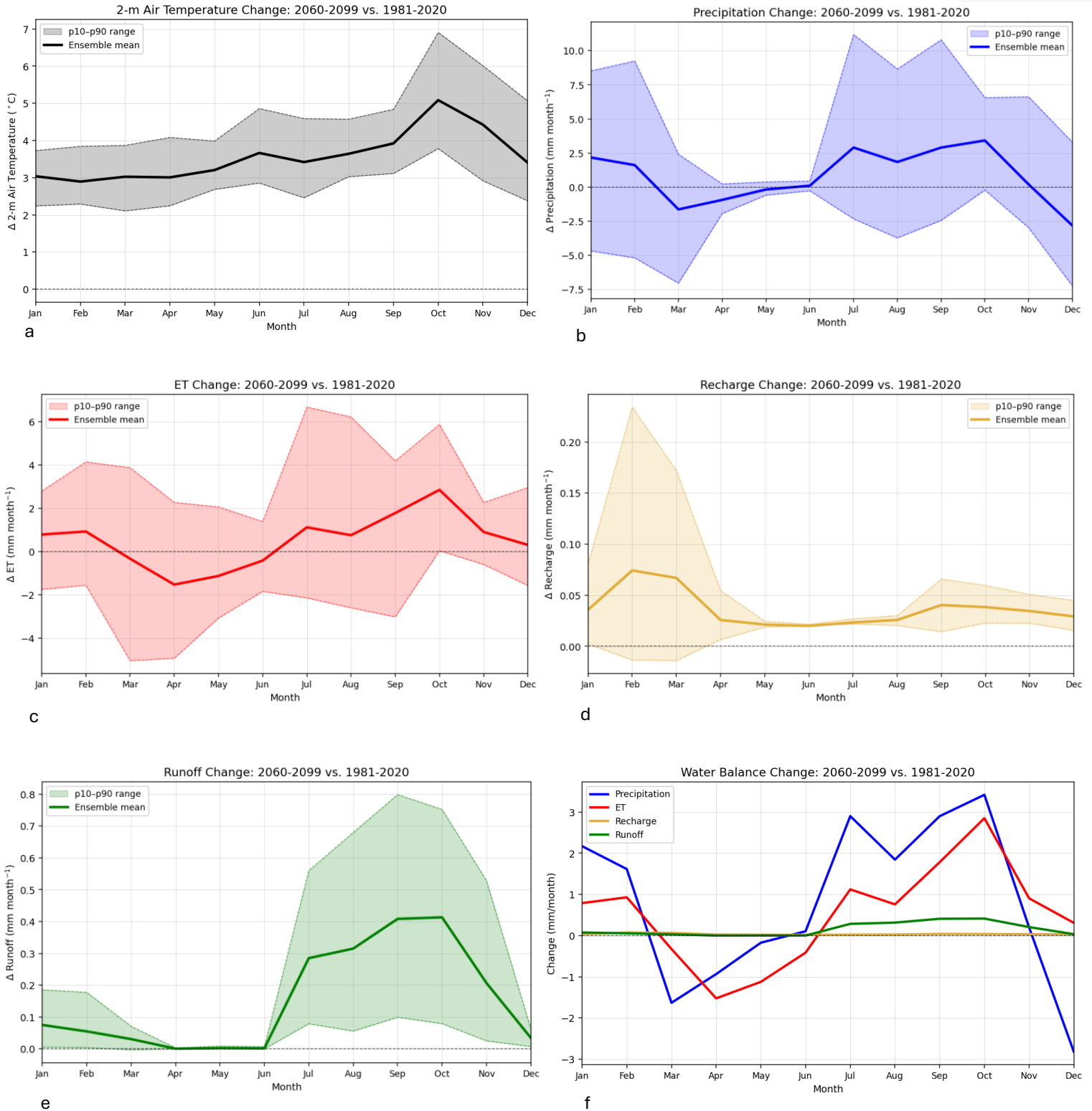


Precipitation (P) in the Lower Gila basin is greatest in the southeast portion of the basin where it can exceed 250 mm/yr on average. Evapotranspiration (ET) is highest (~450 mm/yr) in the wash just west of the Mohawk mountains. Natural recharge is highest (~6 mm) in the Kofa National Wildlife Refuge to the north, and runoff (~3 mm) is highest in the southeast portion of the basin. The Lower Gila basin generally has moderate infiltration potential with areas of higher potential in regions with karst-type geology.

# Lower Gila



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Lower Gila basin show drier springs (13-31% drier March through May) and a drier December (17%). January-February (10-15%) and June-October (7-42%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.9-3.5 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (-0.01 to -0.03 mm/month) from May through December.\* While runoff is projected to remain below 0.5 mm/month, minor increases of 0.21-0.42 mm/month are projected for July-November. Projected increases in temperature range from approximately 2.9 °C in February to 5.1 °C in October. Less precipitation in April and May leads to a projected 12-15% (-1.1 to -1.6 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 11-31% (0.91-2.9 mm/month) increase in ET from September through November 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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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Lower San Pedro Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 1,624 square miles

**Elevation<sup>2</sup>:** Range: 1,735-8,561 ft; Median: 3,616 ft

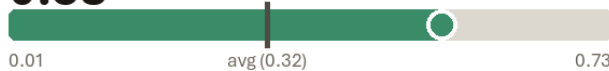
**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (92%), Grassland Herbaceous (2.8%), Evergreen Forest (2.7%)

**Major surface watershed(s)<sup>4</sup>:** Lower San Pedro River, Middle Gila River

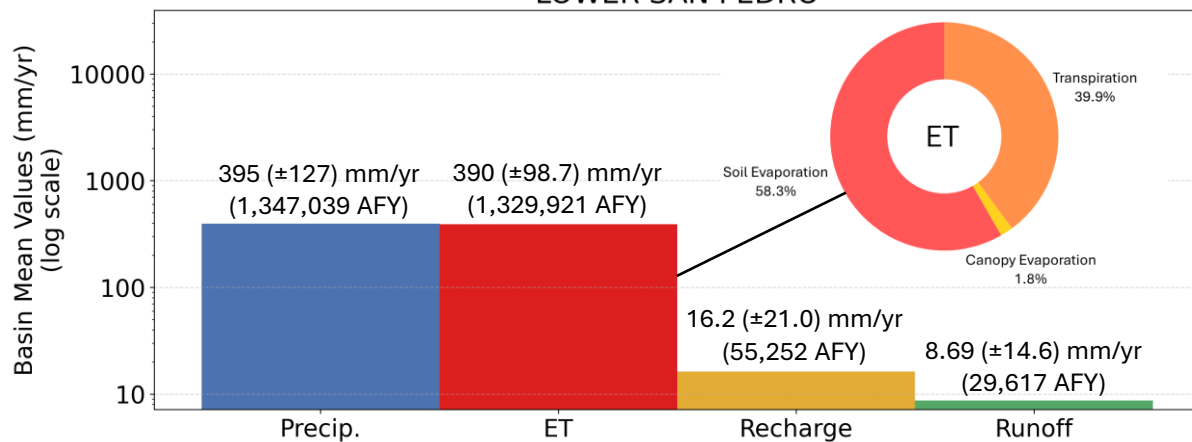
**Groundwater subbasins<sup>1</sup>:** Camp Grant Wash, Mammoth

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.53** (High)

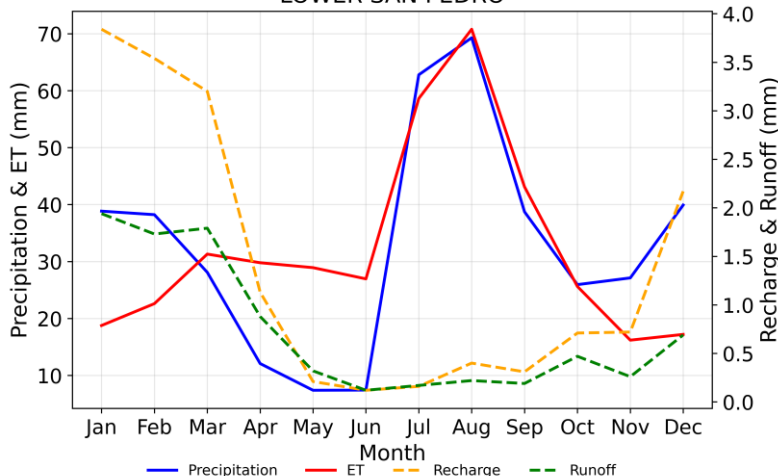


Mean Annual Hydrologic Cycle Components (1980-2020)  
LOWER SAN PEDRO



**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.<sup>6</sup> 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)  
LOWER SAN PEDRO



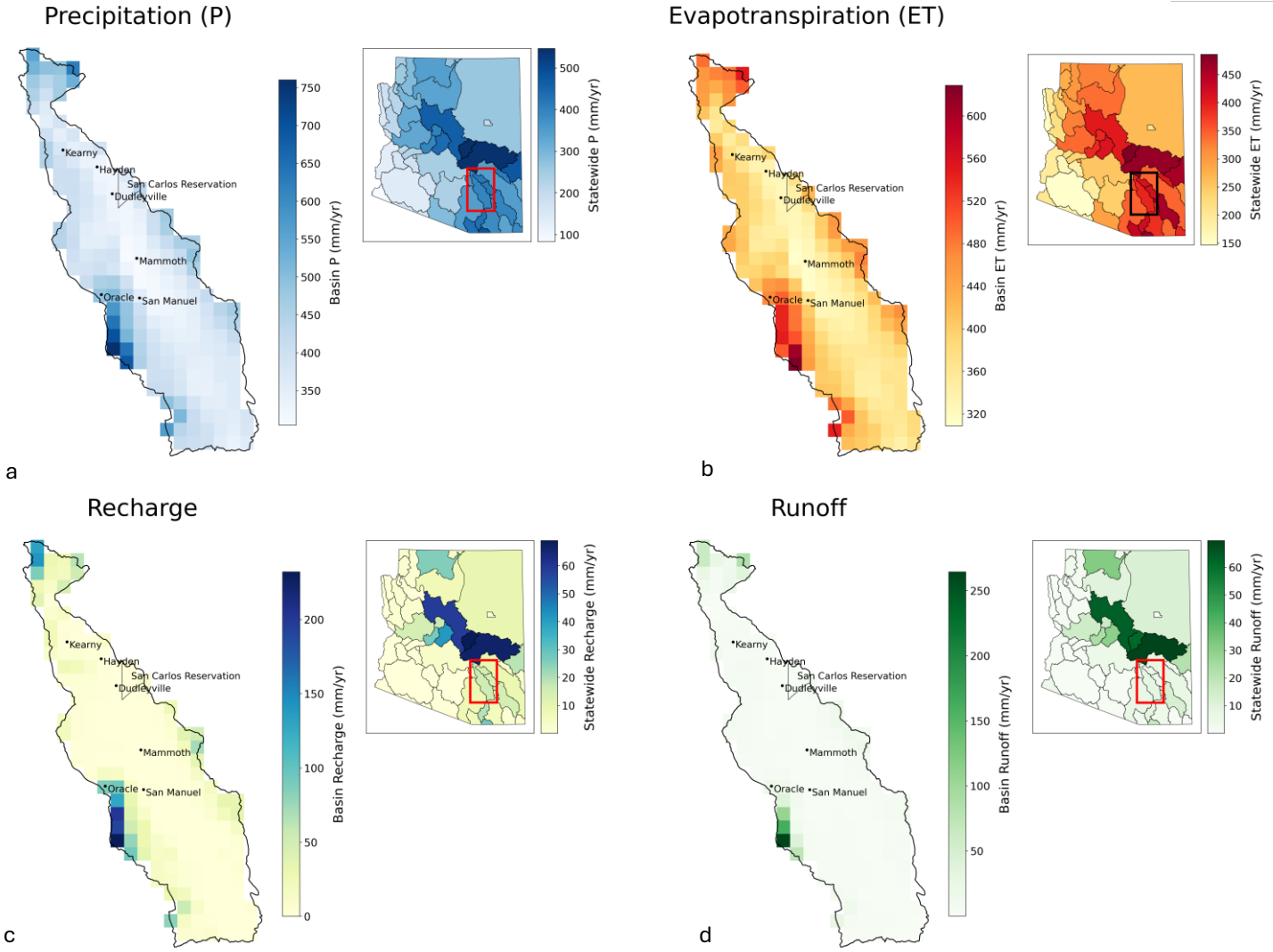
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in relatively low basin-wide annual averages for natural recharge (16.2 mm) and runoff (8.69 mm). P in the Lower San Pedro basin is affected by the North American Monsoon during the summer months. ET is approximately equal to P during these months due to enhanced water availability. ET exceeds P from March through mid-June. Soil evaporation makes up 58.3% of total ET in the basin, while transpiration comprises 39.9% and canopy evaporation accounts for the remainder (1.8%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months.

# Lower San Pedro

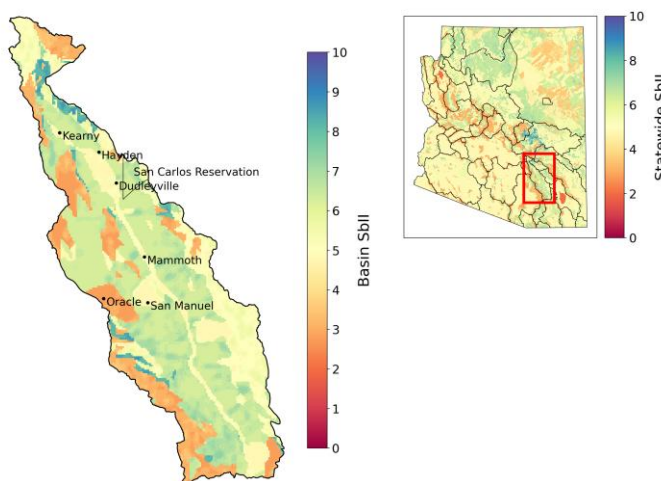


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

## Subsurface Infiltration Index (SbII)



Precipitation in the Lower San Pedro basin is highest in the Santa Catalina Mountains south of Oracle, which receive 700 mm/yr on average. The Santa Catalina Mountains also have the highest evapotranspiration (~550 mm/yr), natural recharge (~200 mm/yr), and runoff (~200 mm/yr) in the basin. Subsurface infiltration potential is moderately high across the basin, particularly in areas of moderately consolidated conglomerate that contain limestone to the east and west of the San Pedro River. High infiltration potential is found in the limestone-dominated formations of the Dripping Springs mountains north of Kearny and in the northern Santa Catalinas south of Oracle.

# Lower San Pedro

## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.

## Lower San Pedro



Climate change projections across the Lower San Pedro basin show less precipitation throughout the majority of the year, with the exception of September and October, which show a 3-29% (1.2-7.8 mm/month) increase in precipitation. This increase in fall precipitation is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity by the end of the century. The greatest declines in precipitation are projected for March-May (20-41%), July-August (7-15%), and November-December (11-15%). Declines in recharge ranging from 16-25% (-0.44 to -0.71 mm/month) are projected for highest recharge months from January to March. Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections are slightly negative (-0.11 to -0.21 mm/month) from June through August.\* Runoff is projected to increase by 0.19 to 0.77 mm/month from July through November. Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Less water availability from precipitation in April-August leads to a projected 8-24% (-2.7 to -9.5 mm/month) decrease in evapotranspiration (ET) in those months, while higher temperatures and greater water availability lead to a projected 12% (3.2 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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# McMullen Valley Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 649 square miles

**Elevation**<sup>2</sup>: Range: 1,657-5,601 ft; Median: 2,239 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (91%), Cultivated Crops (6.5%), Developed – Open Space (0.96%)

**Major surface watershed(s)**<sup>4</sup>: Centennial Wash

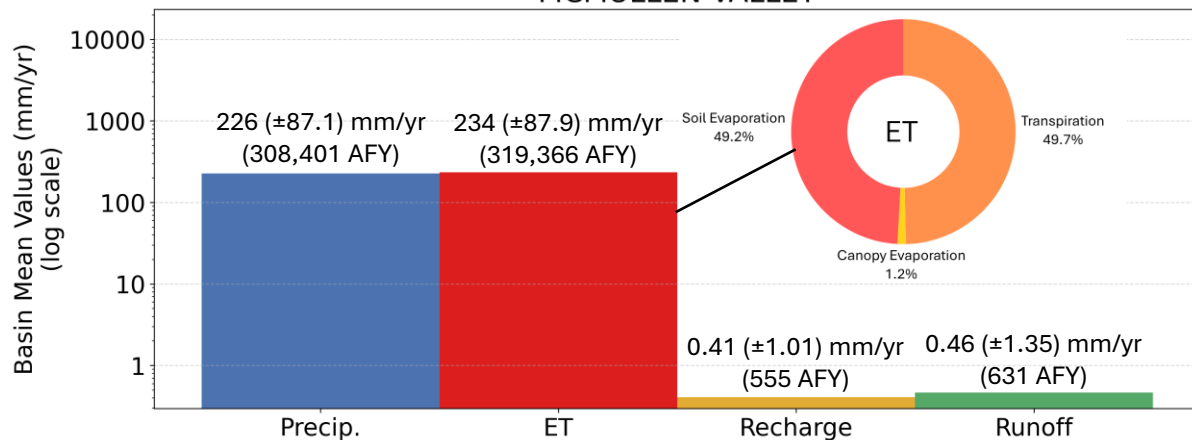
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.68** (Very High)

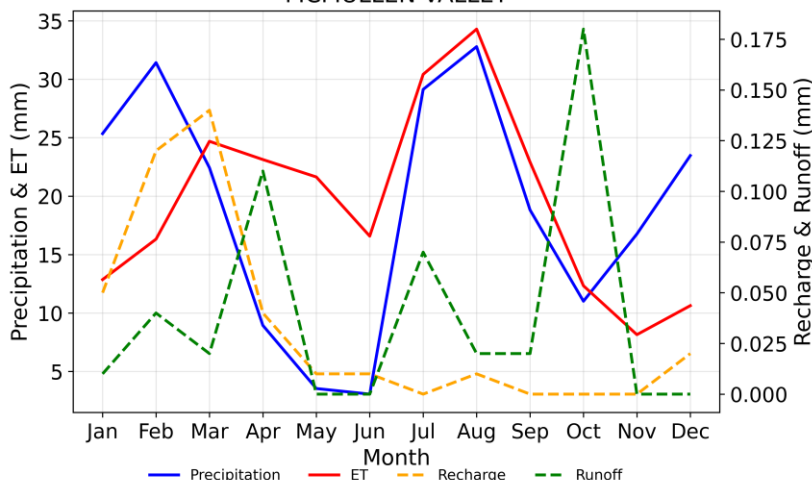


Mean Annual Hydrologic Cycle Components (1980-2020)  
MCMULLEN VALLEY



**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.<sup>6</sup> 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)  
MCMULLEN VALLEY



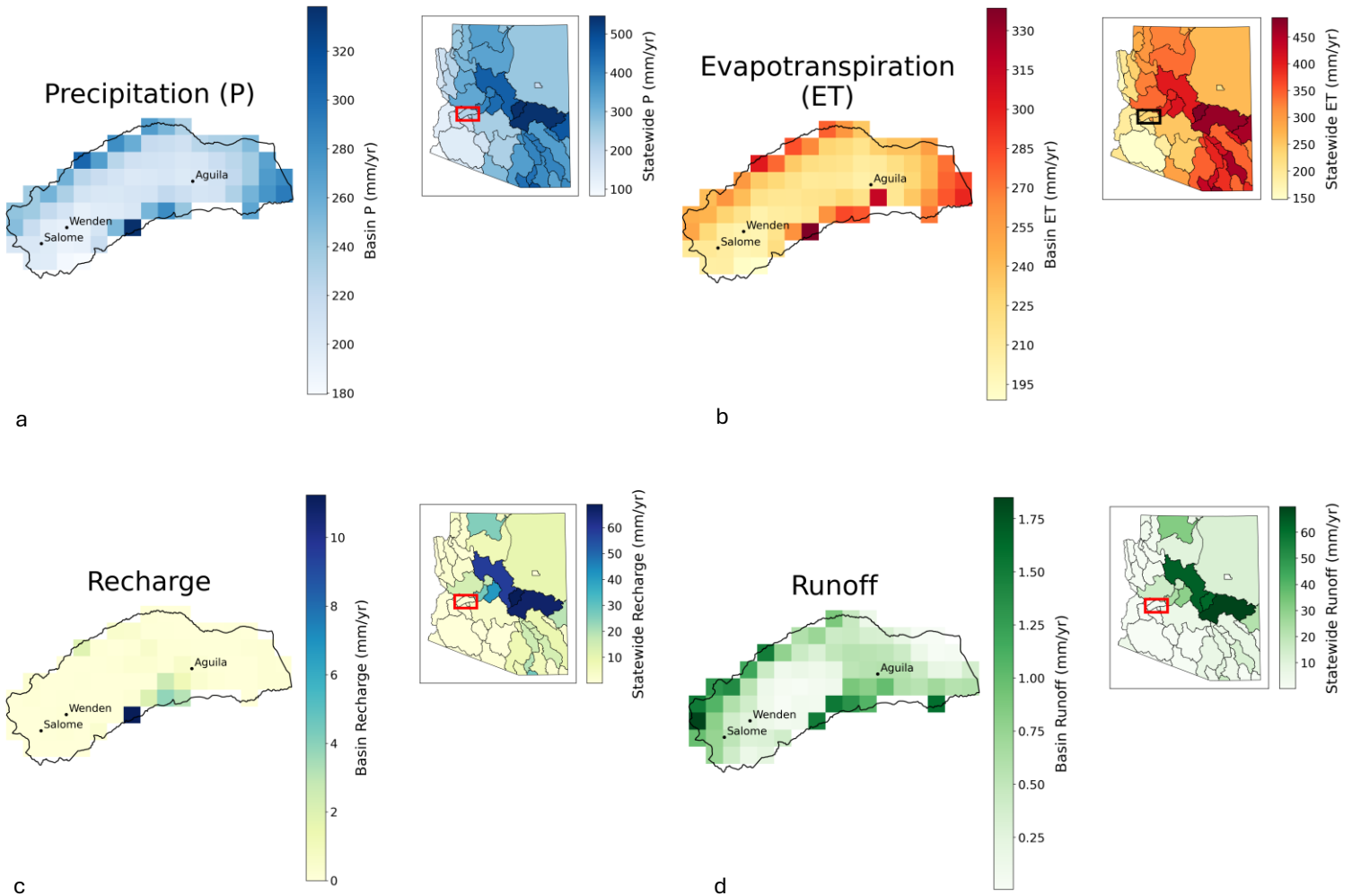
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the McMullen Valley basin. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P during the warmer months from March to October. Soil evaporation makes up 49.2% of total ET, while transpiration comprises 49.7% and canopy evaporation accounts for the remainder (1.2%).

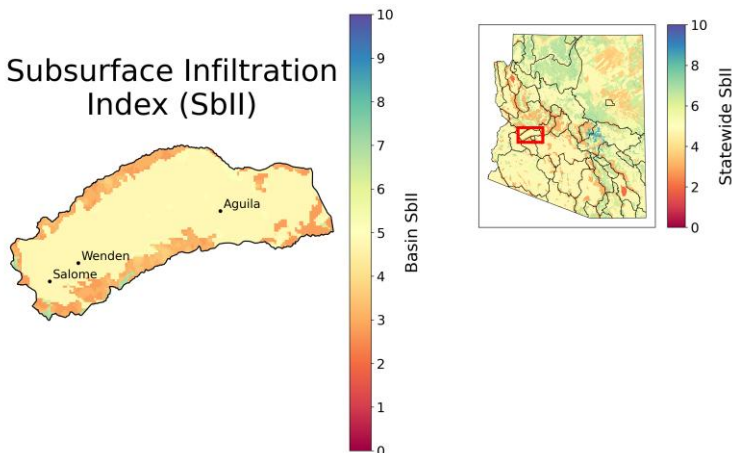
# McMullen Valley



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

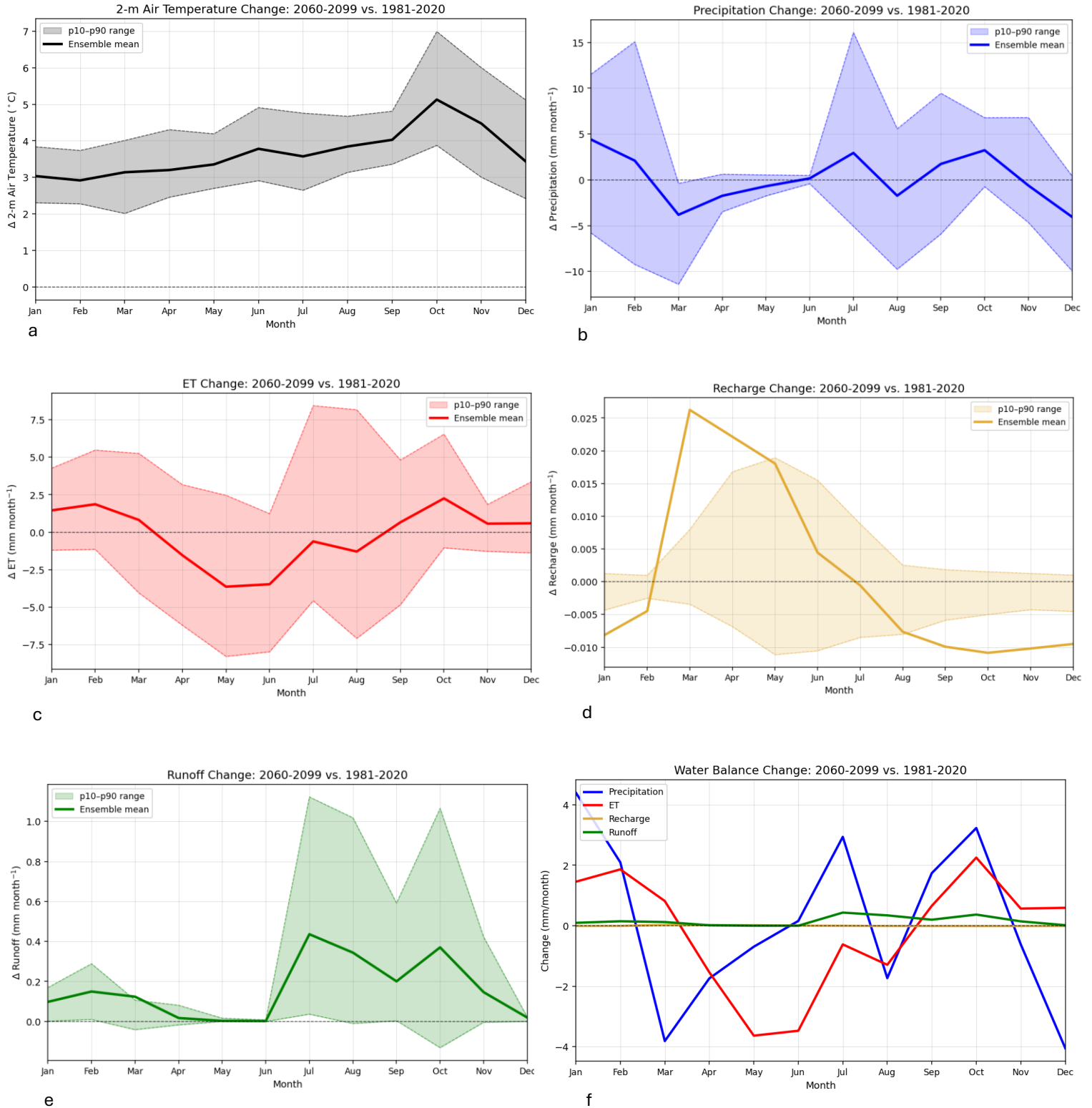


Precipitation (P) in the McMullen Valley basin is greatest in the Harcuvar Mountains Wilderness to the north and the Harquahala Mountains Wilderness to the south. Both P and evapotranspiration (ET) can exceed 300 mm/yr on average in these regions. Natural recharge and runoff are minimal (less than 2.0 mm) across the basin; however, modeling shows recharge can exceed 10 mm on average in a section of the Harquahala Mountains. The McMullen Valley basin generally has low to moderate infiltration potential; however, areas of higher infiltration potential are present in small pockets of limestone geology in the Harquahala Mountains.

# McMullen Valley



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the McMullen Valley basin show drier springs (16-25% drier March through May) and a drier August (5%), November (5%), and December (18%). January (19%), June-July (11-17%), and September-October (9-25%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (1.6-3.3 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (approximately -0.01 mm/month) in January-February and from July through December.\* While runoff is projected to remain below 0.5 mm/month, minor increases of 0.15-0.44 mm/month are projected for July-November. Projected increases in temperature range from approximately 3.0 °C in February to 5.2 °C in October. Less precipitation in April and May leads to a projected 7-18% (-1.6 to -3.7 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 17% (2.2 mm) increase in ET in October, a 13% (1.5 mm) increase in January, and a 11% (1.8 mm) increase in February 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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# Meadview Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 190 square miles

**Elevation<sup>2</sup>:** Range: 1,105-6,759 ft; Median: 3,601 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (91%), Evergreen Forest (5.3%), Woody Wetlands (1.5%)

**Major surface watershed(s)<sup>4</sup>:** Colorado River / Lake Mead

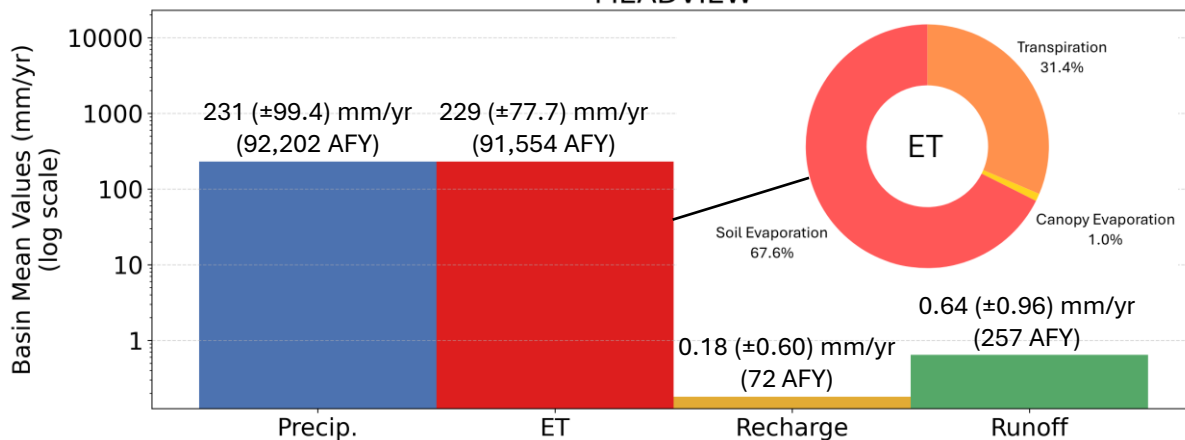
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.68** (Very High)

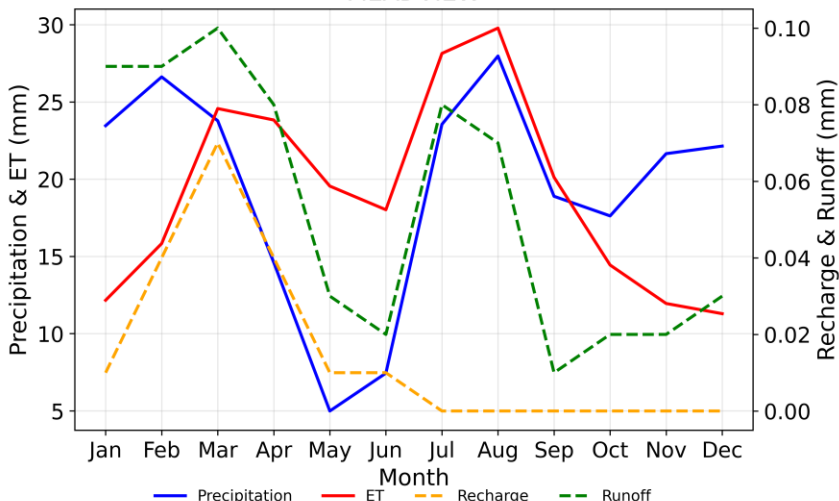


Mean Annual Hydrologic Cycle Components (1980-2020)  
MEADVIEW



**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.<sup>6</sup> 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)  
MEADVIEW



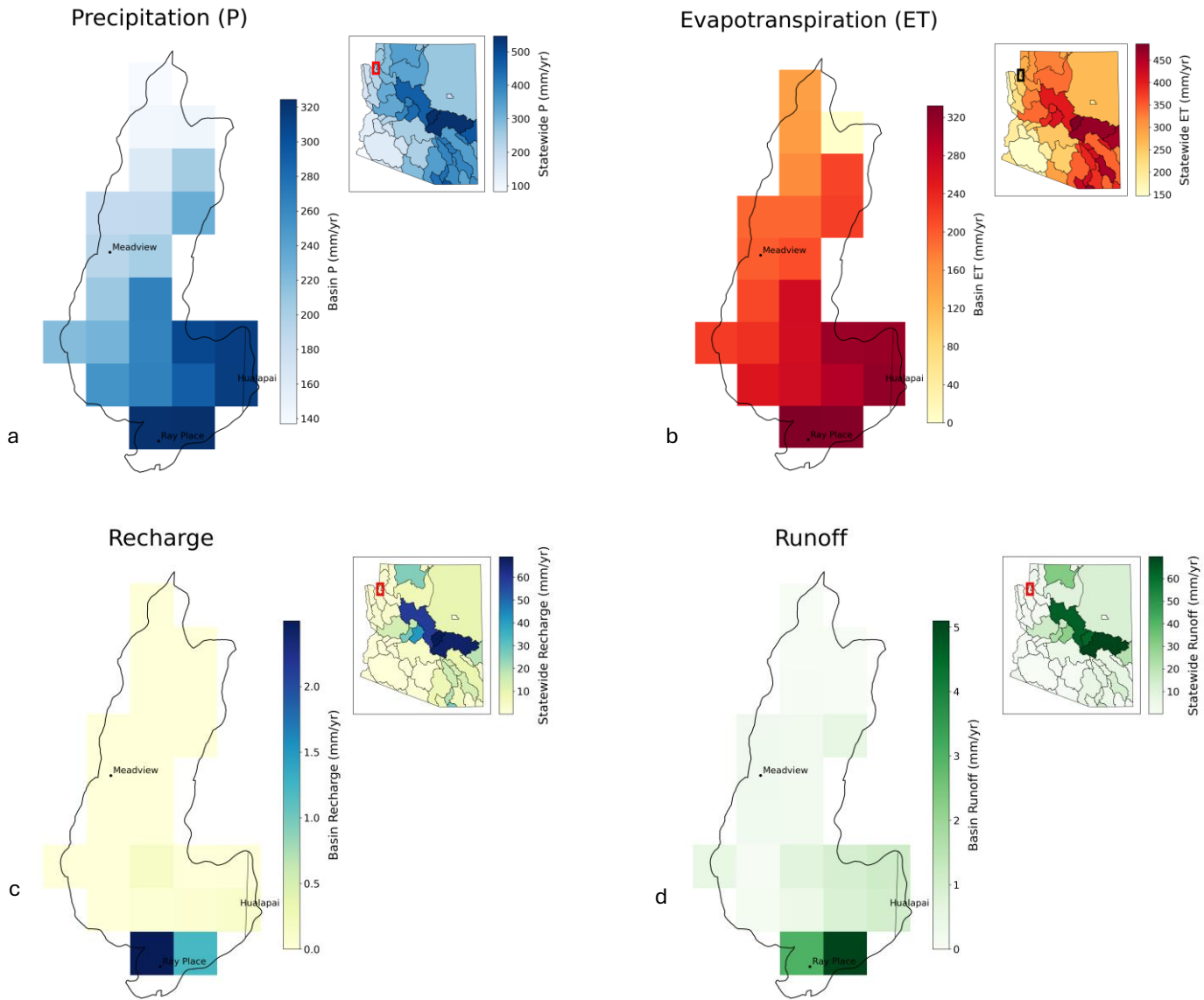
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Meadview 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 March through mid-September. Soil evaporation makes up 67.6% of total ET in the basin, while transpiration comprises 31.4% and canopy evaporation accounts for the remainder (1.0%). Natural recharge (0.18 mm/yr) and runoff (0.64 mm/yr) are near zero on average across the basin.

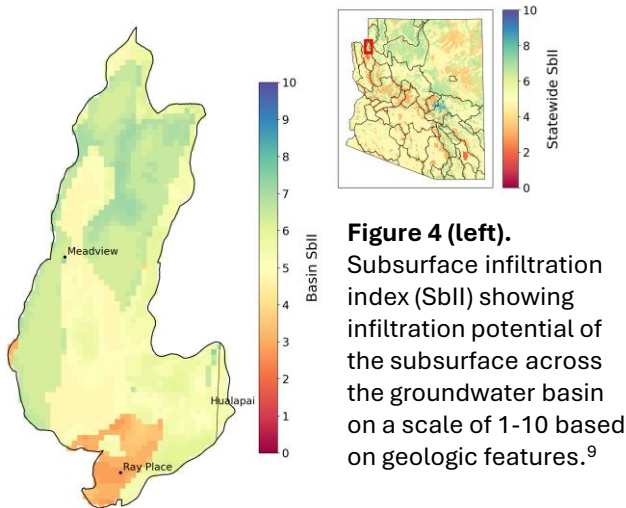
# Meadview



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



## Subsurface Infiltration Index (SbII)

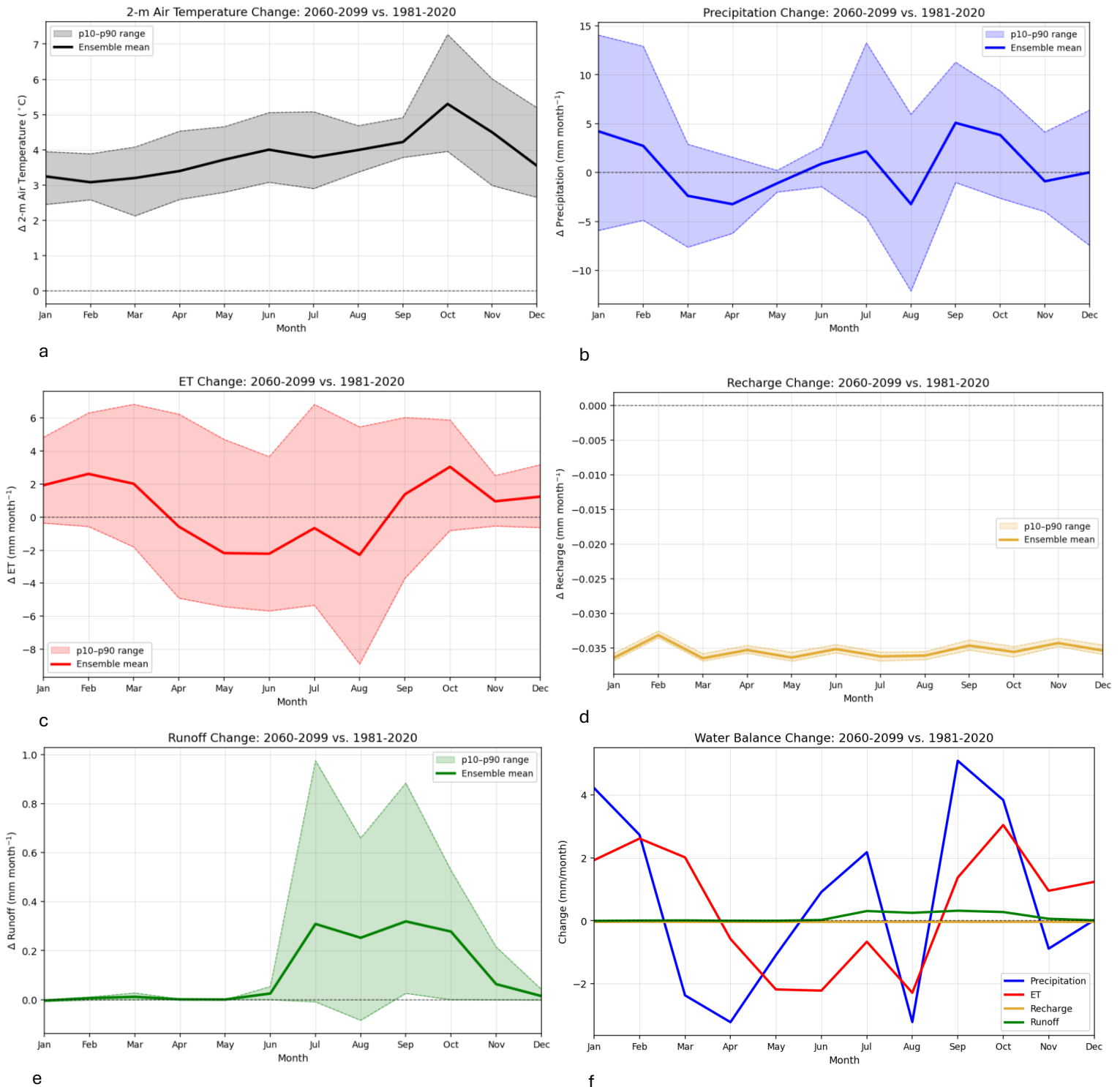


**Figure 4 (left).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

Precipitation (P) in the Meadview basin is greatest at higher elevations to the southeast, where P exceeds 310 mm/yr on average. ET (~310 mm/yr) is also highest in this region. Natural recharge and runoff are minimal across the basin, with the highest values (2 and 4 mm/yr, respectively) occurring in the southernmost portion of the basin. The basin has relatively high infiltration potential due to the presence of moderately consolidated conglomerate that contains limestone in the northern and western parts 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Meadview basin show drier springs (10-23% drier March through May), and a drier August (10%) and November (5%). September and October are projected to be 22-29% (3.9-5.1 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. Natural recharge is projected to remain near zero and slightly negative (approximately -0.05 mm/month) throughout the year.\* While runoff is projected to remain near zero for most of the year, minor increases of 0.26-0.33 mm/month are projected for 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 22% (3.1 mm) increase in evapotranspiration (ET) in October and a 17% (1.9-2.6 mm/month) increase in January-February compared to the baseline period, while less water availability in August leads to a projected decline in ET (8% or -2.1 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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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Morenci Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 1,599 square miles

**Elevation<sup>2</sup>:** Range: 3,268-10,722 ft; Median: 6,049 ft

**Top 3 land cover types by area<sup>3</sup>:** Evergreen Forest (52%), Shrub/Scrub (44%), Barren Land (1.4%)

**Major surface watershed(s)<sup>4</sup>:** San Francisco River, Upper Gila River

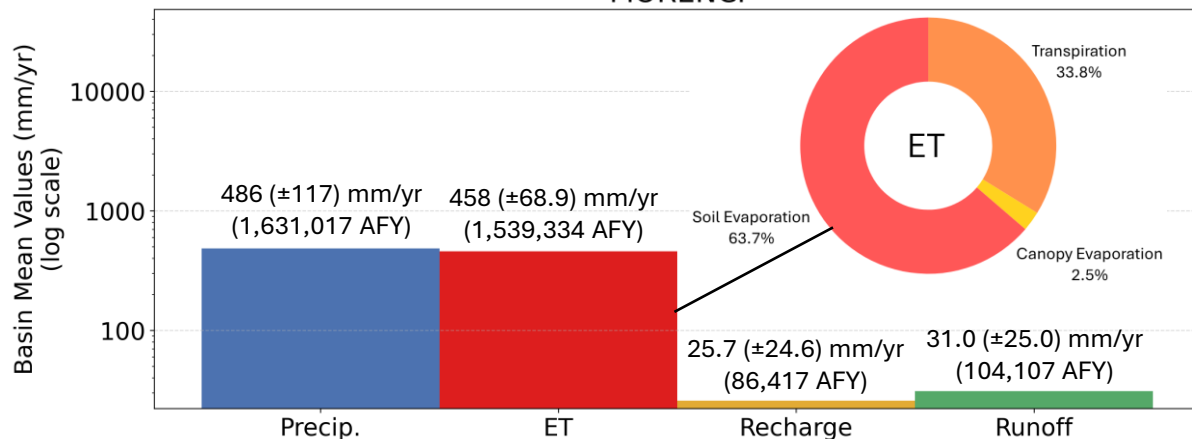
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.45** (Moderate)

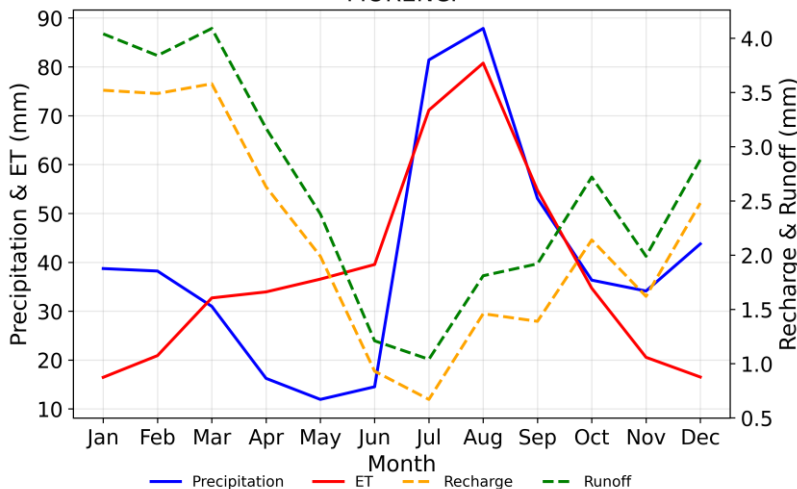


Mean Annual Hydrologic Cycle Components (1980-2020)  
MORENCI



**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.<sup>6</sup> 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)  
MORENCI



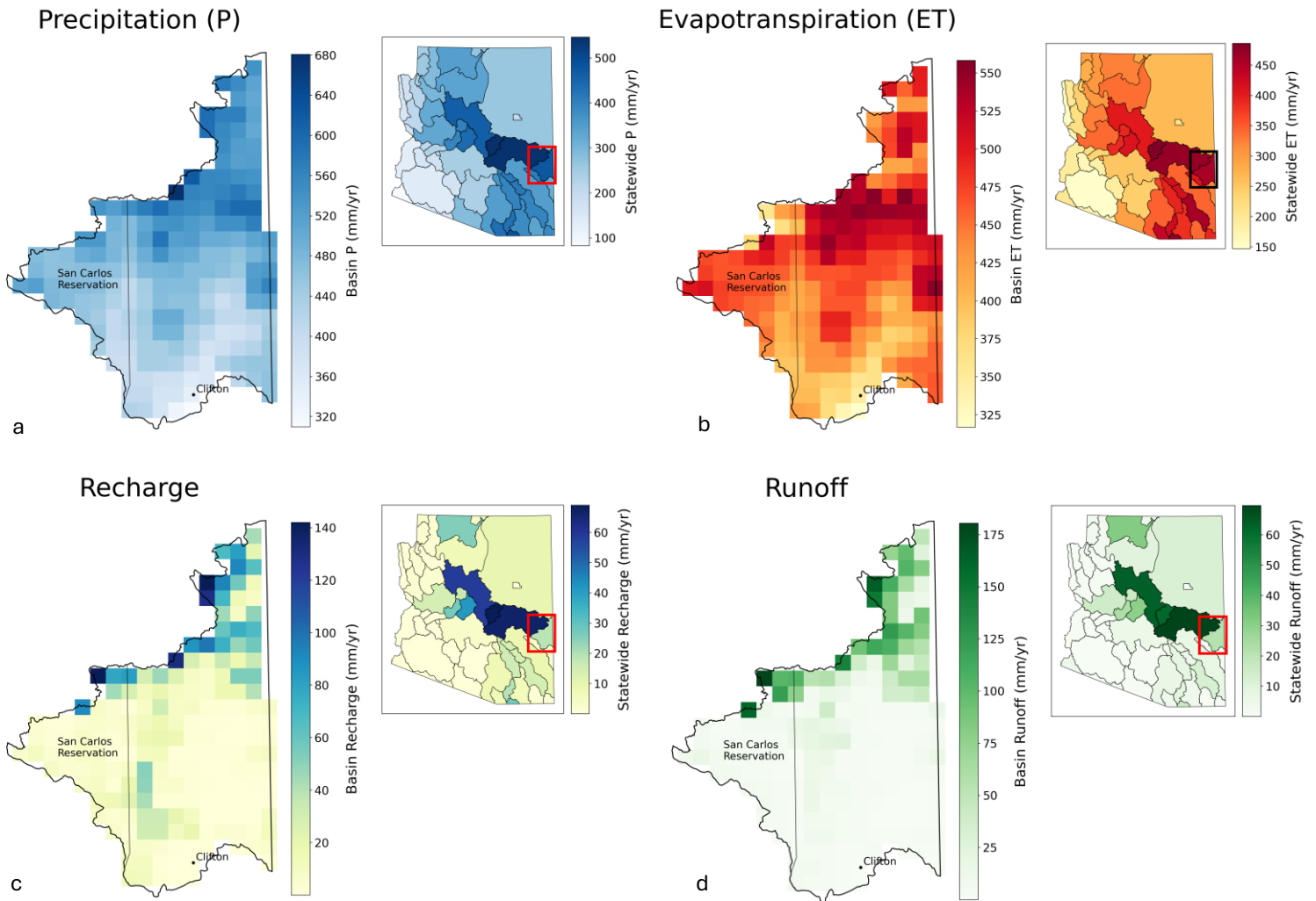
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Morenci basin is affected by the North American Monsoon during the summer months. The greatest atmospheric losses occur during the warmer months, where evapotranspiration (ET) exceeds P from mid-March through June and tracks with P from July to October. Soil evaporation makes up 63.7% of total ET in the basin, while transpiration comprises 33.8% and canopy evaporation accounts for the remainder (2.5%). Natural recharge (25.7 mm/yr) and runoff (31.0 mm/yr) peak from January to April due to springtime snowmelt and lower atmospheric demand. Groundwater supplies an estimated 45% of total streamflow in the Morenci basin.

# Morenci

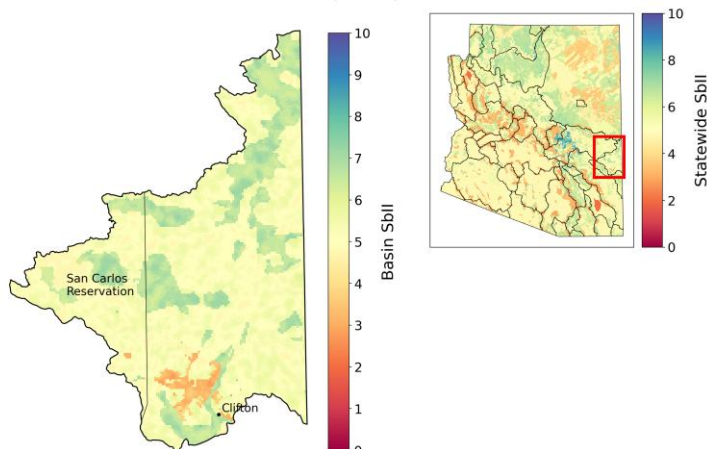


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

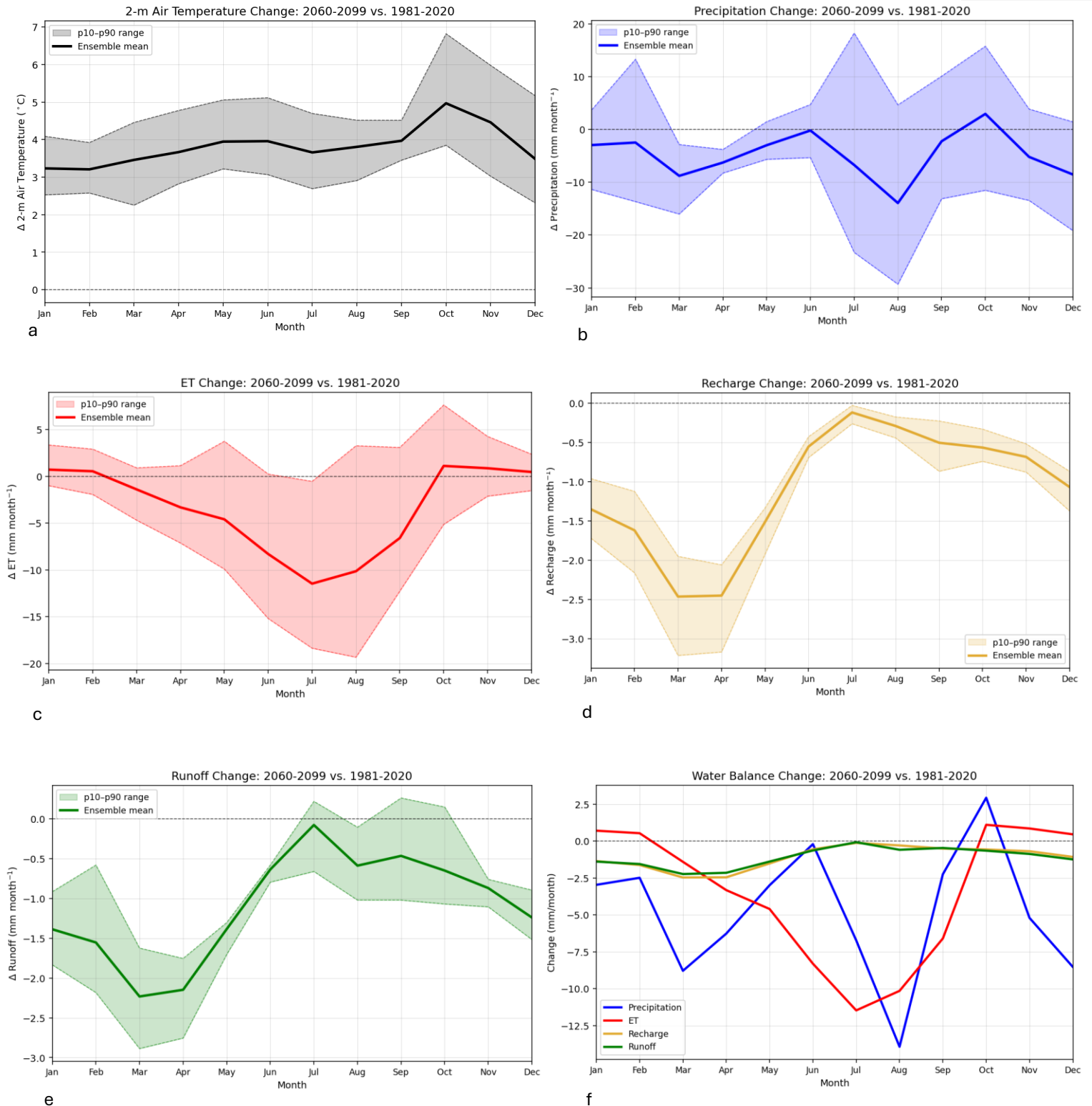
## Subsurface Infiltration Index (SbII)



Precipitation (P) in the Morenci basin is greatest in the higher elevations in the northern portion of the basin, exceeding 640 mm/year on average. Evapotranspiration (ET, ~525 mm/yr), natural recharge (~120 mm/yr) and runoff (~150 mm/yr) are also highest in this region of the basin. The Morenci basin generally has moderate to high infiltration potential. The areas with highest infiltration potential result from deposits of rim gravels and weakly to moderately consolidated conglomerate that contains limestone.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Morenci basin show less precipitation throughout the majority of the year, with the exception of October, which shows an 8% (2.9 mm) increase in precipitation. The greatest declines in precipitation are projected for March-May (24-41% or -2.5 to -8.8 mm/month) and August (15% or -14 mm). Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (January-April) showing declines of 79-87% (-1.4 to -2.5 mm/month). Recharge projections are slightly negative (-0.06 to -0.16 mm/month) from July through November.\* Runoff is projected to decrease in all months of the year, with 72-84% (-1.4 to -2.3 mm/month) declines in the highest runoff months (January-April). Projected increases in temperature range from approximately 3.2 °C in February to 5.0 °C in October. Less water availability from precipitation in April-August leads to a projected 10-18% (-3.4 to -11 mm/month) decrease in evapotranspiration (ET) in those months 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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7. AZGeo City Points shapefile. Retrieved from AZGeo Data Hub: <https://azgeo-open-data-agic.hub.arcgis.com/datasets/azgeo::city-points/about>
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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Paria

## Groundwater Basin Profile



### Basin Summary Statistics

**Size**<sup>1</sup>: 408 square miles

**Elevation**<sup>2</sup>: Range: 3,082-7,355 ft; Median: 6,037 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (96.5%), Barren Land (2.4%), Open Water (0.71%)

**Major surface watershed(s)**<sup>4</sup>: Paria River, Colorado River

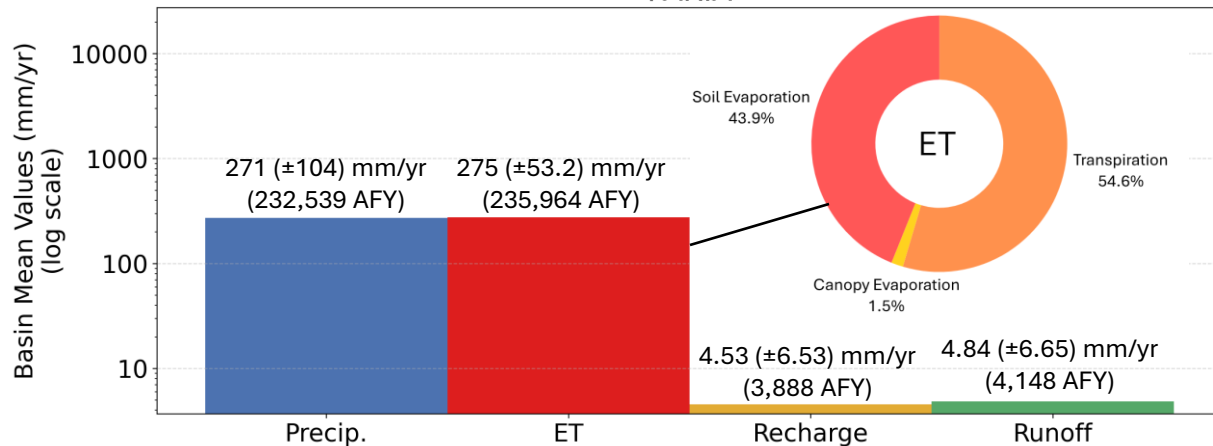
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.55** (High)

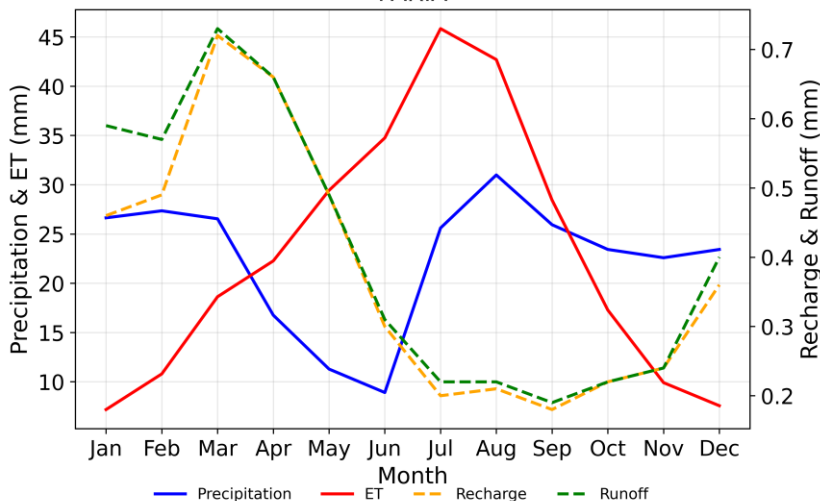


Mean Annual Hydrologic Cycle Components (1980-2020)  
PARIA



**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.<sup>6</sup> 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)  
PARIA

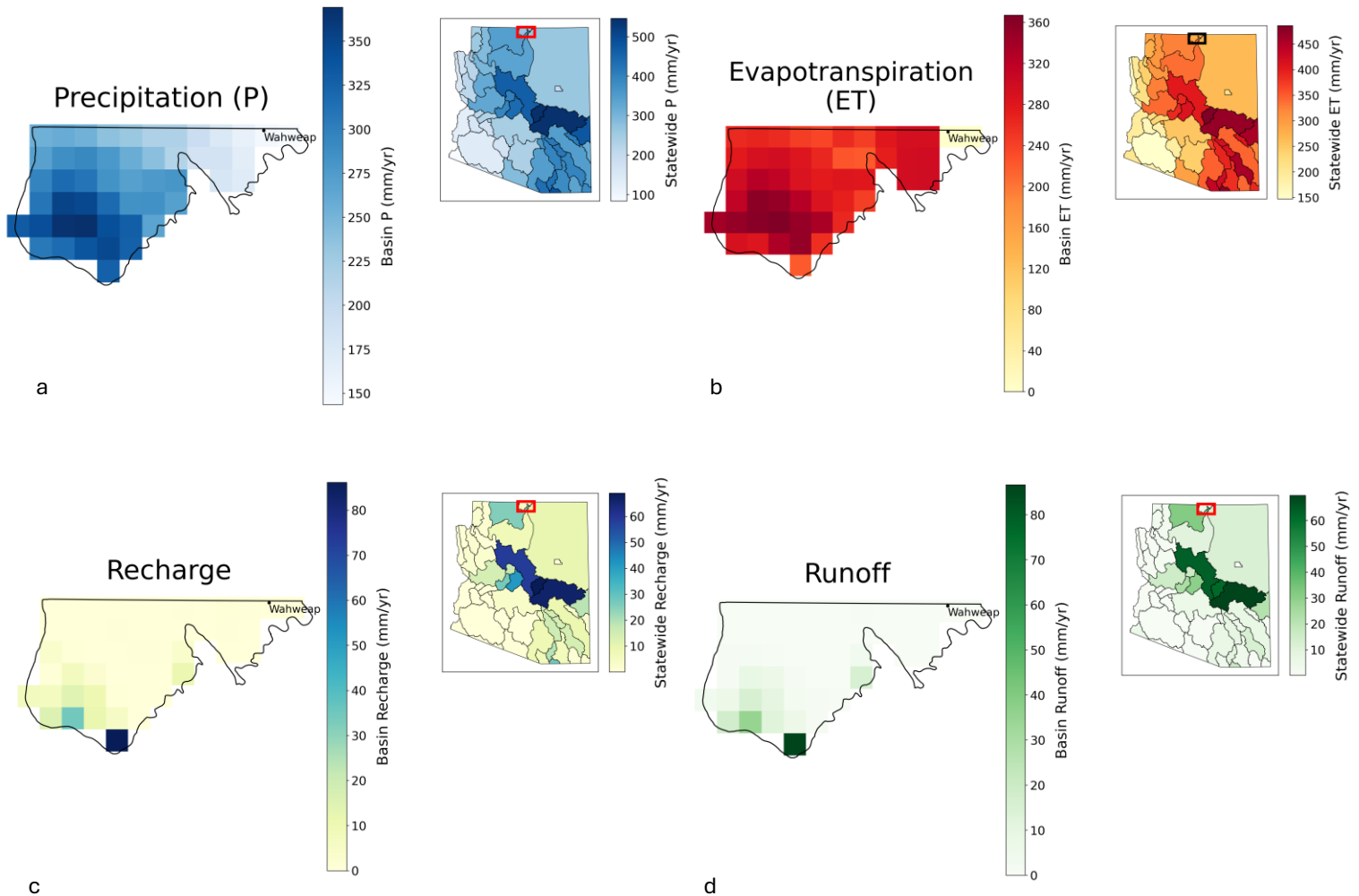


**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

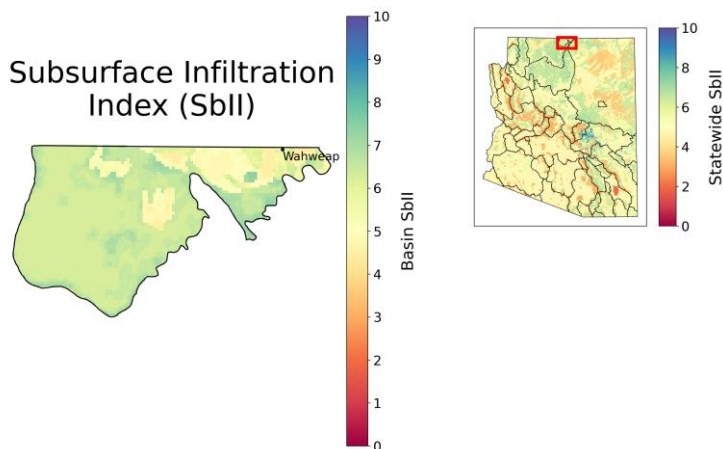
Precipitation (P) in the Paria basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. The greatest atmospheric losses occur during the summer months, where evapotranspiration (ET) exceeds P from mid-March through mid-September. Transpiration makes up the majority (54.6%) of total ET in the basin, while soil evaporation comprises 43.9% and canopy evaporation accounts for the remainder (1.5%). Natural recharge (4.53 mm/yr) and runoff (4.84 mm/yr) peak in March due to springtime snowmelt. Groundwater is estimated to supply 55% of total streamflow in the Paria basin.



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



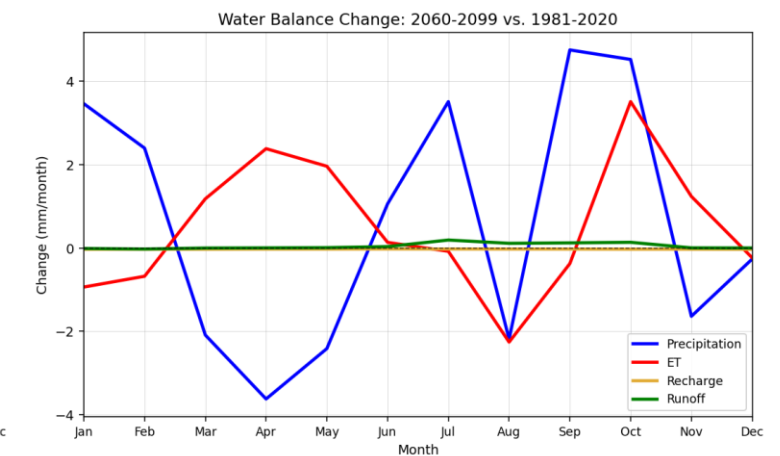
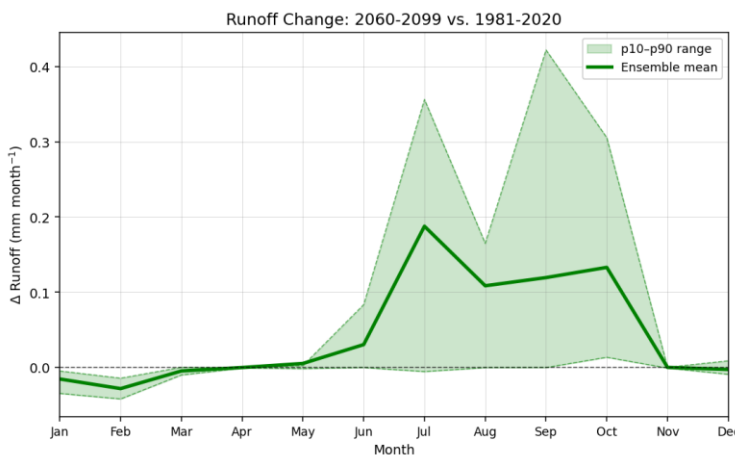
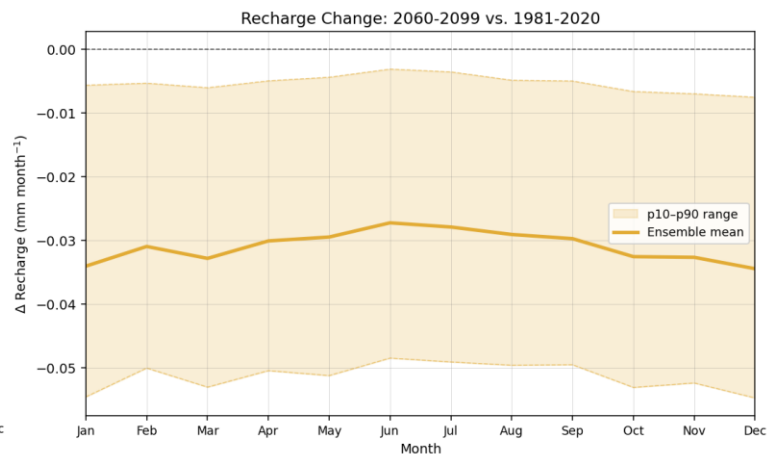
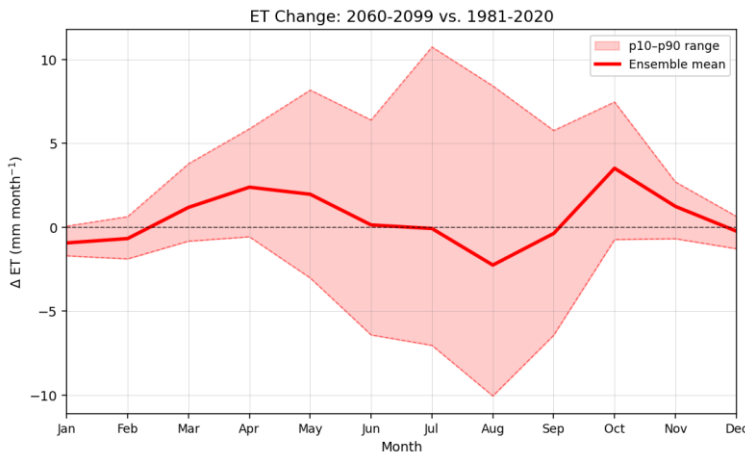
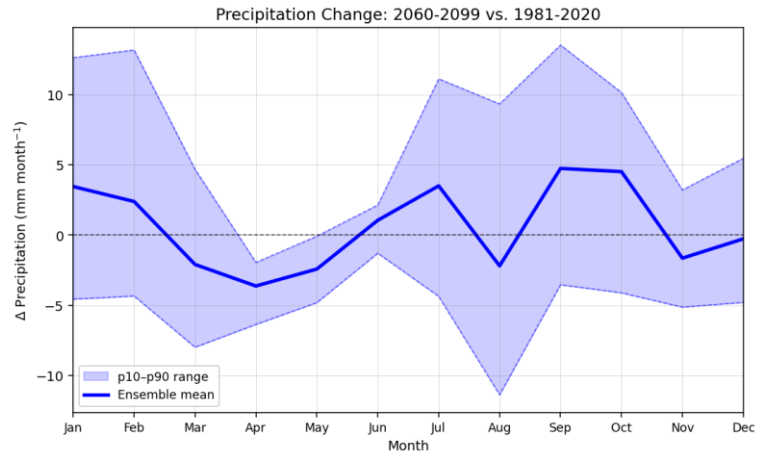
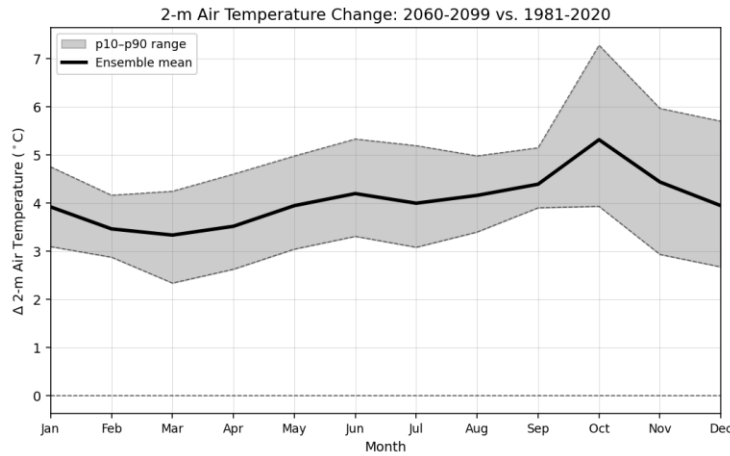
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Paria basin is greatest in southwest portion of Paria Plateau, where P exceeds 350 mm/yr on average. ET (~350 mm/yr) is also highest in this region. Natural recharge (80 mm/yr) and runoff (80mm/yr) are highest at the southern mountain front of the Plateau. The basin has relatively high infiltration potential due to the presence of karst-type geology.



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



a

b

c

d

e

f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Paria basin show drier springs (8-26% drier March through May), and a drier August (7%) and November (8%). September and October are projected to be 17-20% (4.6 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. Natural recharge is projected to remain near zero and slightly negative (approximately -0.04 mm/month) throughout the year.\* While runoff is projected to remain near zero for most of the year, minor increases of 0.10-0.20 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.3 °C in March to 5.4 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 22% (3.5 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 (6% or -2.2 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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# Parker

## Groundwater Basin Profile



### Basin Summary Statistics

**Size**<sup>1</sup>: 2,230 square miles

**Elevation**<sup>2</sup>: Range: 183-4,856 ft; Median: 976 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (74%), Barren Land (12%), Cultivated Crops (6.2%)

**Major surface watershed(s)**<sup>4</sup>: Colorado River

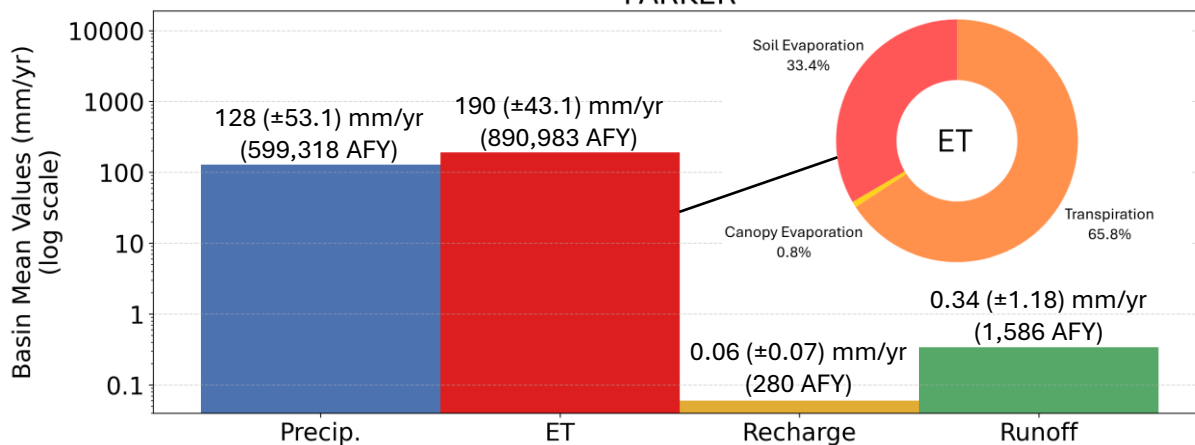
**Groundwater subbasins**<sup>1</sup>: La Posa Plains, Colorado River Indian Reservation, Cibola Valley

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.01** (Very Low)

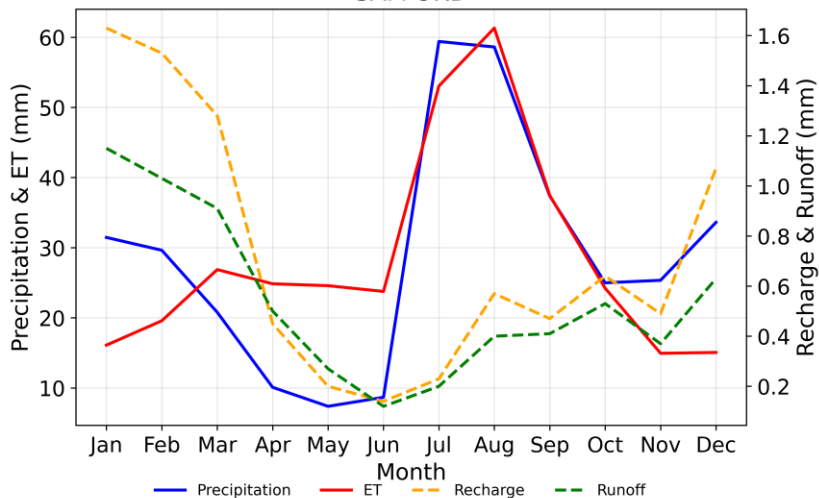


Mean Annual Hydrologic Cycle Components (1980-2020)  
PARKER



**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.<sup>6</sup> 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)  
SAFFORD

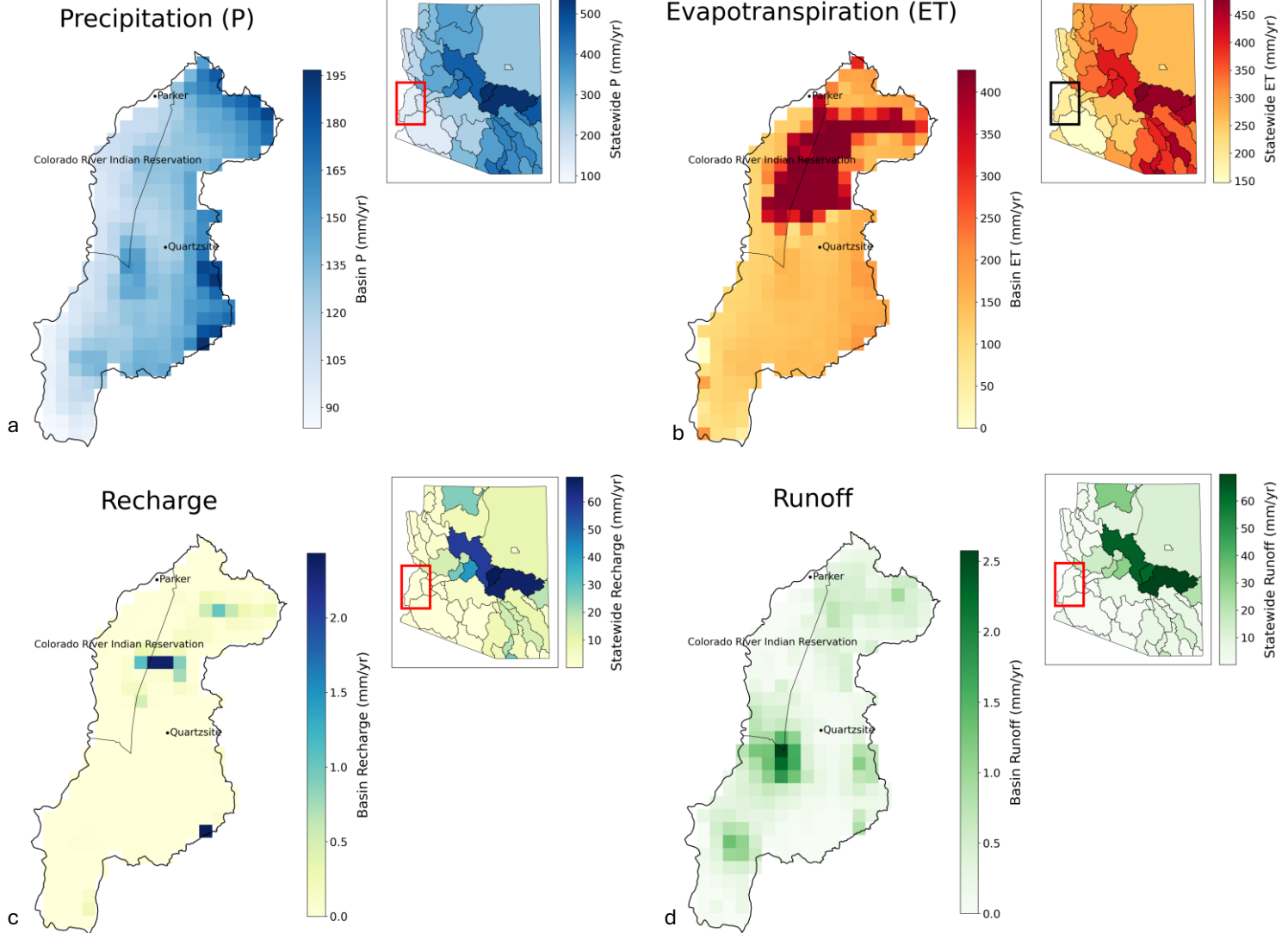


On annual timescales, evapotranspiration (ET) exceeds annual precipitation (P) across the basin, resulting in basin-wide averages near zero for natural recharge (0.06 mm) and runoff (0.34 mm). ET is greater than P for most of the year, with the exception of the winter months (from mid-October to mid-February). Soil evaporation makes up 33.4% of total ET in the basin, while transpiration comprises 65.8% and canopy evaporation accounts for the remainder (0.8%).

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

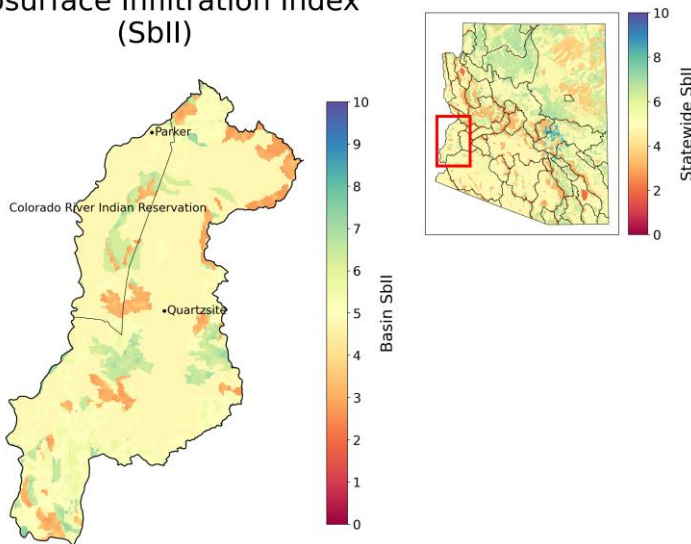
**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are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

**Parker**



**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.<sup>9</sup>

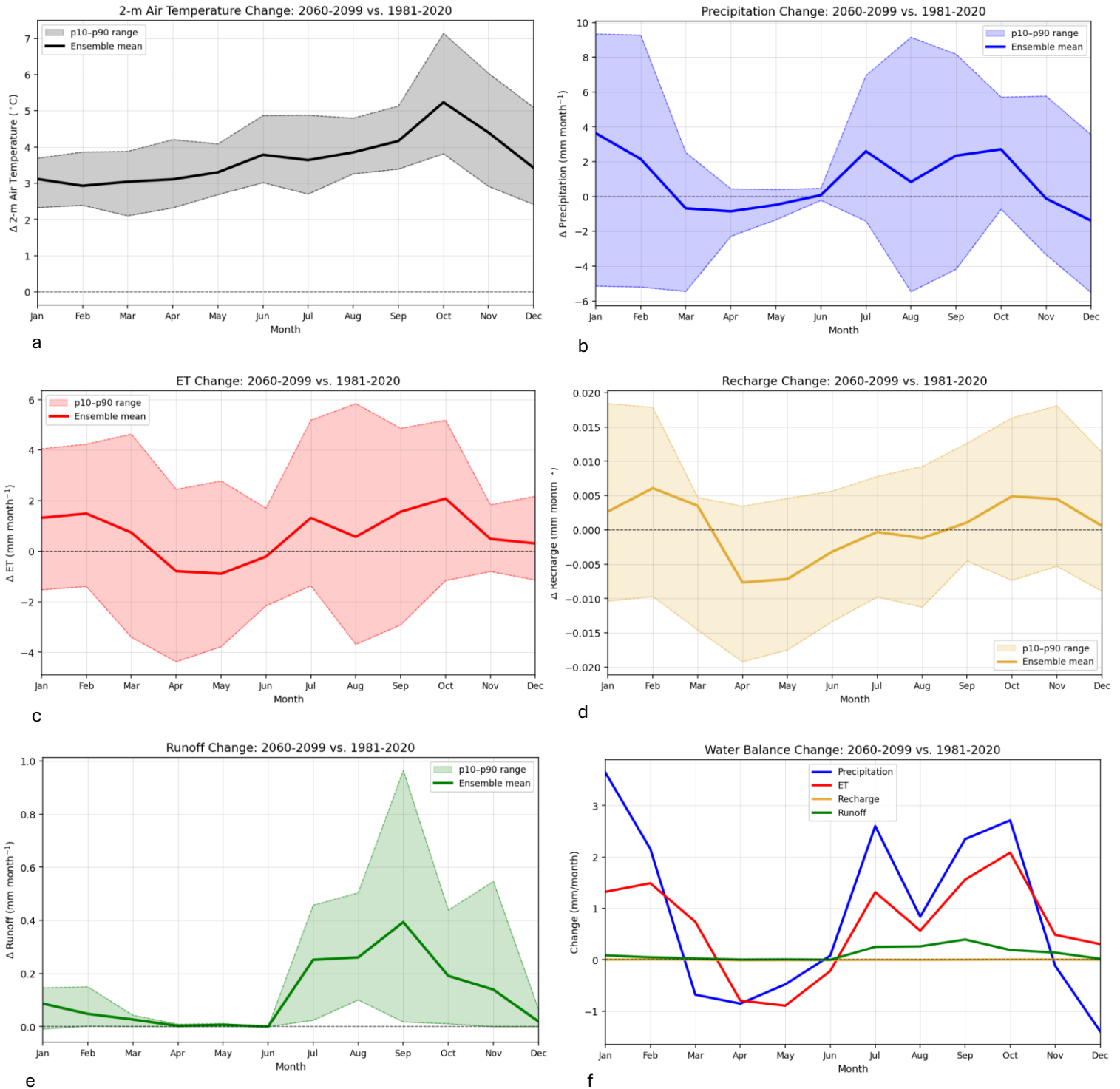
**Subsurface Infiltration Index (SbII)**



ET in the Parker basin is greatest in the Bouse Dunes, between Parker and Bouse, AZ, exceeding 400 mm/yr. P is highest at the eastern edges of the basin in the Plomosa Mountains, nearing 200 mm/yr. Runoff and natural recharge are both minimal across the basin due to low water availability. Infiltration potential varies across the basin, but is generally greater in the karst-type geology and alluvial deposits along the low mountain regions.



### 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Parker basin show drier springs (6-23% drier March through May) and a drier December (8%). January-February (12-22%) and June-October (4-38%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.4-2.8 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge remains negative (-0.03 to -0.07 mm/month) throughout the year.\* While remaining below 0.4 mm/month, runoff is projected to increase by 0.14 to 0.38 mm/month from July through November by the end of the century. Projected increases in temperature range from approximately 3.0 °C in February to 5.3 °C in October. Evapotranspiration (ET) is projected to generally track with precipitation throughout the year, showing increases of 3-25% (0.55-2.1 mm/month) from July through October due to high temperatures and greater water availability.

\*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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# Peach Springs Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 1,409 square miles

**Elevation<sup>2</sup>:** Range: 1,135-7,085 ft; Median: 5,157 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (83%), Evergreen Forest (14%), Barren Land (1.1%)

**Major surface watershed(s)<sup>4</sup>:** Colorado River/Lake Mead, Truxton Wash/Red Lake

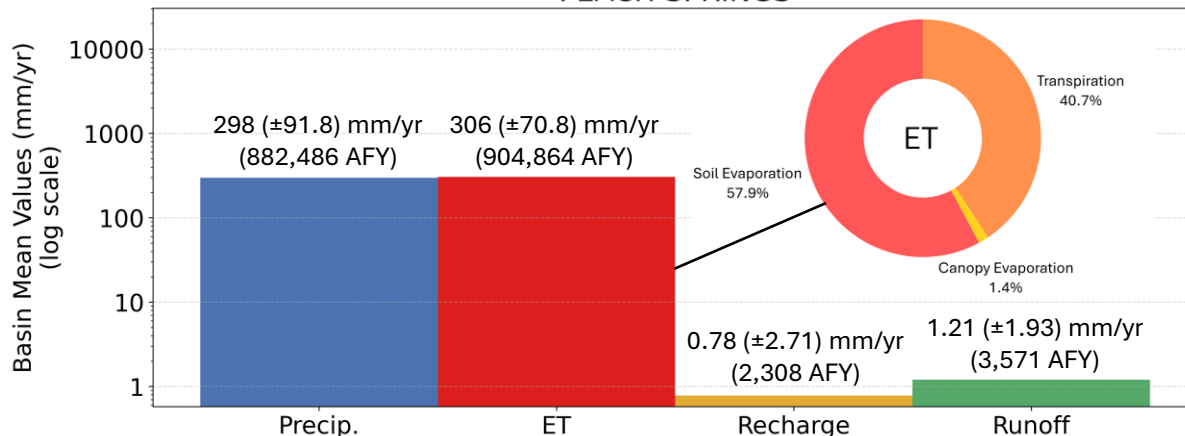
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.62** (High)

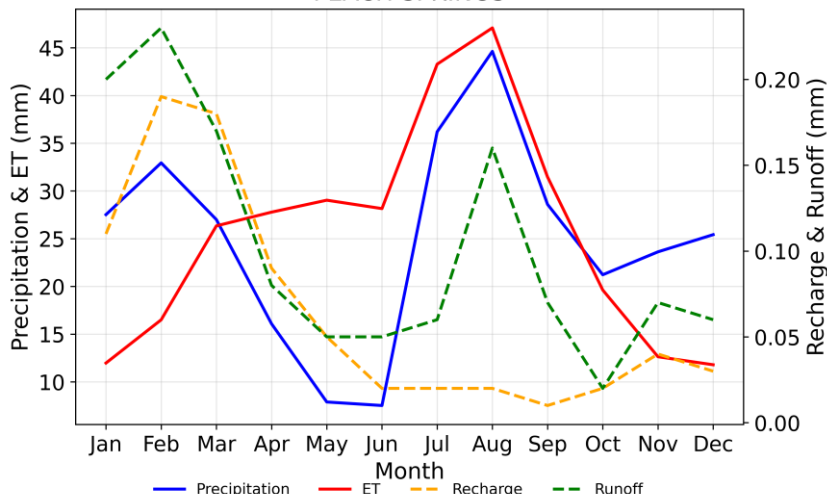


Mean Annual Hydrologic Cycle Components (1980-2020)  
PEACH SPRINGS



**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.<sup>6</sup> 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)  
PEACH SPRINGS



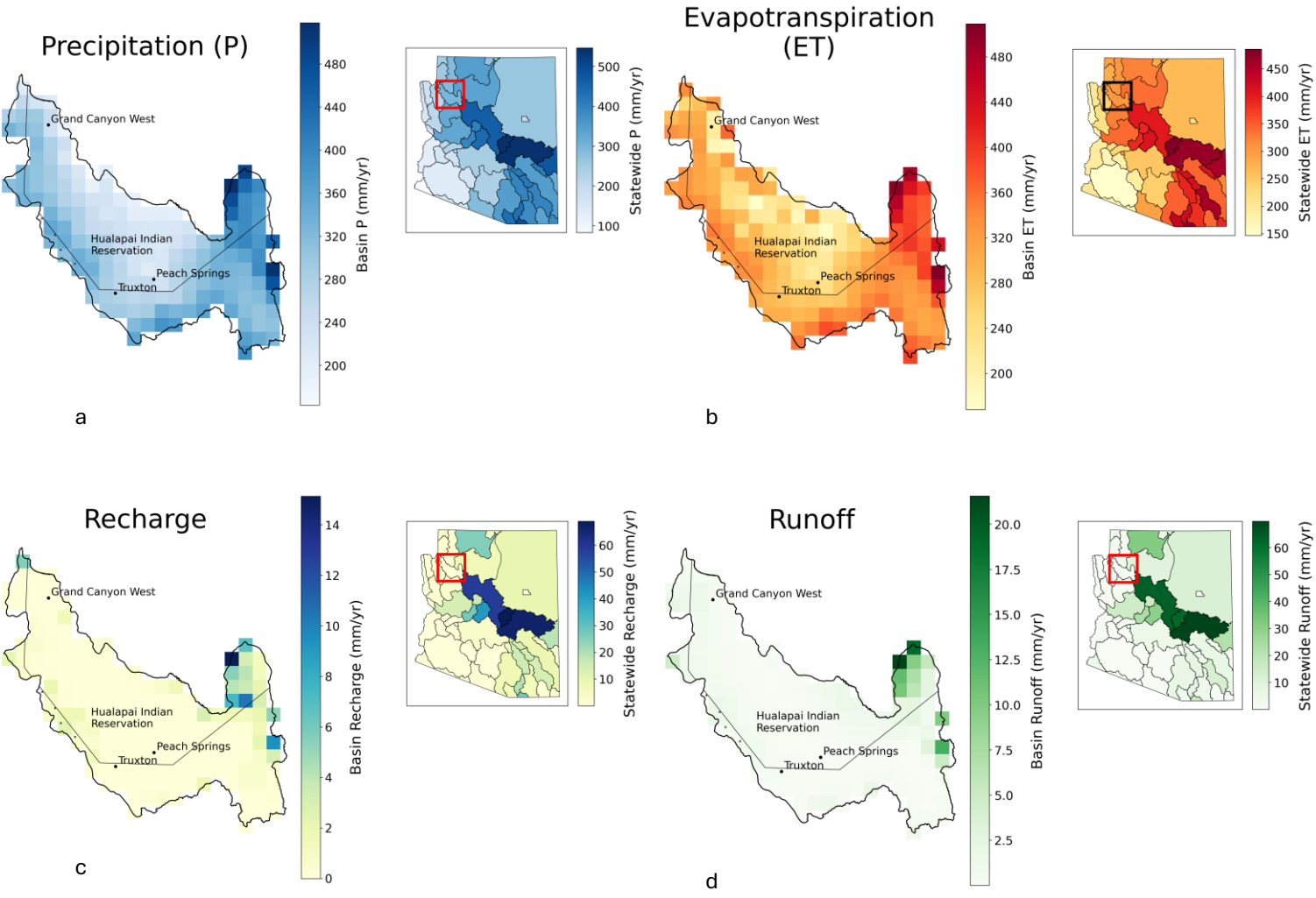
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Peach Springs basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. On annual timescales, evapotranspiration (ET) is approximately equal to P, with the greatest atmospheric losses occurring during the summer months. ET exceeds P from March through mid-September. Soil evaporation makes up 57.9% of total ET in the basin, while transpiration comprises 40.7% and canopy evaporation accounts for the remainder (1.4%). Natural recharge (0.78 mm/yr) and runoff (1.21 mm/yr) are near zero on average across the basin. Groundwater is estimated to supply 62% of total streamflow in the Peach Springs basin.

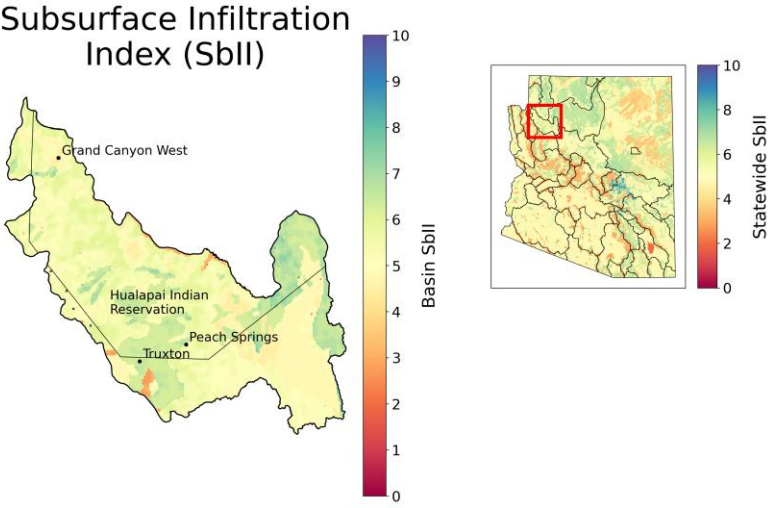
# Peach Springs



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



**Figure 4 (below).** Subsurface infiltration index (Sbll) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

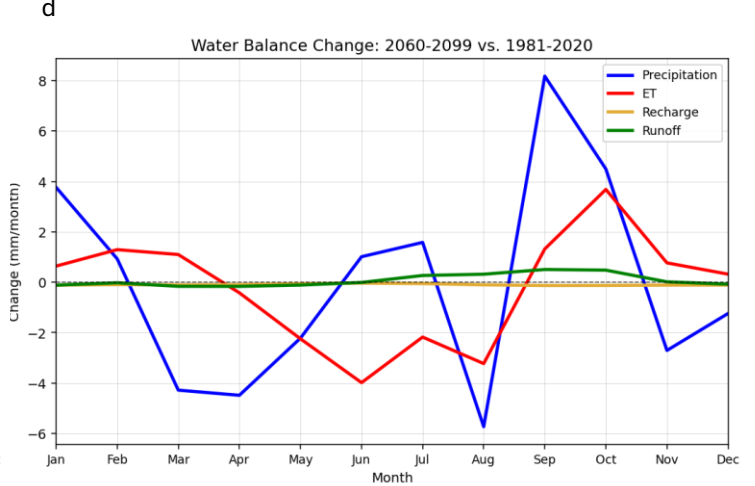
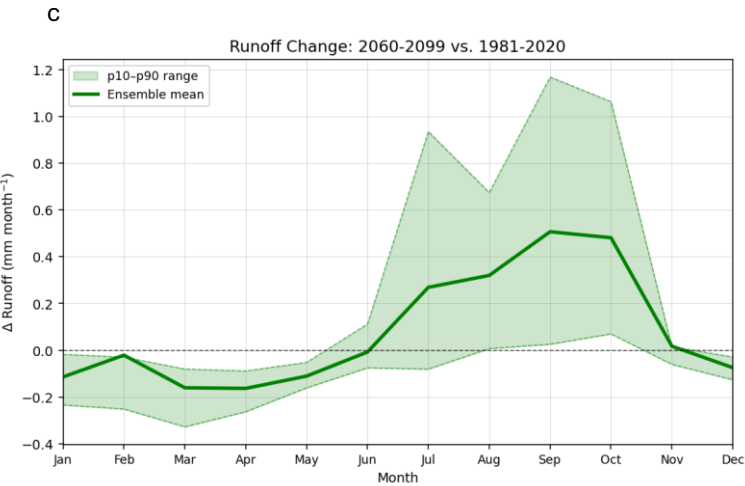
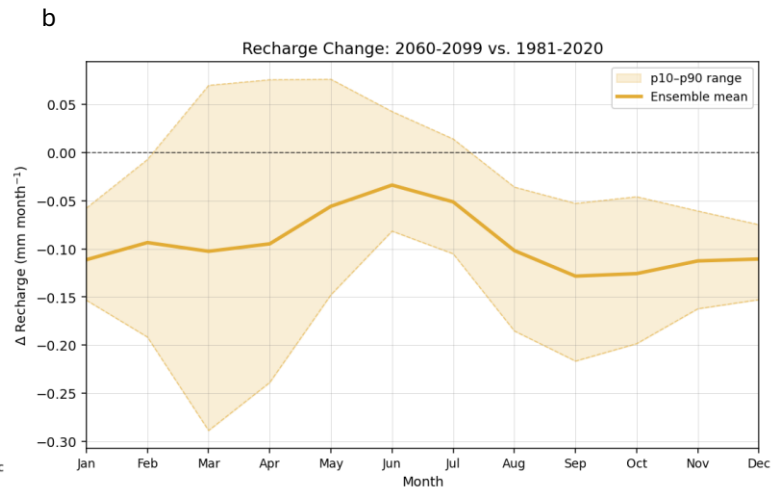
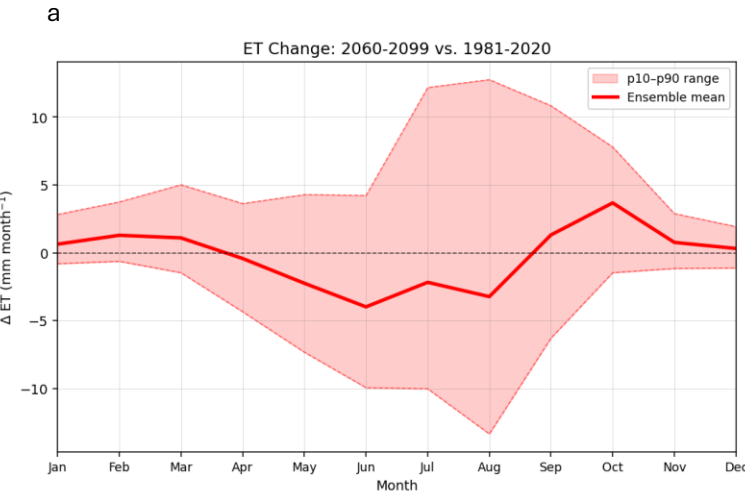
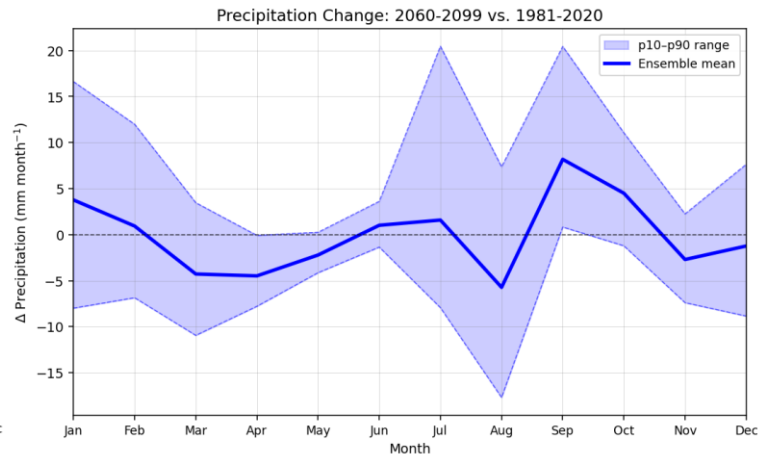
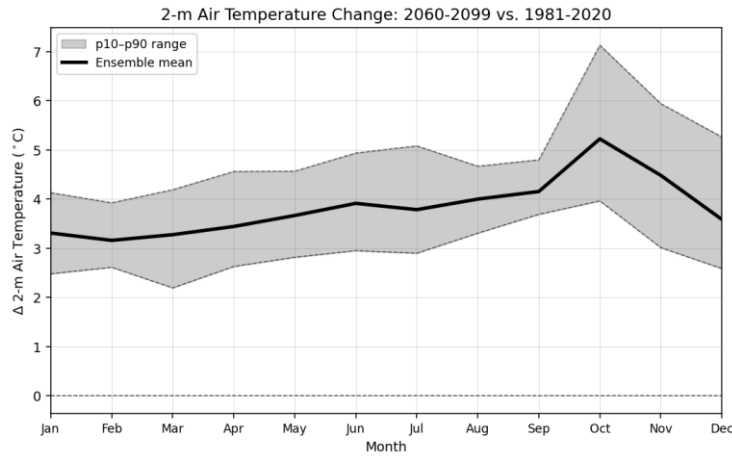


Precipitation (P) in the Peach Springs basin is greatest at the higher elevations to the east, where P exceeds 450 mm/yr on average. ET (450 mm/yr), natural recharge (10 mm/yr), and runoff (15 mm/yr) are also highest in this region. Overall, the basin has moderate infiltration potential with pockets of higher potential that result from faulting in higher elevation areas and karst-type geology.

# Peach Springs



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Peach Springs basin show drier springs (15-29% drier March through May), and a drier August (11%) and November (13%). September and October are projected to be 20-30% (4.4-8.2 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. Natural recharge is projected to remain near zero throughout the year, and slightly negative (-0.01 to -0.13 mm/month) from June through February. While runoff is projected to remain below 0.7 mm/month, minor increases of 0.28-0.52 mm/month are projected for July-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 19% (3.7 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 (6% or -3.1 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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# Phoenix AMA Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 5,386 square miles

**Elevation**<sup>2</sup>: Range: 738-5,861 ft; Median: 1,491 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (69%), Developed – Medium Intensity (10%), Developed – Low Intensity (8.0%)

**Major surface watershed(s)**<sup>4</sup>: Salt, Verde, and Gila Rivers

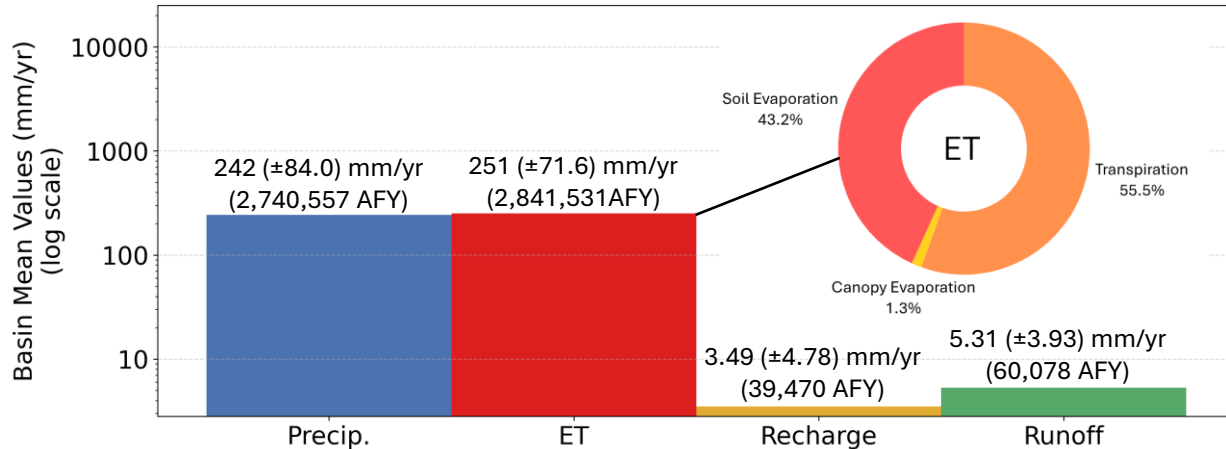
**Groundwater subbasins**<sup>1</sup>: Lake Pleasant, Carefree, Hassayampa, West Salt River, East Salt River, Fountain Hills, Rainbow Valley

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.36** (Moderate)

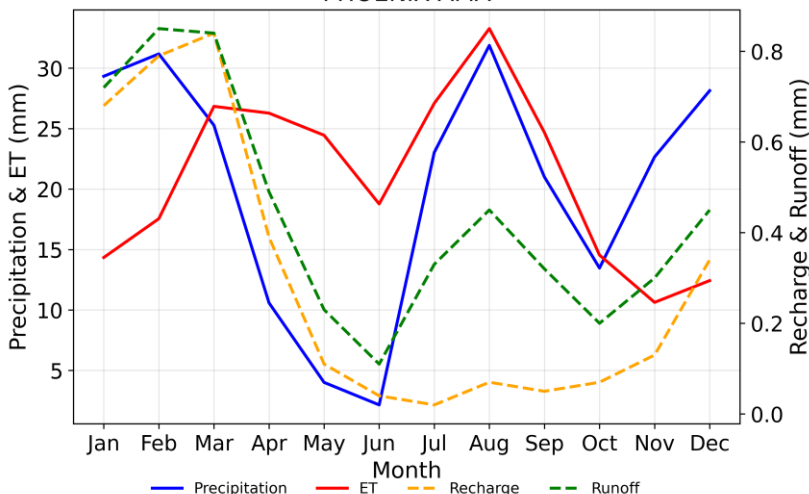


Mean Annual Hydrologic Cycle Components (1980-2020)  
PHOENIX AMA



**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.<sup>6</sup> 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)  
PHOENIX AMA



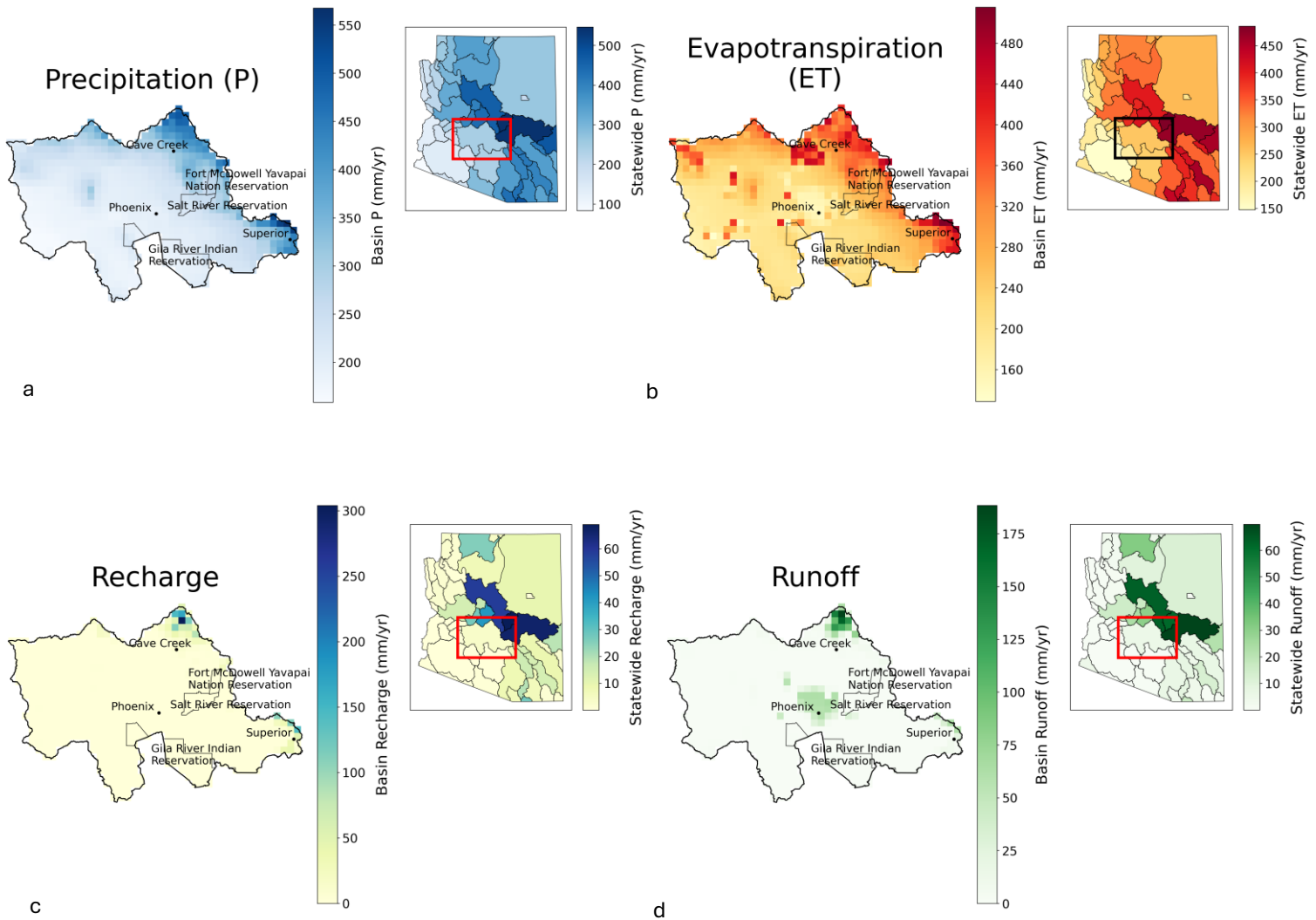
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (3.49 mm) and runoff (5.31 mm). ET is greater than P from March through October. Soil evaporation makes up 43.2% of total ET in the basin, while transpiration comprises 55.5% and canopy evaporation accounts for the remainder (1.3%). P exceeds ET during the winter months when there is lower atmospheric demand. This cool weather precipitation yields slightly higher values of natural recharge and runoff from January through March.

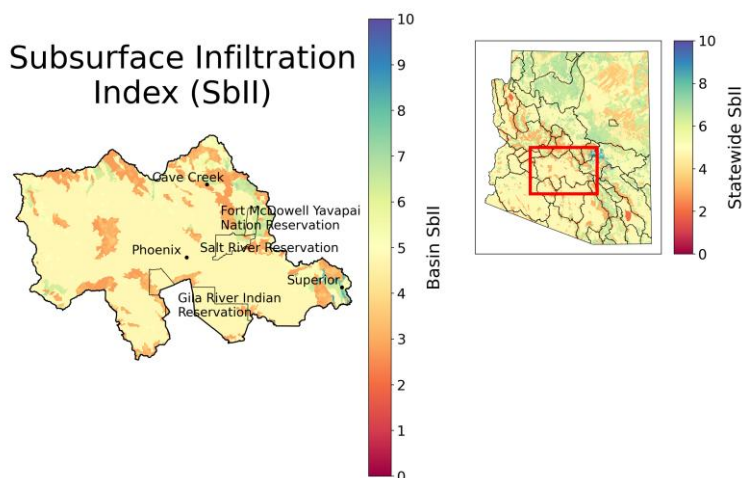
# Phoenix AMA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



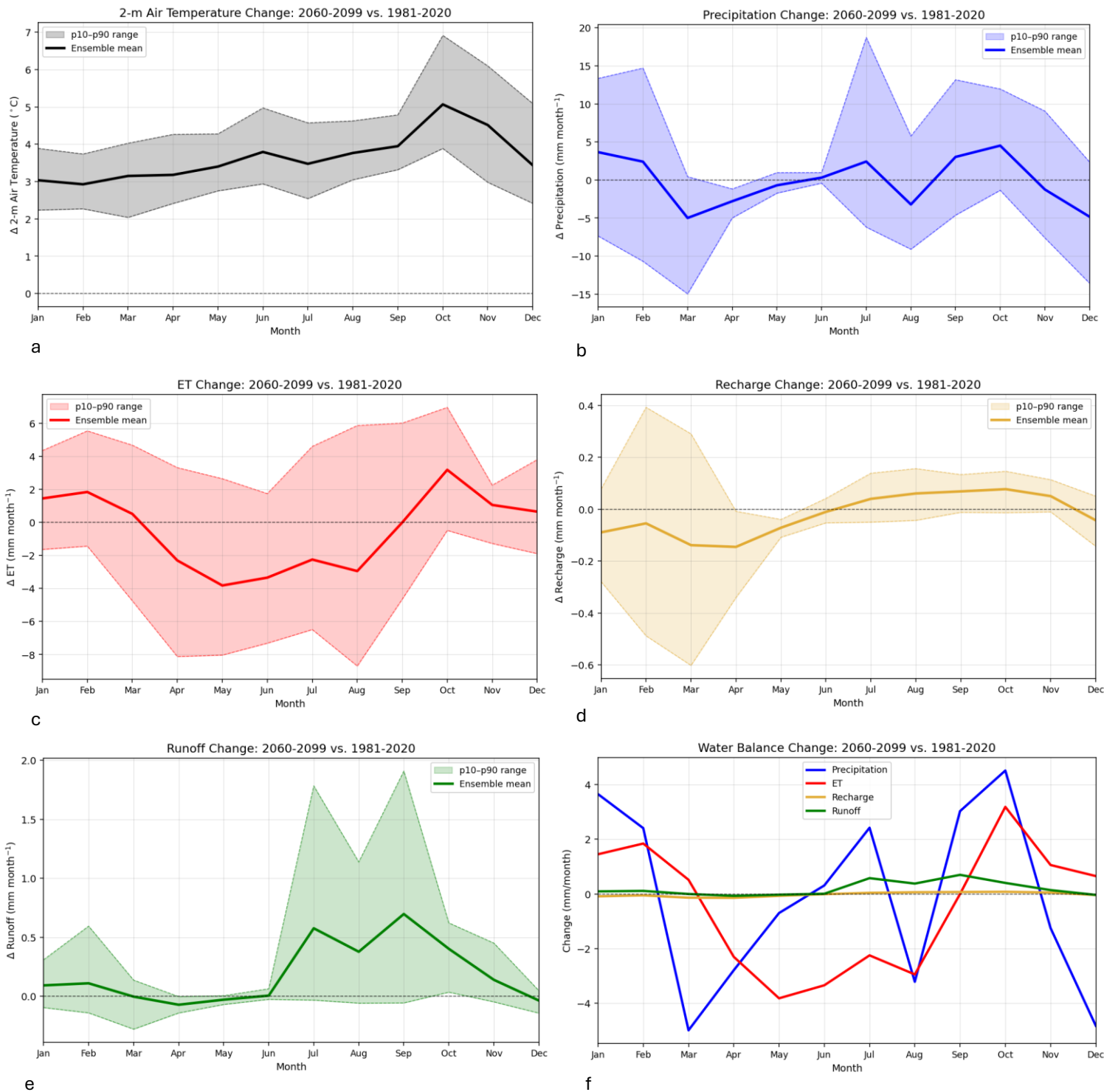
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Phoenix AMA is greatest in the higher-elevation areas to the north and east of the Phoenix metro area. In these regions, P can exceed 500 mm/yr. ET is highest over the open water of Lake Pleasant and in the mountains where there is greater water availability. Runoff (>150 mm/yr) and natural recharge (>200 mm/yr) are highest in the northernmost portion of the basin north of Cave Creek. Infiltration potential varies across the basin, with high potential highlighted in the eastern portion of the basin near the town of Superior due to the presence of faults and karst-type geology in this area.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Phoenix AMA show drier springs (17-33% drier March through May) and a drier August (10%), November (6%), and December (16%). September and October are projected to be 14-28% (2.9-4.6 mm) 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 (January-April) are projected to have declines of 12-41% (-0.07 to -0.15 mm/month). Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections from June through November remain near zero and are slightly negative (-0.02 to -0.10 mm/month).<sup>\*</sup> While remaining below 1.1 mm/month, runoff is projected to increase by 0.14-0.71 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 5.1 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 21% (3.2 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability April to August leads to projected declines in ET (9-23% or -2.3 to -3.9 mm) during the warmer months.

<sup>\*</sup>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/>
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# Pinal AMA

## Groundwater Basin Profile



### Basin Summary Statistics

**Size**<sup>1</sup>: 4,096 square miles

**Elevation**<sup>2</sup>: **Range**: 528-6,847 ft; **Median**: 1,792 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (83%), Cultivated Crops (10%), Developed – Open Space (1.8%)

**Major surface watershed(s)**<sup>4</sup>: Santa Rosa Wash, Aguirre Valley, Lower Santa Cruz, Middle Gila River

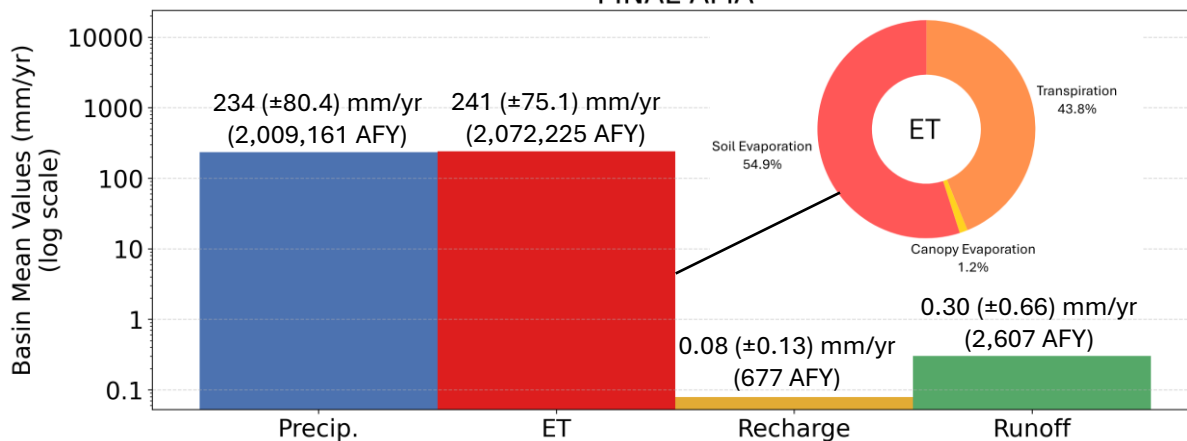
**Groundwater subbasins**<sup>1</sup>: Santa Rosa, Aguirre Valley, Maricopa-Stanfield, Vekol Valley, Eloy

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.46** (Moderate)

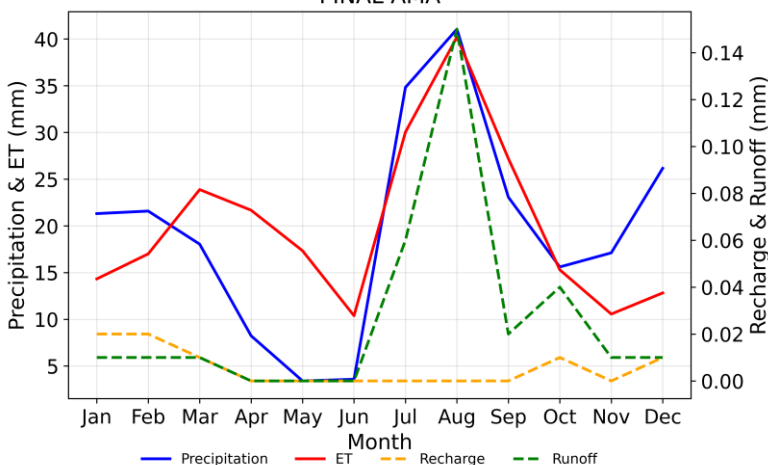


Mean Annual Hydrologic Cycle Components (1980-2020)  
PINAL AMA



**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.<sup>6</sup> 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)  
PINAL AMA

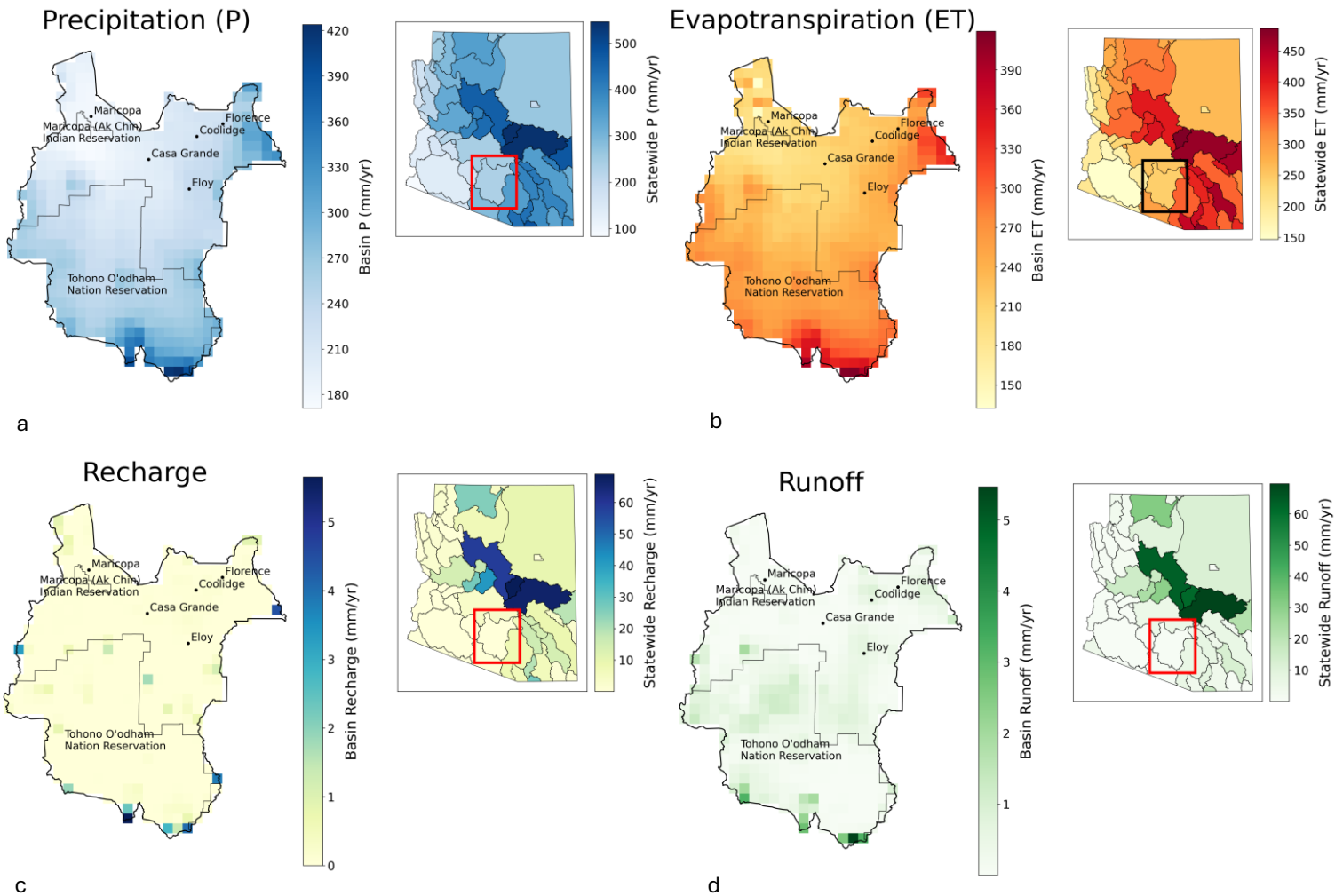


**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

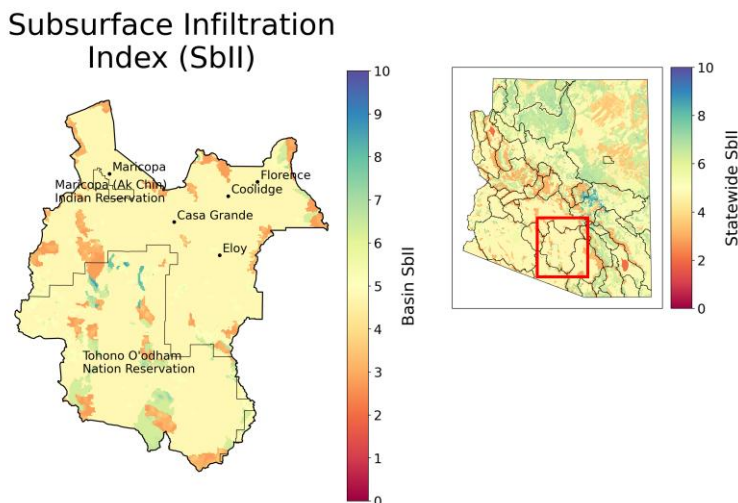
On annual timescales, evapotranspiration (ET) is greater than precipitation (P) on average across the basin, resulting in near zero annual averages for natural recharge (0.08 mm) and runoff (0.30 mm). ET is greater than P from mid-February to June, and tracks with P from June to October due to enhanced water availability from the North American Monsoon. Soil evaporation makes up 54.9% of total ET in the basin, while transpiration comprises 43.8% and canopy evaporation accounts for the remainder (1.2%).



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



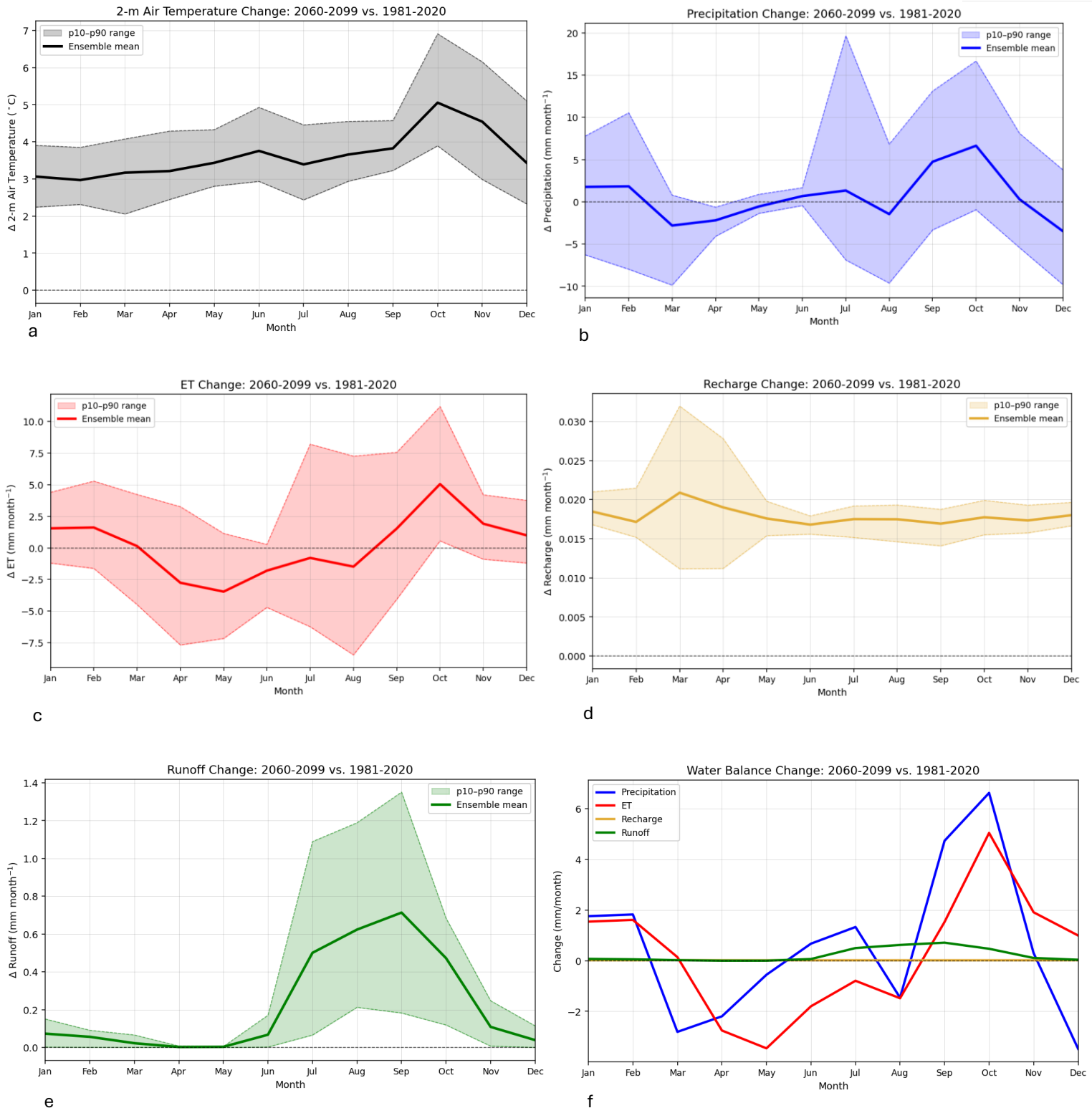
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation in the Pinal AMA is highest in the Quinlan and Comobabi Mountains in the southern portion of the basin. These regions receive 400 mm/yr of precipitation on average. The Quinlan and Comobabi Mountains also have the highest evapotranspiration (~400 mm/yr), natural recharge (~4 mm/yr), and runoff (~4 mm/yr) in the basin. Subsurface infiltration potential is moderate across the basin with pockets of high infiltration potential from the presence of karst-type geology.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Pinal AMA show drier springs (14-34% drier March through May) and a drier August (3%) and December (12%). September and October are projected to be 21-38% (4.8-6.7 mm) 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. Natural recharge is projected to remain near zero and slightly negative (-0.01 to -0.02 mm/month) throughout the year.\* While remaining below 0.8 mm/month, runoff is projected to increase by 0.48-0.73 mm/month from July to October by the end of the century. Projected increases in temperature range from approximately 3.0 °C in February to 5.1 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 30% (5.1 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability in April-May leads to projected declines in ET (13-22% or -2.9 to -3.5 mm/month) during the warmer 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

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# Prescott AMA

## Groundwater Basin Profile



### Basin Summary Statistics

**Size**<sup>1</sup>: 480 square miles

**Elevation**<sup>2</sup>: Range: 4,281-7,864 ft; Median: 5,076 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (55%), Evergreen Forest (19%), Grassland Herbaceous (8.3%)

**Major surface watershed(s)**<sup>4</sup>: Upper Verde River, Agua Fria River

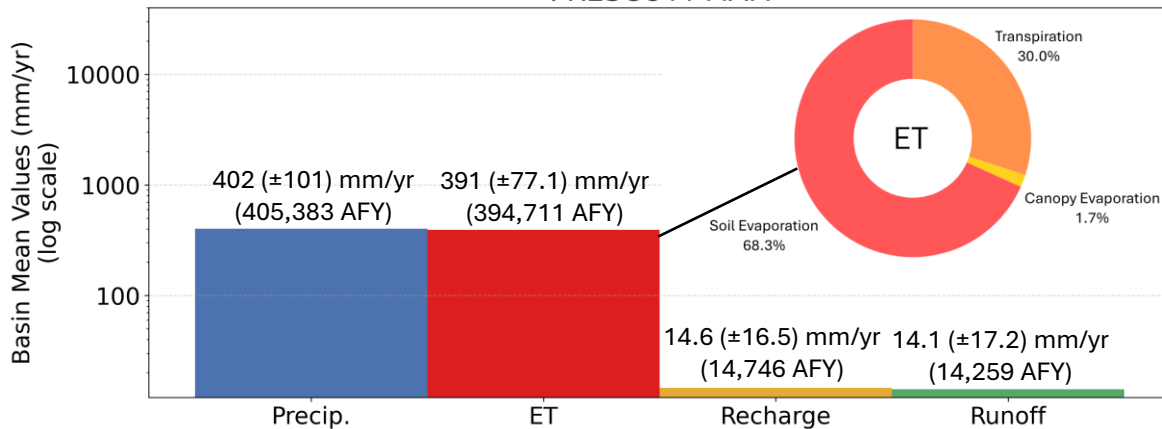
**Groundwater subbasins**<sup>1</sup>: Little Chino Valley, Upper Agua Fria

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.36** (Moderate)

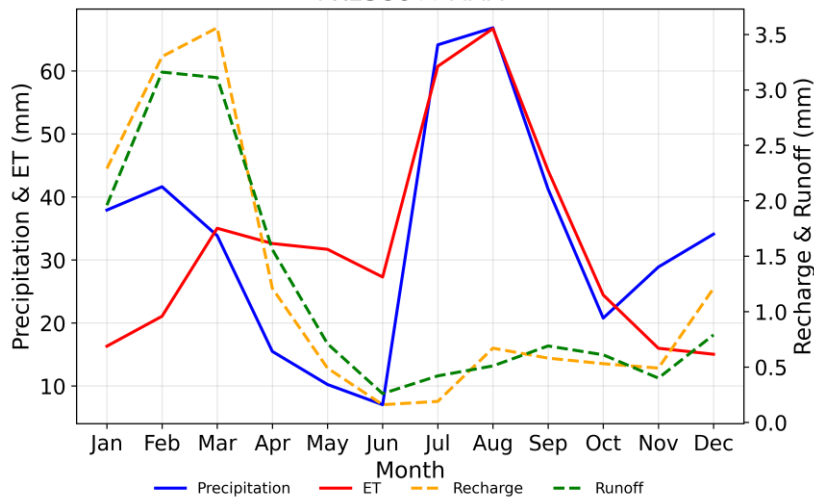


Mean Annual Hydrologic Cycle Components (1980-2020)  
PRESCOTT AMA



**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.<sup>6</sup> 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)  
PRESCOTT AMA



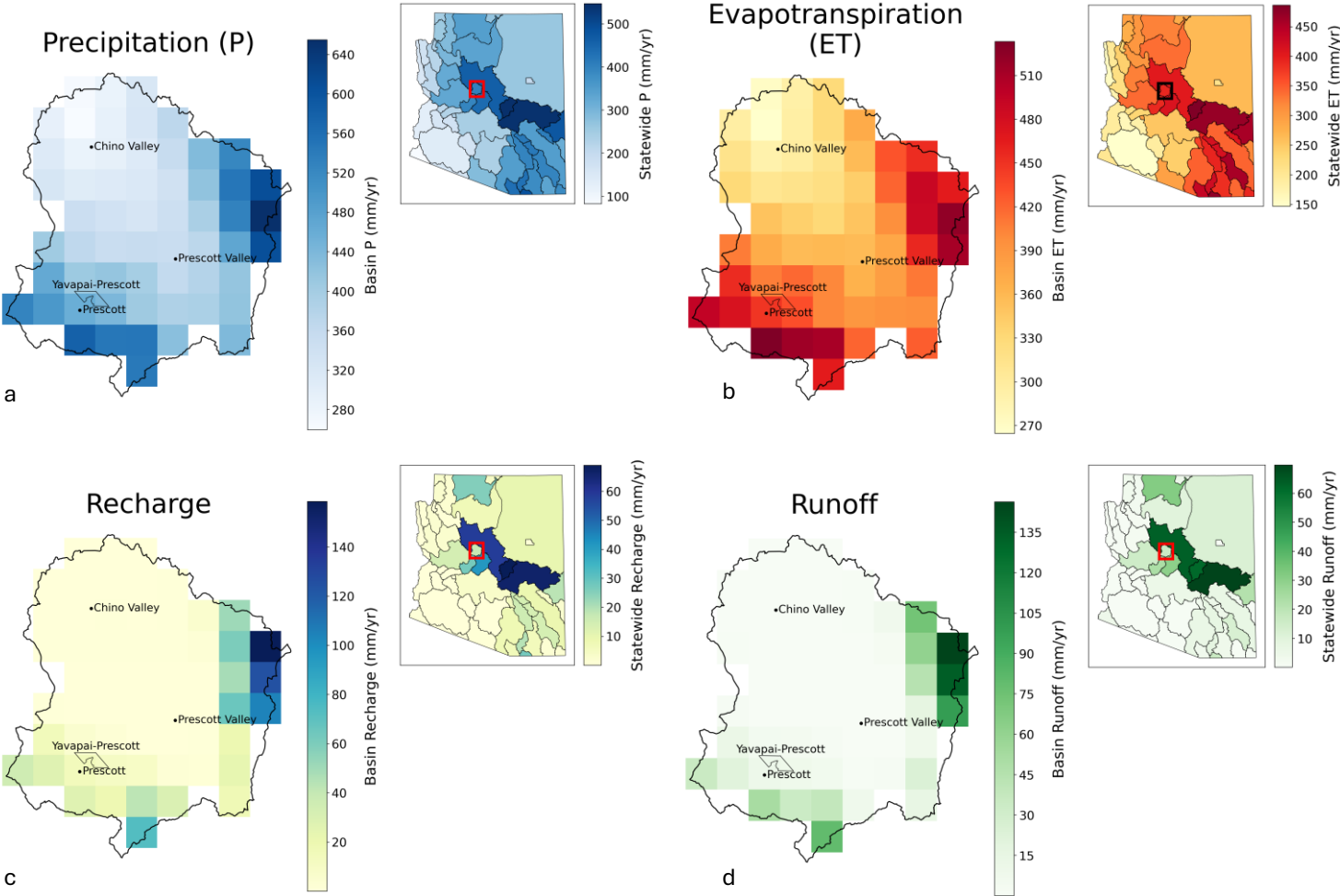
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Prescott AMA is affected by the North American Monsoon during the summer months. On annual timescales, P exceeds evapotranspiration (ET); however, ET exceeds P seasonally from March to mid-June by as much as 20 mm (in May). Soil evaporation makes up 68.3% of total ET, while transpiration comprises 30.0% and canopy evaporation accounts for the remainder (1.7%). Natural recharge (14.6 mm/yr) and runoff (14.1 mm/yr) peak in March due to springtime snowmelt.

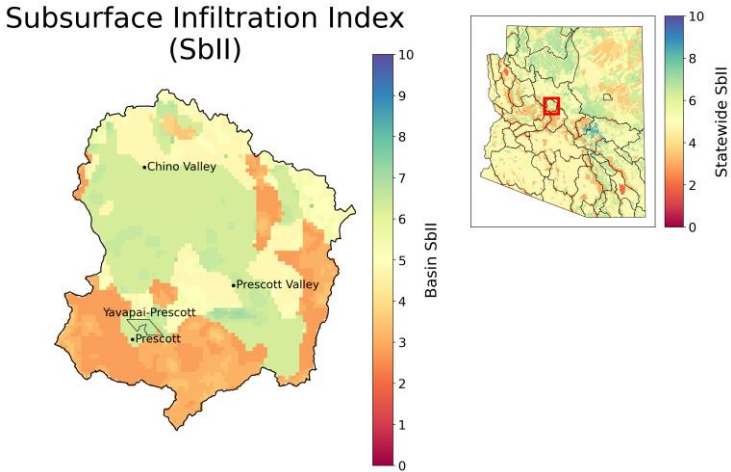
# Prescott AMA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



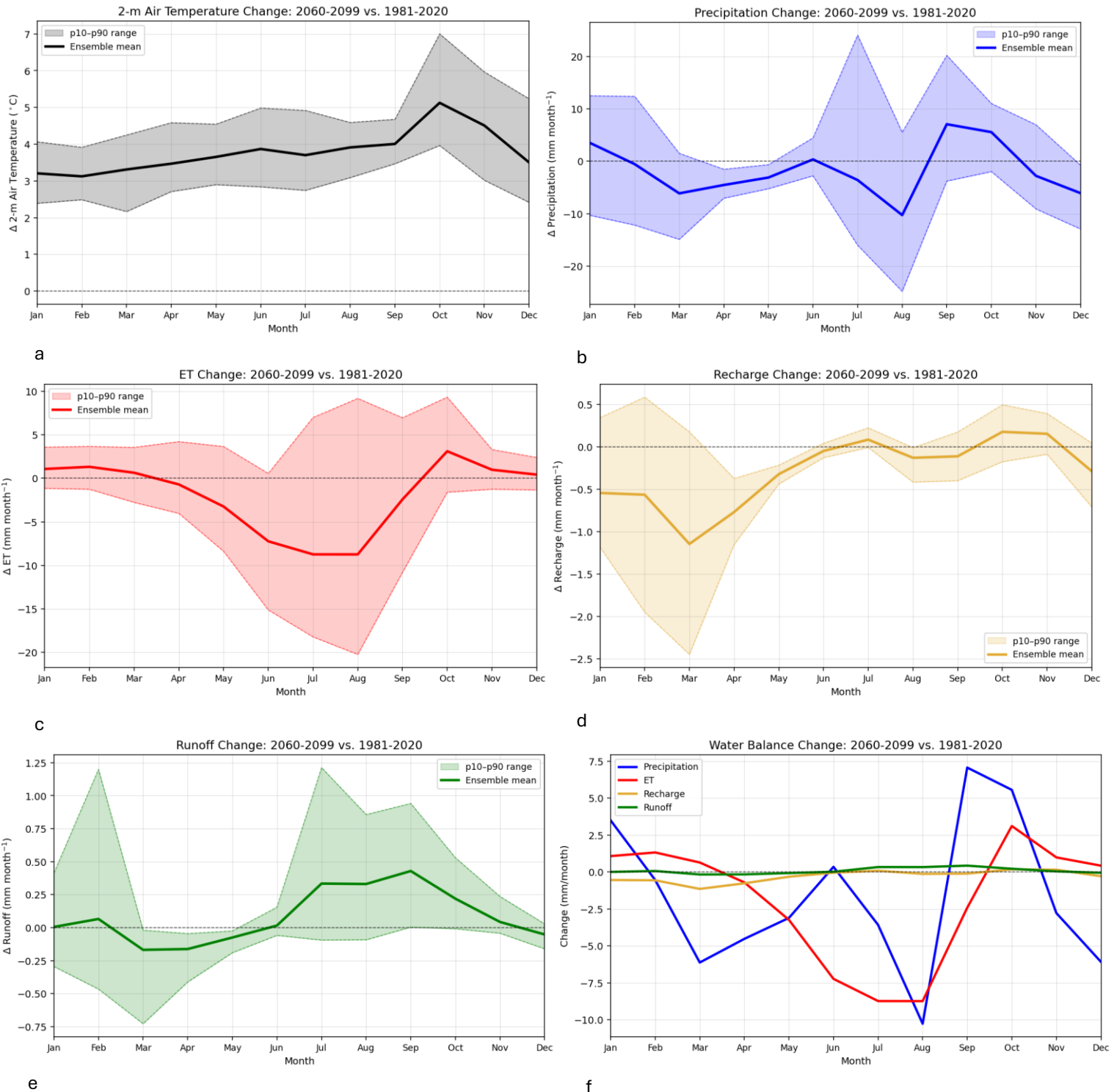
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Prescott AMA is greatest in the Bradshaw Mountains to the south and the Black Hills to the east where P can exceed 600 mm/yr on average. Evapotranspiration (ET, ~500 mm/yr), natural recharge (~100 mm/yr) and runoff (~100 mm/yr) are also highest in these high elevation regions. Infiltration potential varies across the basin, with the areas of highest potential along alluvial fan deposits to the east and west of Granite Creek.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Prescott AMA show drier springs (18-32% drier March through May) and a drier July (5%), August (15%), November (11%), and December (18%). September and October are projected to be 17-24% (5.4-6.9 mm) 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 are projected for most months of the year, with declines of 26-50% (-0.58 to -1.2 mm/month) in the highest recharge months (January-April). Slight increases in recharge are projected for July (0.09 mm)\*, October (0.17 mm), and November (0.15 mm). Runoff is projected to decrease by -0.07 to -0.17 mm/month March through May and increase by 0.22-0.43 mm/month from July through October. Projected increases in temperature range from approximately 3.2 °C in February to 5.2 °C in October. Less precipitation in July and August leads to a projected 13-14% (-8.7 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 12% (3.1 mm) increase in ET in October compared to the baseline period.

\*Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections are slightly negative (-0.01 mm) in July. 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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# Ranegras Plain Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 912 square miles

**Elevation<sup>2</sup>:** Range: 921-3,934 ft; Median: 1,402 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (94%), Barren Land (2.4%), Grassland Herbaceous (1.4%)

**Major surface watershed(s)<sup>4</sup>:** Bouse Wash

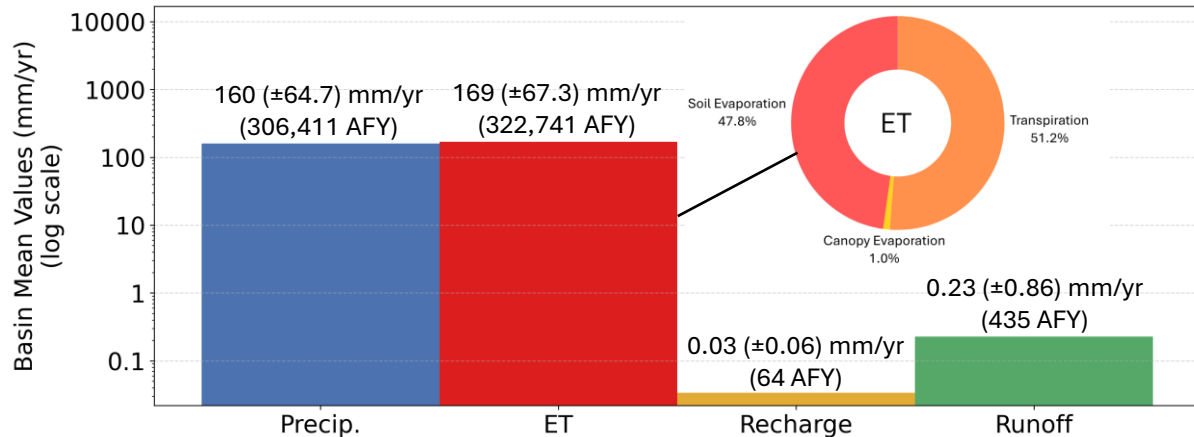
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.03** (Very Low)

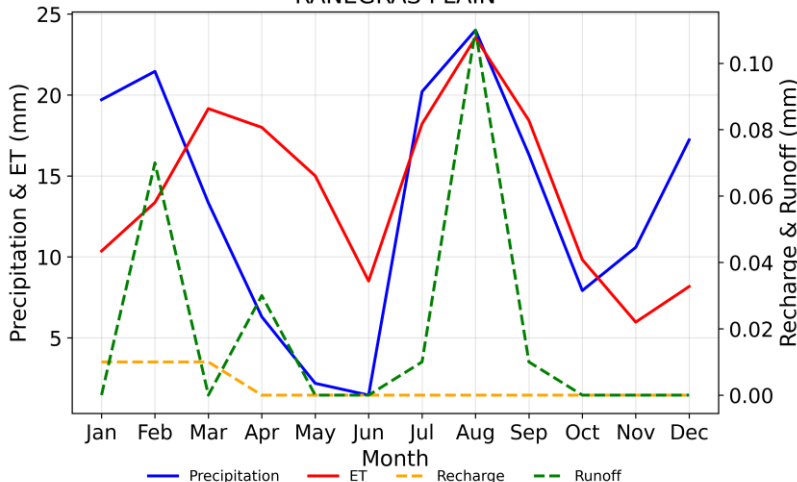


## Mean Annual Hydrologic Cycle Components (1980-2020) RANEGRAS PLAIN



**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.<sup>6</sup> 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) RANEGRAS PLAIN



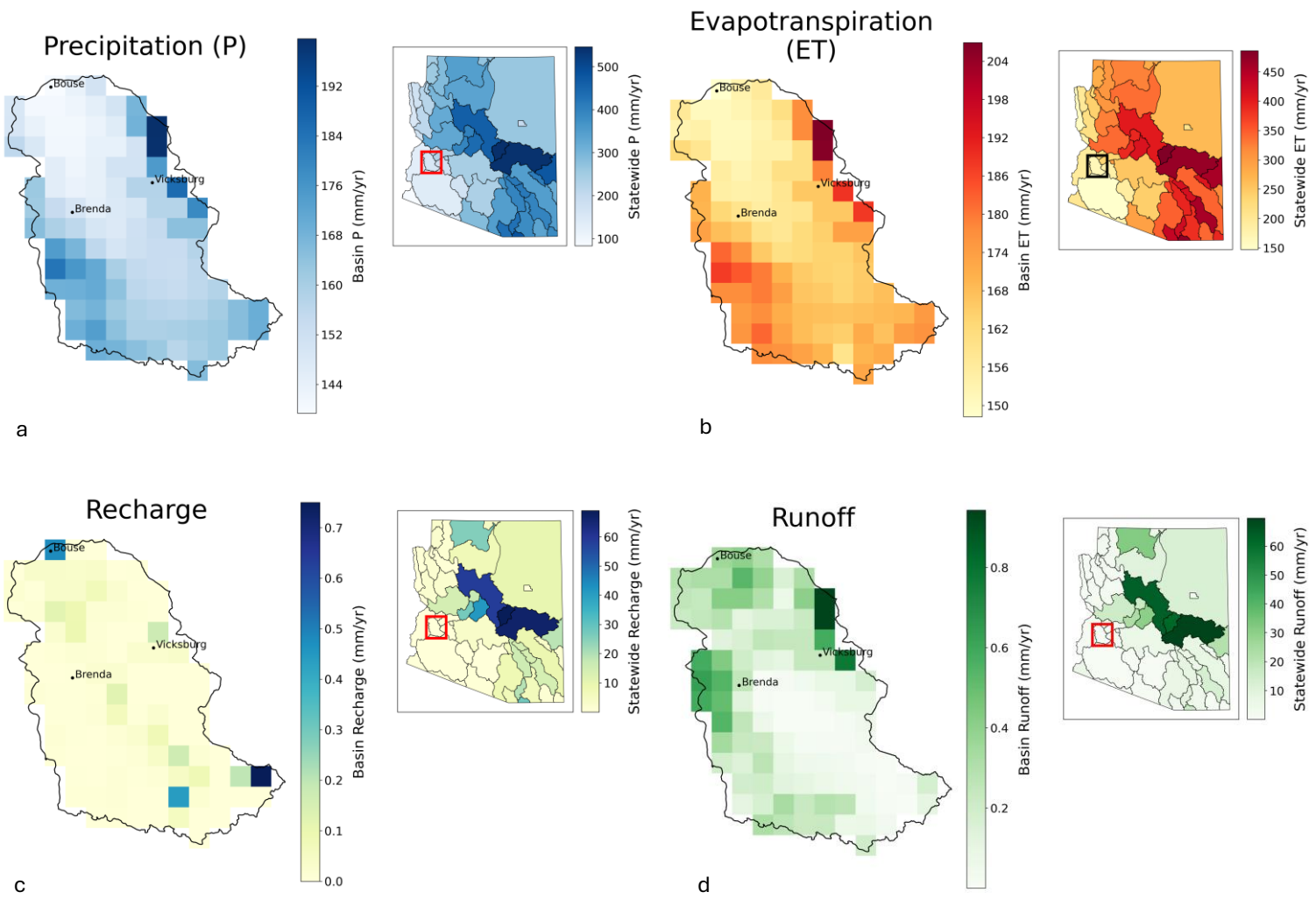
On annual timescales, evapotranspiration (ET) exceeds precipitation (P), resulting in near-zero values for natural recharge and runoff in the Ranegras Plain basin. P is affected by the North American Monsoon during the summer months and large frontal systems in the winter. ET exceeds P from March to June and tracks closely with P from June through October. Soil evaporation makes up 47.8% of total ET, while transpiration comprises 51.2% and canopy evaporation accounts for the remainder (1.0%).

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

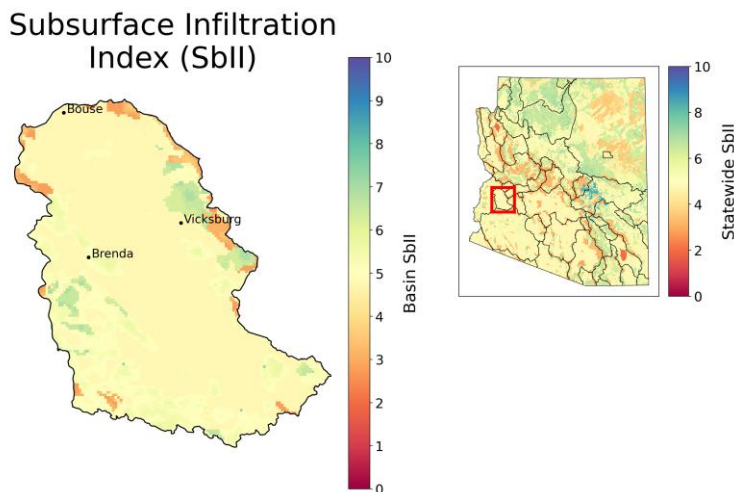
# Ranegras Plain



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

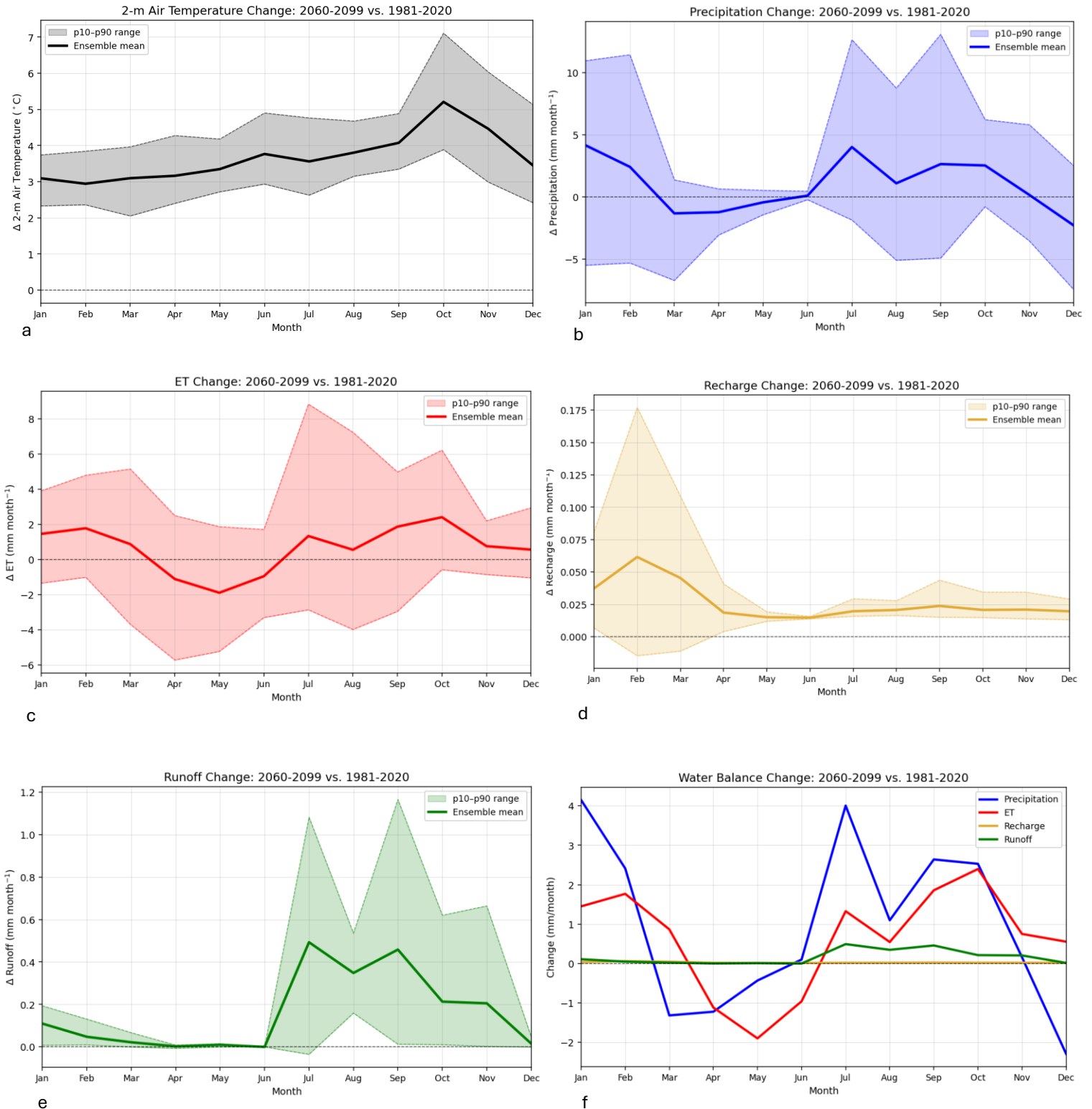


Precipitation (P) in the Ranegras Plain basin is greatest in the higher elevations of the basin, particularly in the Granite Wash Mountains northeast of Vicksburg. Both P and evapotranspiration (ET) can exceed 190 mm/yr on average in this region. Natural recharge and runoff are minimal (less than 1.0 mm/yr) across the basin. The Ranegras Plain basin generally has moderate infiltration potential; however, areas of higher infiltration potential are present in regions with karst-type geology in the Granite Wash Mountains to the northeast and the Plomosa Mountains to the west.

# Ranegras Plain



## Climatic 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Ranegras Plain basin show drier springs (9-23% drier March through May) and a drier December (13%). January-February (11-22%) and June-October (4-30%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.5-2.7 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (approximately -0.01 mm/month) from May through December.\* While runoff is projected to remain below 0.5 mm/month, minor increases of 0.21-0.47 mm/month are projected for July-November. Projected increases in temperature range from approximately 3.0 °C in February to 5.3 °C in October. Less precipitation in April and May leads to a projected 7-15% (-1.2 to -1.9 mm/month) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 24% (2.4 mm) increase in ET in October, a 14% (1.5 mm) increase in January, and a 12% (1.7 mm) increase in February 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

1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
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# Sacramento Valley Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 1,587 square miles

**Elevation**<sup>2</sup>: Range: 453-8,356 ft; Median: 2,620 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (95%), Evergreen Forest (3.0%), Developed – Low Intensity (0.63%)

**Major surface watershed(s)**<sup>4</sup>: Sacramento Wash

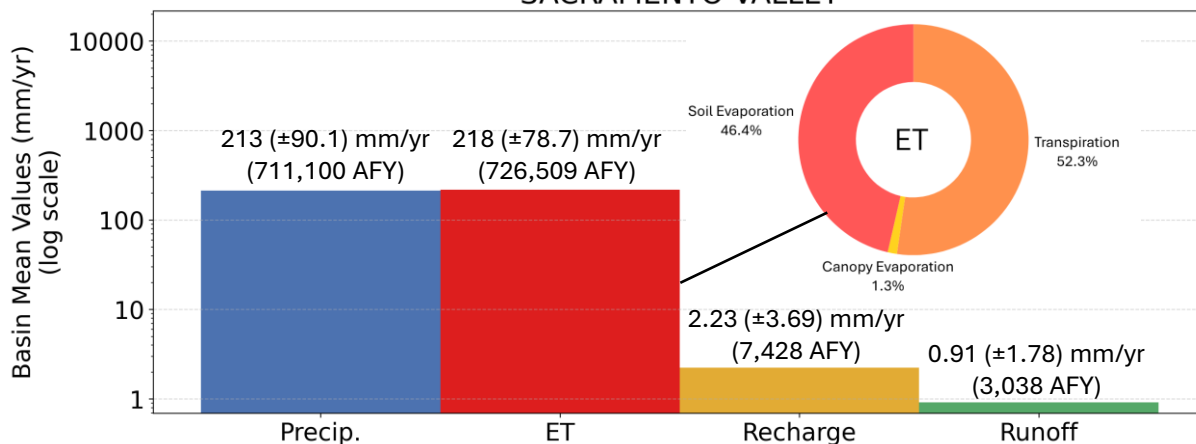
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.50** (Moderate)

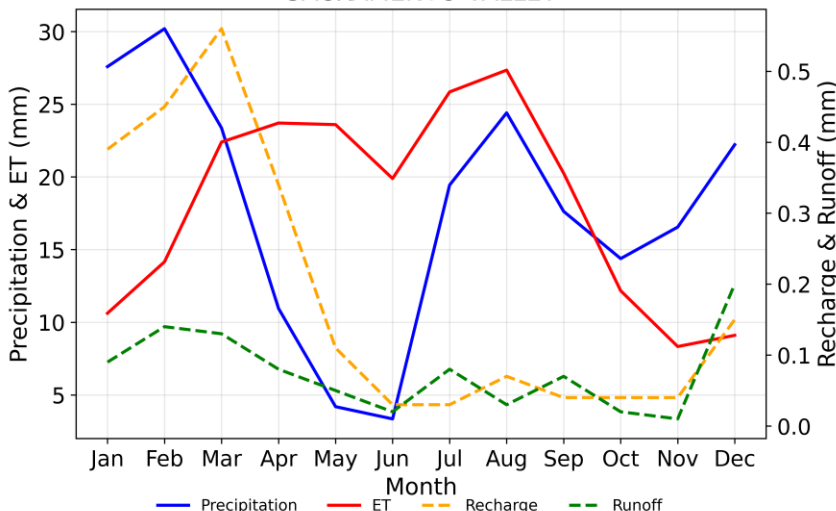


Mean Annual Hydrologic Cycle Components (1980-2020)  
SACRAMENTO VALLEY



**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.<sup>6</sup> 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)  
SACRAMENTO VALLEY



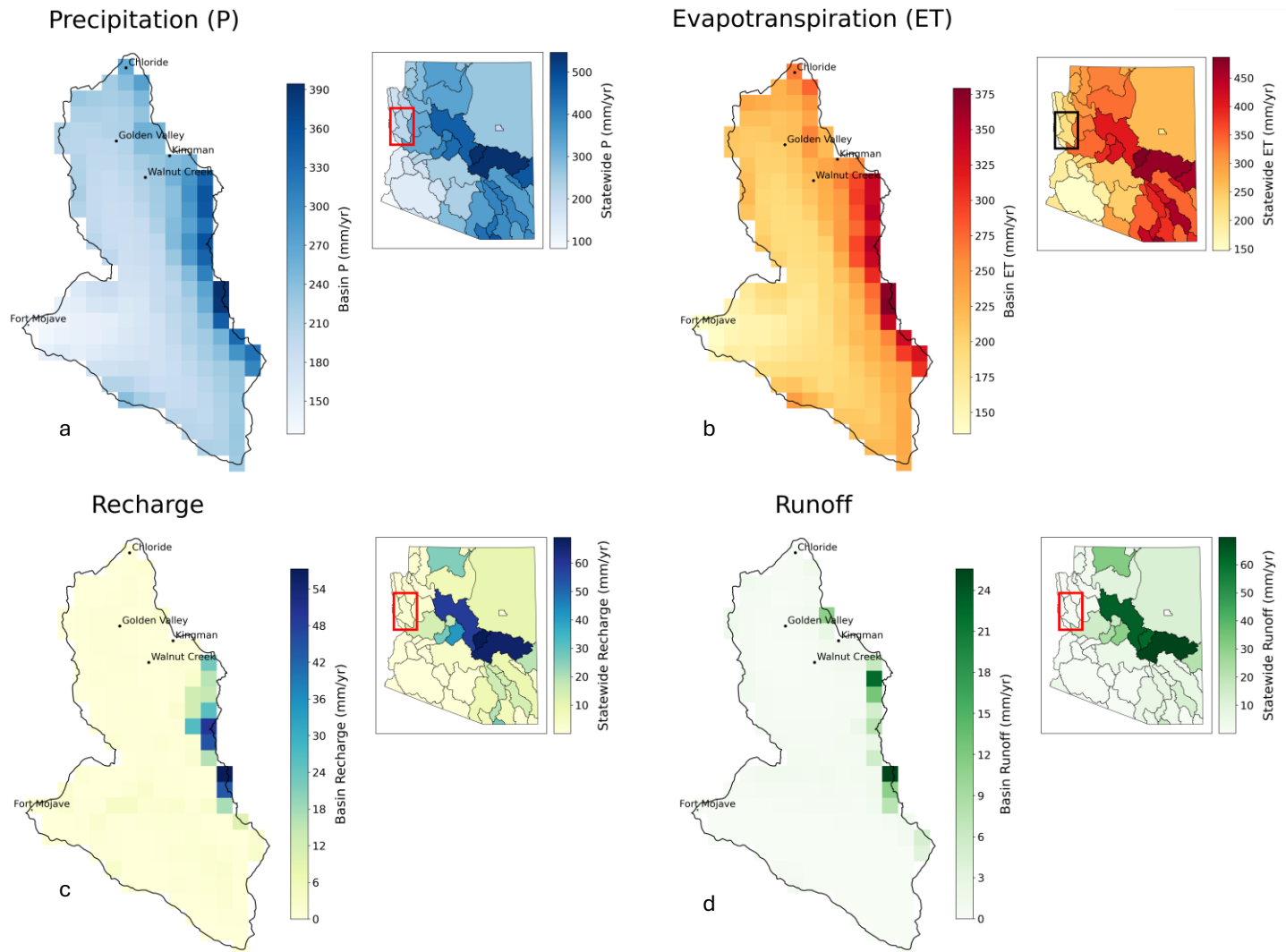
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Sacramento Valley basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. On annual timescales, evapotranspiration (ET) is approximately equal to P, resulting in low basin-wide averages of natural recharge (2.23 mm/yr) and runoff (0.91 mm/yr). Soil evaporation makes up 46.4% of total ET in the basin, while transpiration comprises 52.3% and canopy evaporation accounts for the remainder (1.3%). Natural recharge is slightly higher in the cooler months when P exceeds ET.

# Sacramento Valley

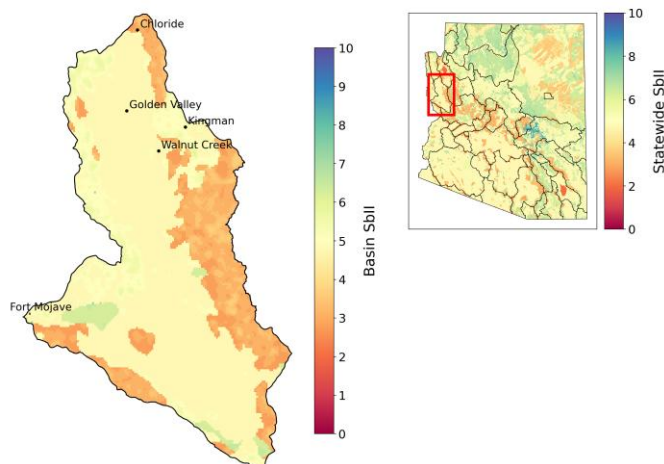


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

## Subsurface Infiltration Index (SbII)

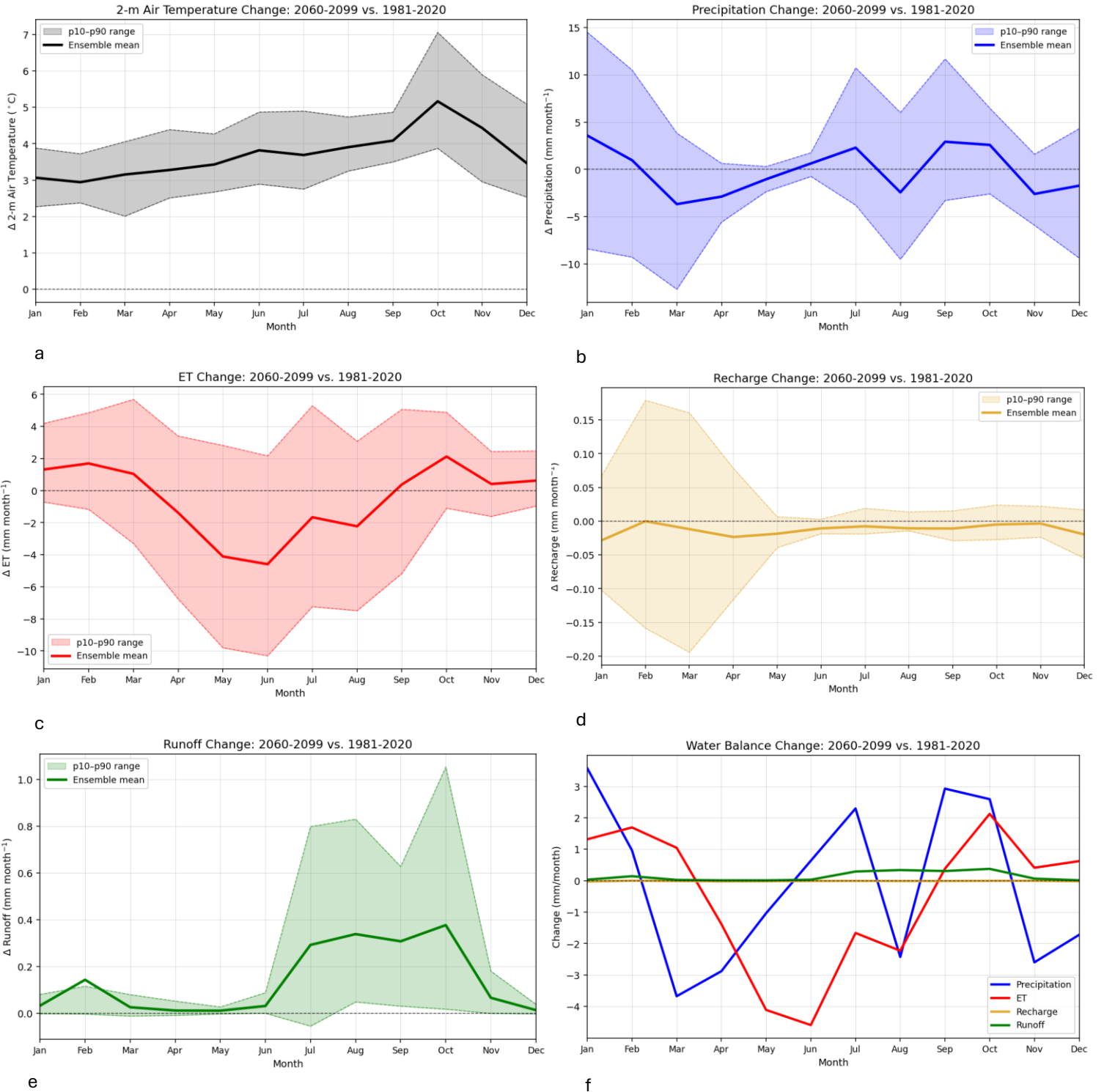


Precipitation (P) in the Sacramento Valley basin is greatest at the higher elevations, particularly in the Hualapai Mountains where P can exceed 360 mm/yr on average. ET (~350 mm/yr), natural recharge (~50 mm/yr), and runoff (~15 mm/yr) are also highest in this region. Infiltration potential varies across the basin. The area of highest infiltration potential results from higher permeability soils in the alluvial fans along the Sacramento Wash just south of the Warm Springs Wilderness in the eastern portion of the basin.

# Sacramento Valley



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Sacramento Valley basin show drier springs (14-28% drier March through May), and a drier August (9%), November (17%), and December (7%). July, September, and October are projected to be 12-17% (2.4-2.9 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. Natural recharge is projected to remain near zero throughout the year, and slightly negative from June through November (-0.01 to -0.02 mm/month).<sup>\*</sup> While runoff is projected to remain below 0.6 mm/month, minor increases of 0.3-0.4 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.0 °C in February to 5.2 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 16% (2.1 mm) increase in evapotranspiration (ET) in October and 12% (1.3 mm) in January compared to the baseline period, while less water availability in August leads to a projected decline in ET (9% or -2.2 mm).

<sup>\*</sup>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.

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# Safford Groundwater Basin Profile

## Basin Summary Statistics

**Size**<sup>1</sup>: 4,750 square miles

**Elevation**<sup>2</sup>: Range: 2,464-10,702 ft; Median: 3,959 ft

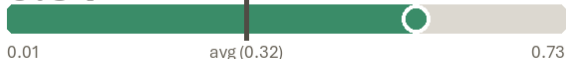
**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (88%), Evergreen Forest (6.0%), Grassland Herbaceous (1.9%)

**Major surface watershed(s)**<sup>4</sup>: Gila, San Carlos, and San Simon Rivers

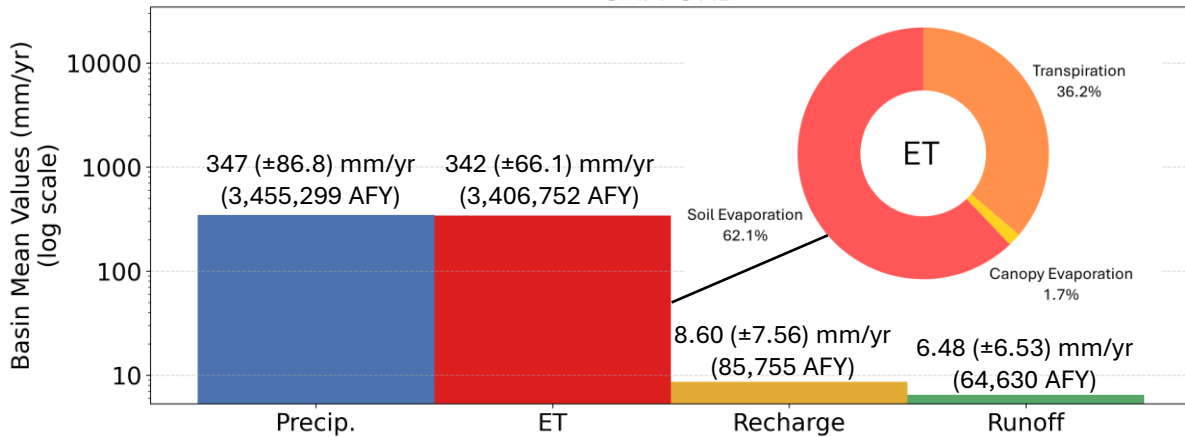
**Groundwater subbasins**<sup>1</sup>: Gila Valley, San Carlos Valley, and San Simon Valley

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.54** (High)

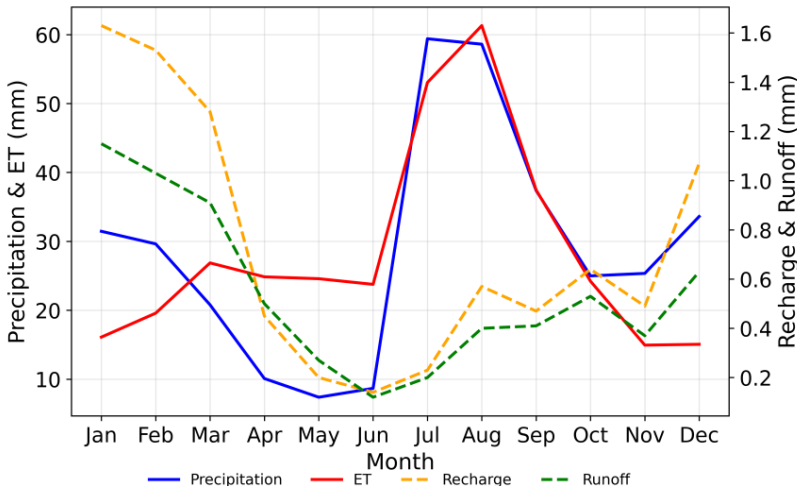


Mean Annual Hydrologic Cycle Components (1980-2020)  
SAFFORD



**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.<sup>6</sup> 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)  
SAFFORD



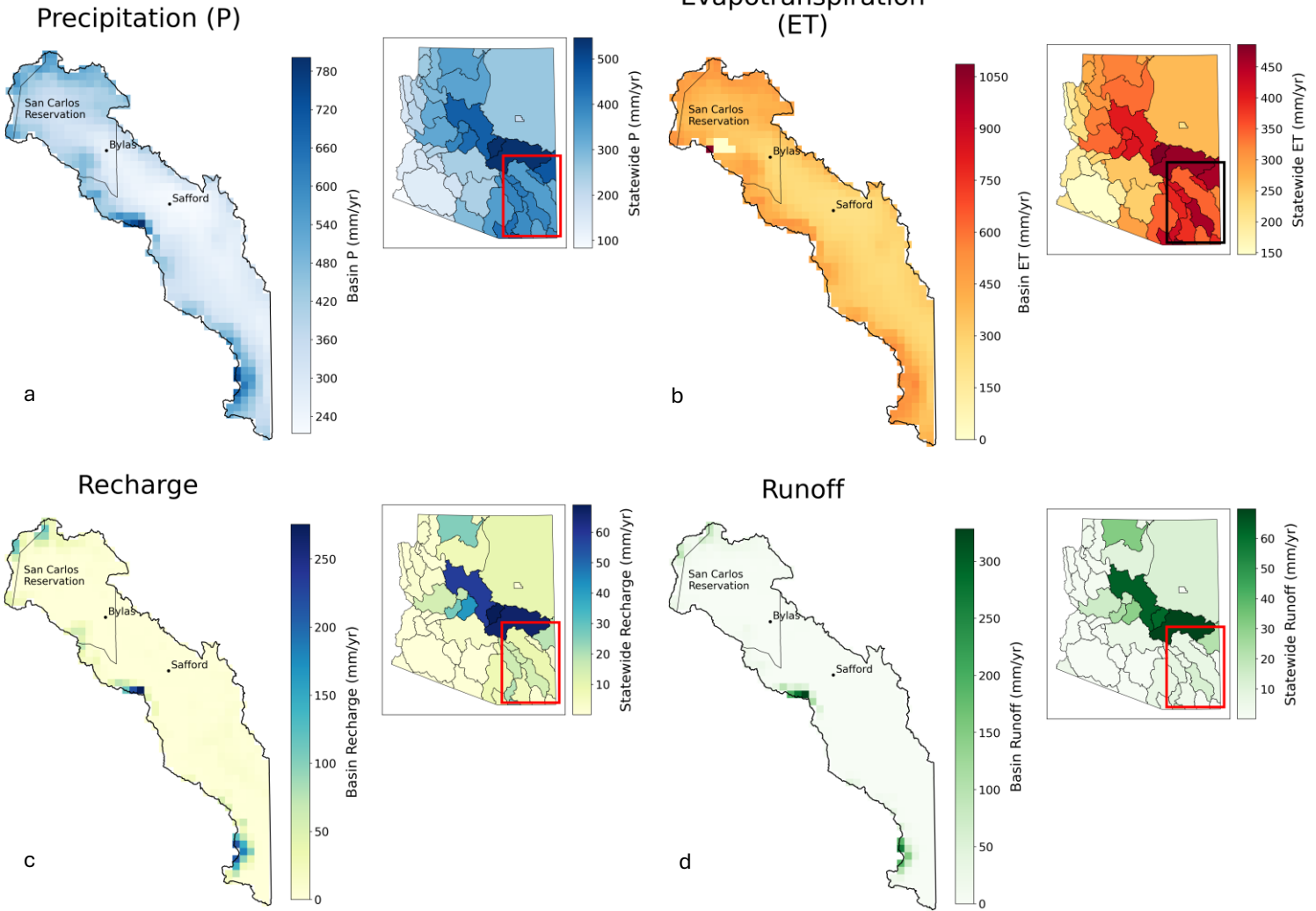
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in relatively low basin-wide annual averages for natural recharge (8.60 mm) and runoff (6.48 mm). P in the Safford basin is affected by the North American Monsoon during the summer months. ET is approximately equal to P during these months due to enhanced water availability. ET exceeds P from mid-February through mid-June. Soil evaporation makes up 62.1% of total ET in the basin, while transpiration comprises 36.2% and canopy evaporation accounts for the remainder (1.7%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months.

# Safford

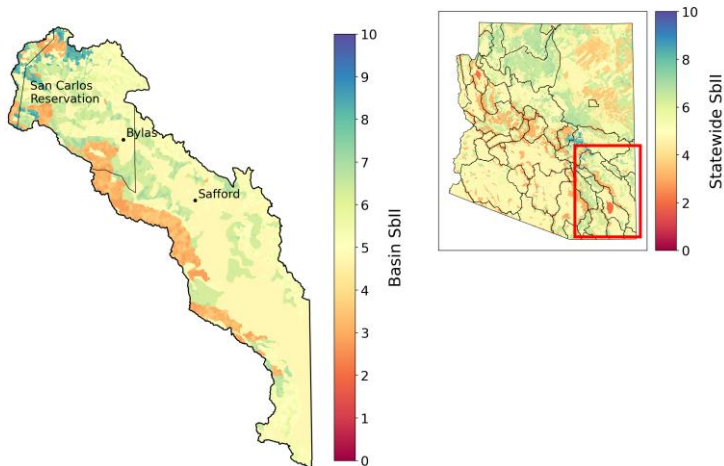


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

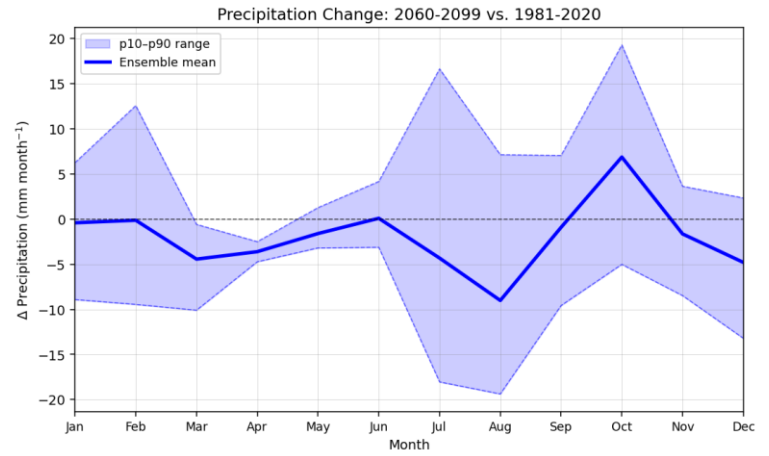
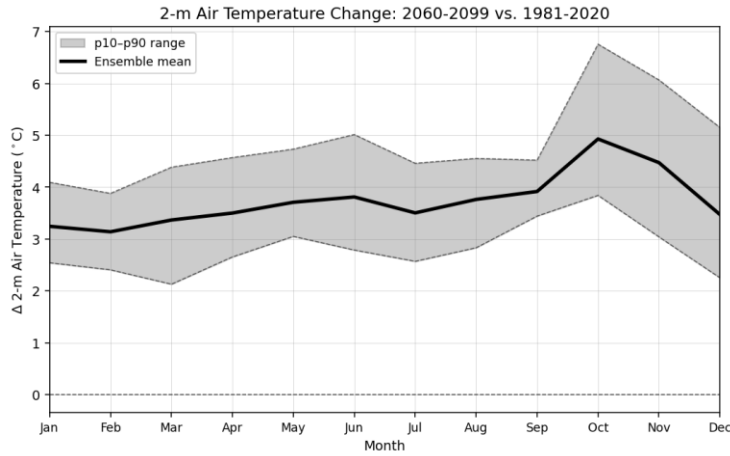
## Subsurface Infiltration Index (SbII)



The Sky Island regions of Mt. Graham and the Chiricahua Mountains account for the highest precipitation in the Safford basin, each receiving over 750 mm/year. These high elevation forests also account for the highest evapotranspiration in the basin, particularly during the summer months. Natural recharge and runoff are higher near these regions than elsewhere in the basin (over 200 mm/year and 300 mm/year at Mt. Graham, respectively). Infiltration potential is greatest in the northwestern portion of the Safford basin due to high permeability soils in that area.

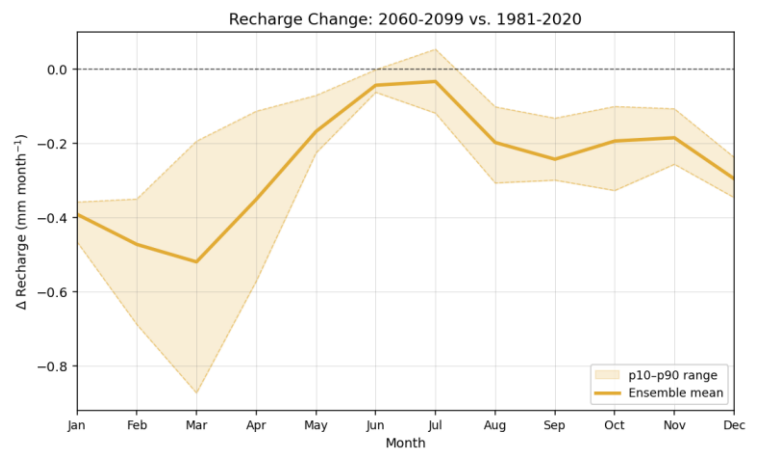
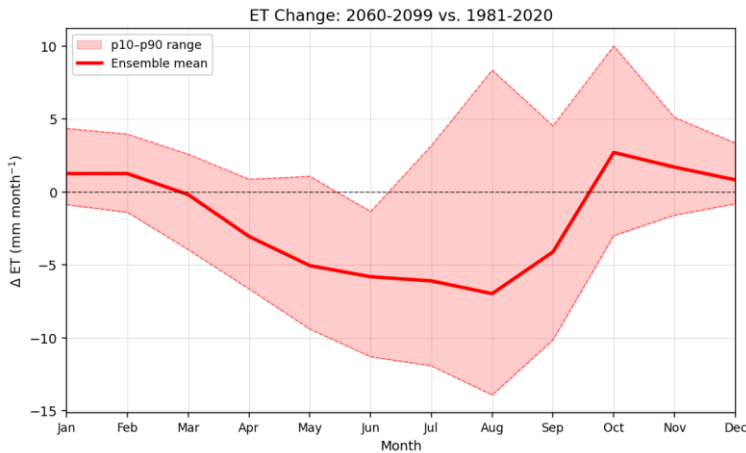


### Climate Change Projections: Changes in Temperature, Precipitation, ET, Recharge, and Runoff (2060-2099 vs. 1981-2020)



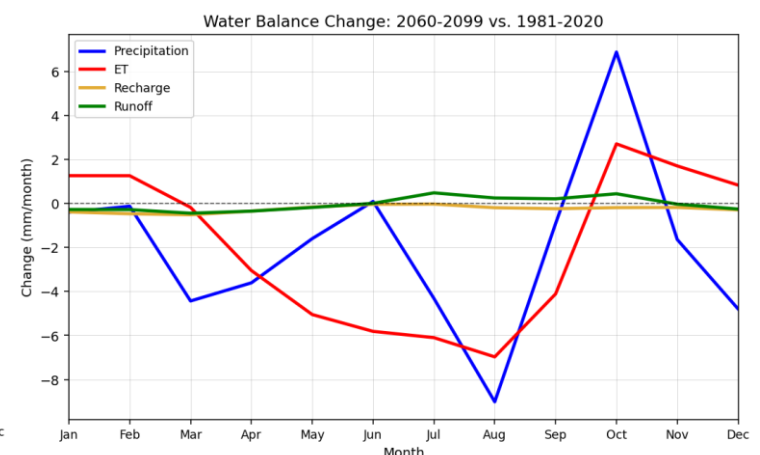
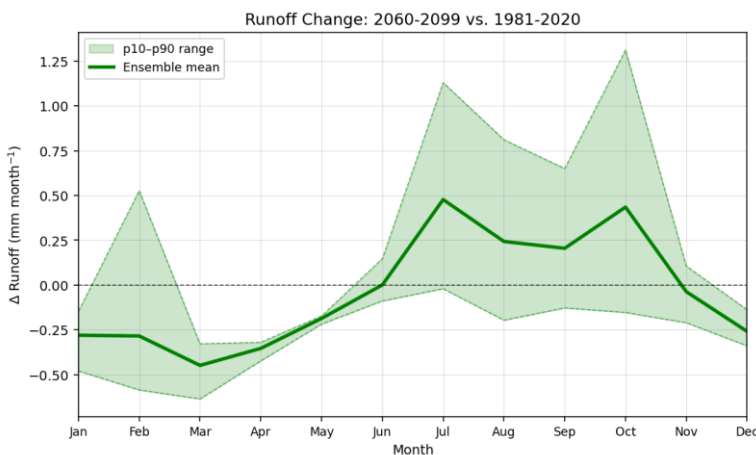
a

b



c

d



e

f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Safford basin show drier springs (20-39% drier March through May), a drier July-August (7-15%), and a drier November-December (7-13%). October is projected to be 26% (6.9 mm) 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. Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (January-April) showing declines of 55-76% (-0.35 to -0.52 mm/month). Recharge projections are slightly negative (-0.02 to -0.14 mm/month) from June to November.\* Runoff is projected to decline 45-77% in January-April (-0.28 to -0.45 mm/month) and 13-71% in November-December (-0.03 to -0.26 mm/month). From July through October, runoff is projected to increase by 0.21 to 0.48 mm/month. Projected increases in temperature range from approximately 3.2 °C in February to 5.0 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 11% (2.6 mm) increase in evapotranspiration (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.

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# Salt River Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 5,230 square miles

**Elevation<sup>2</sup>:** Range: 1,485-11,417 ft; Median: 5,773 ft

**Top 3 land cover types by area<sup>3</sup>:** Evergreen Forest (51%), Shrub/Scrub (43%), Grassland Herbaceous (2.5%)

**Major surface watershed(s)<sup>4</sup>:** Salt River, Black River, White River, Carrizo Creek

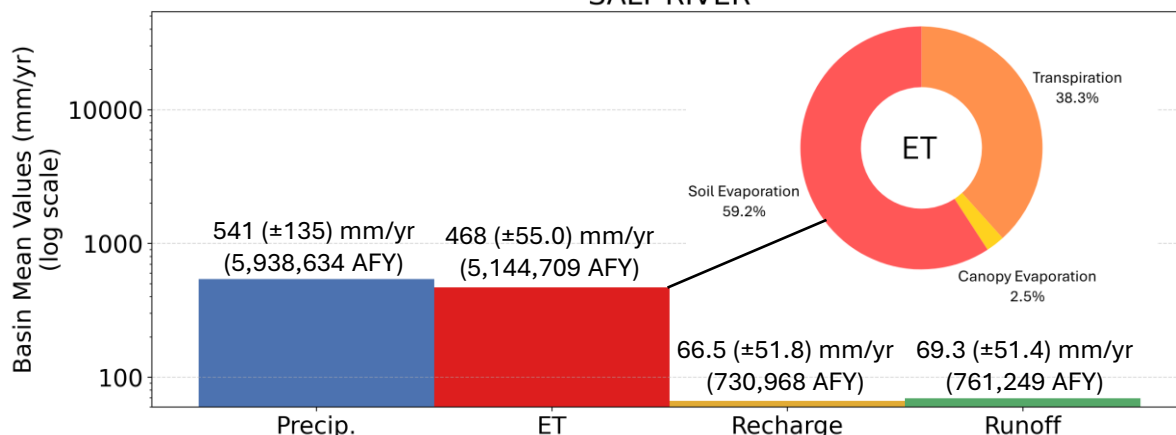
**Groundwater subbasins<sup>1</sup>:** Salt River Canyon, Black River, White River, Salt River Lakes

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.46** (Moderate)

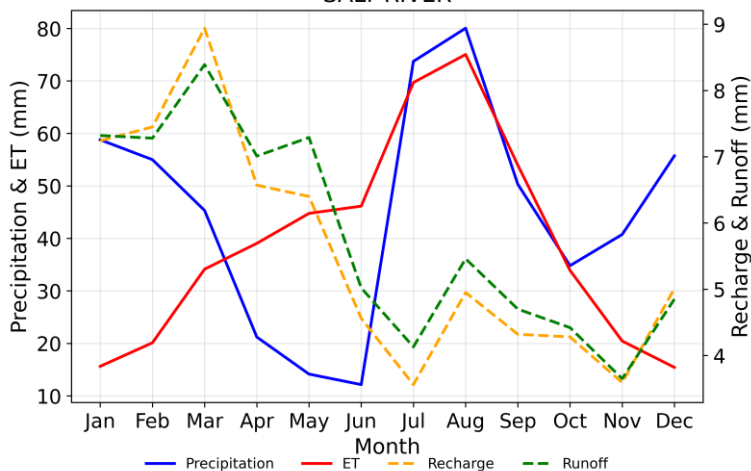


Mean Annual Hydrologic Cycle Components (1980-2020)  
SALT RIVER



**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.<sup>6</sup> 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)  
SALT RIVER



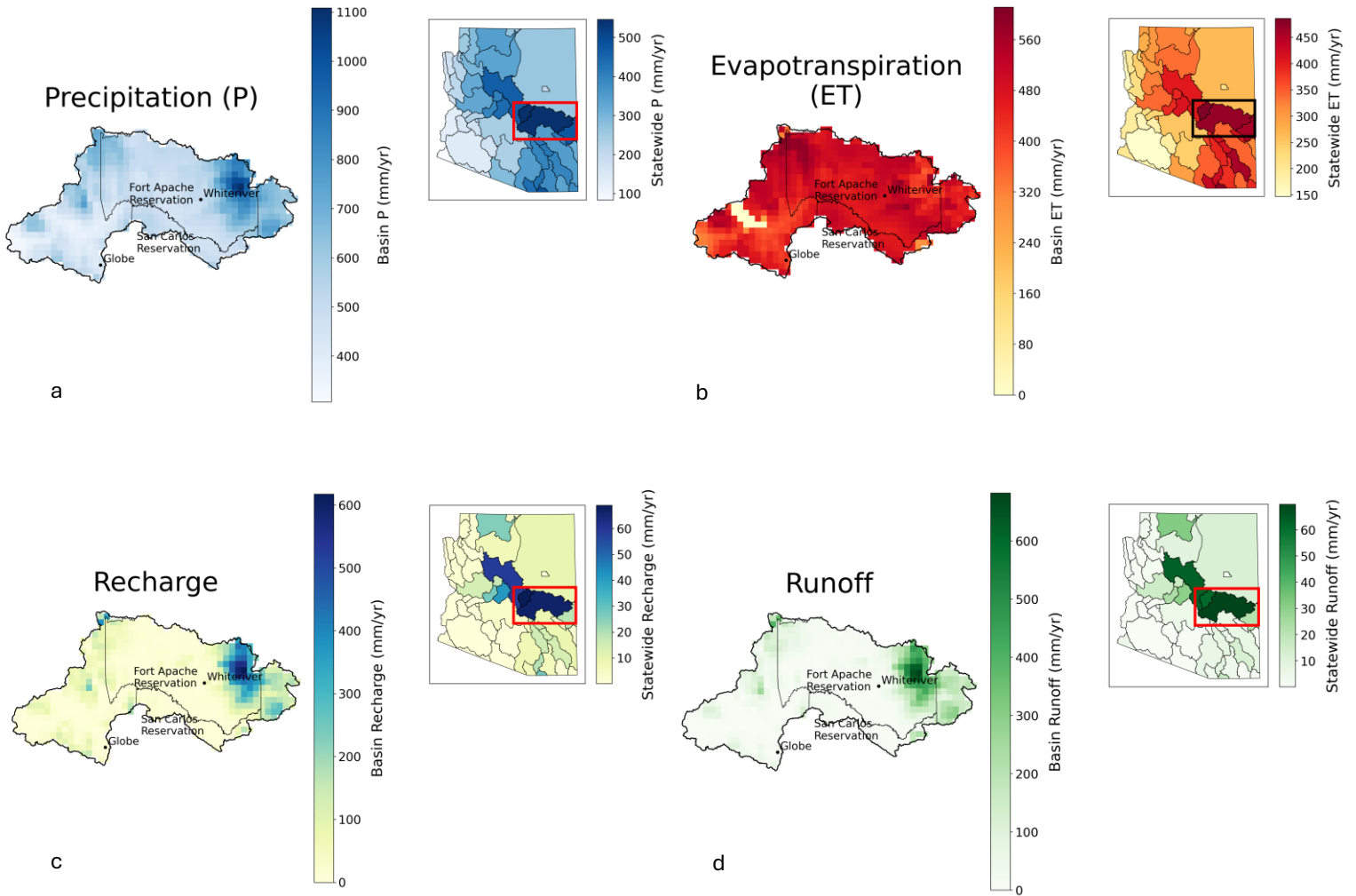
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Salt River 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 July. Soil evaporation makes up 59.2% of total ET in the basin, while transpiration comprises 38.3% and canopy evaporation accounts for the remainder (2.5%). The Salt River basin has the second highest average annual natural recharge (66.5 mm/yr) and the highest runoff (69.3 mm/yr) in the state. Natural recharge and runoff peak in March due to springtime snowmelt.

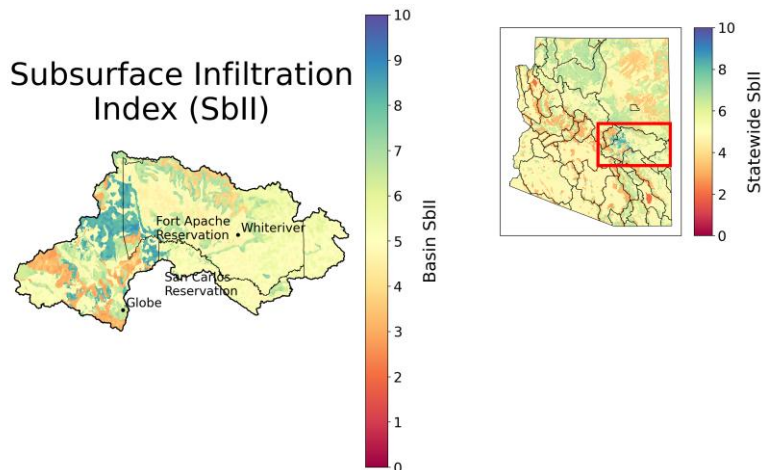
# Salt River



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



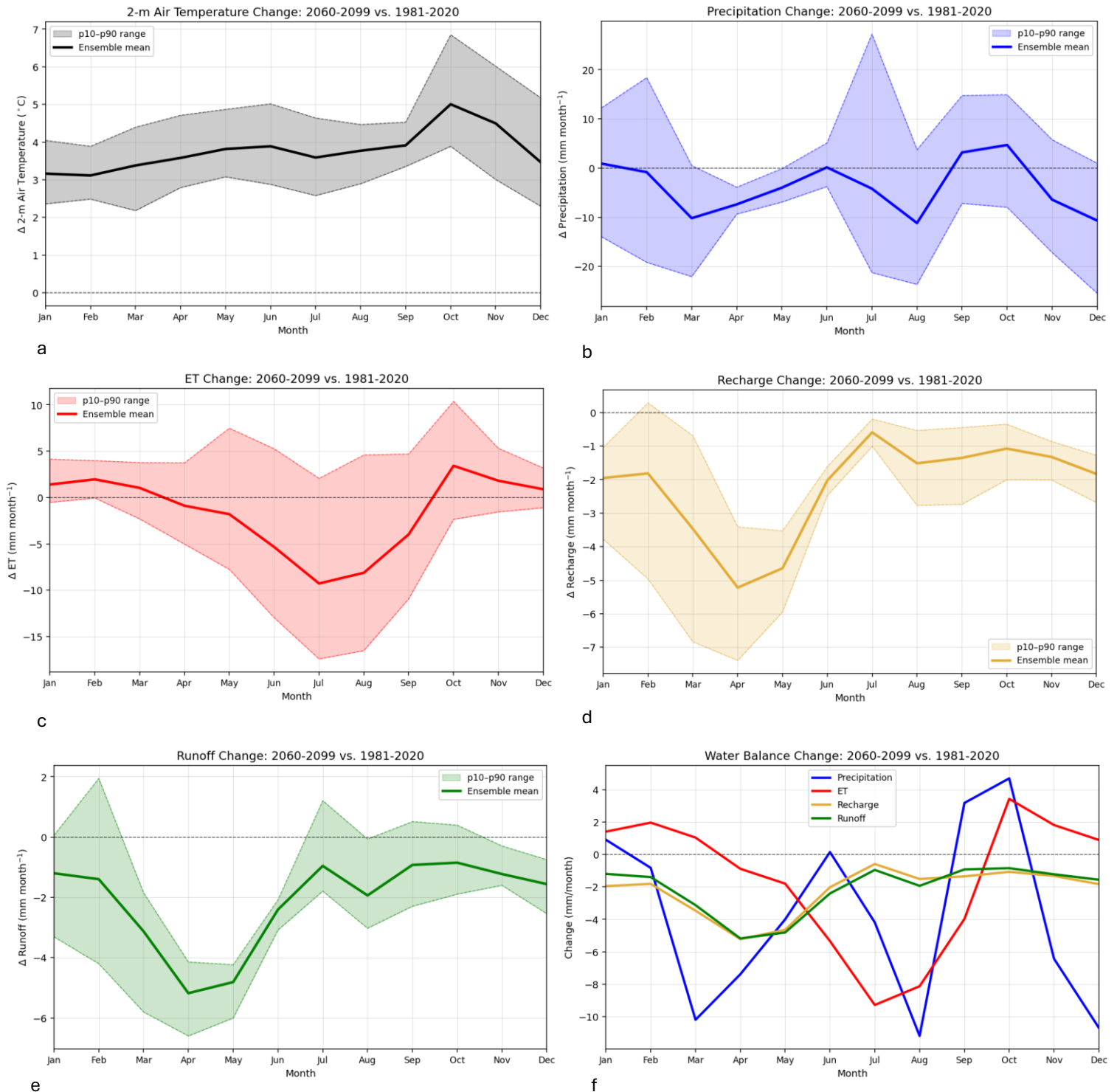
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Natural recharge is greatest in the far eastern portion of the basin, exceeding 500 mm/year near the White Mountains. Most of the basin's runoff is generated in the White Mountains, with additional runoff generated in the Sierra Anchas and Mogollon Rim to the west and northwest. Infiltration potential is greatest in the Sierra Anchas in northwestern portion of the Upper Salt watershed due to presence of karst-type geology and faulting in that region, as well as alluvial deposits along the Salt 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Salt River basin show drier springs (21-38% drier March through May), a drier July-August (6-13%), and a drier November-December (17-19%). September and October are projected to be 6-13% (2.9-4.9 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. Declines in natural recharge are projected for all months of the year, with projections in the highest recharge months (February-May) showing declines of 30-71% (-1.9 to -5.3 mm/month). Recharge projections are slightly negative (-0.25 mm) in July.\* Runoff is projected to decrease in all months of the year, with 27-71% (-1.5 to -5.2 mm/month) declines in the highest runoff months (February-May). Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 10% (3.4 mm) increase in evapotranspiration (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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# San Bernardino Valley Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 387 square miles

**Elevation**<sup>2</sup>: Range: 3,704-6,529 ft; Median: 4,481 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (97.6%), Evergreen Forest (1.8%), Woody Wetlands (0.29%)

**Major surface watershed(s)**<sup>4</sup>: San Bernardino River

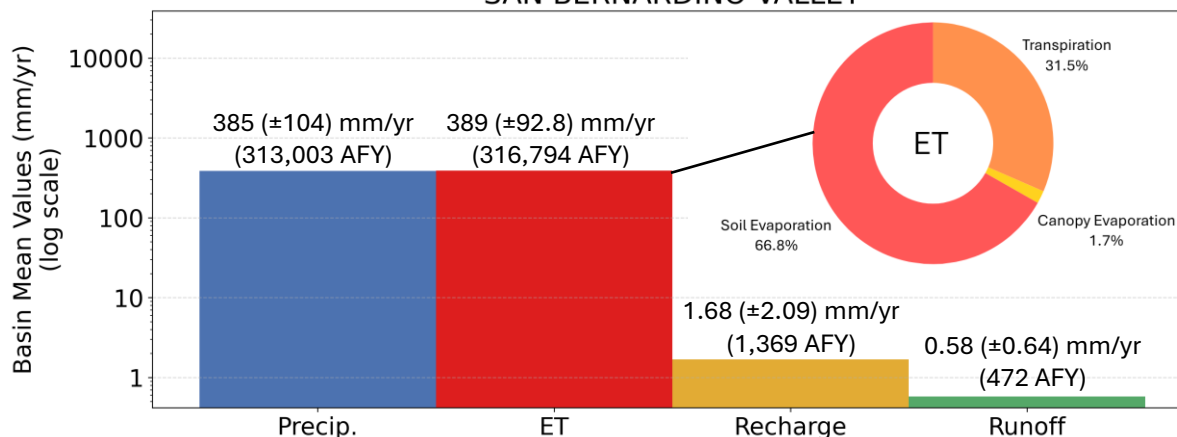
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.65** (High)

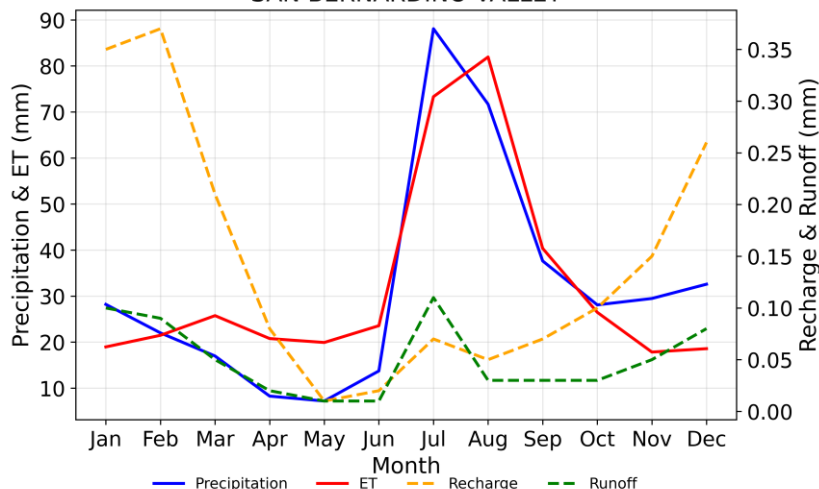


Mean Annual Hydrologic Cycle Components (1980-2020)  
SAN BERNARDINO VALLEY



**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.<sup>6</sup> 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)  
SAN BERNARDINO VALLEY



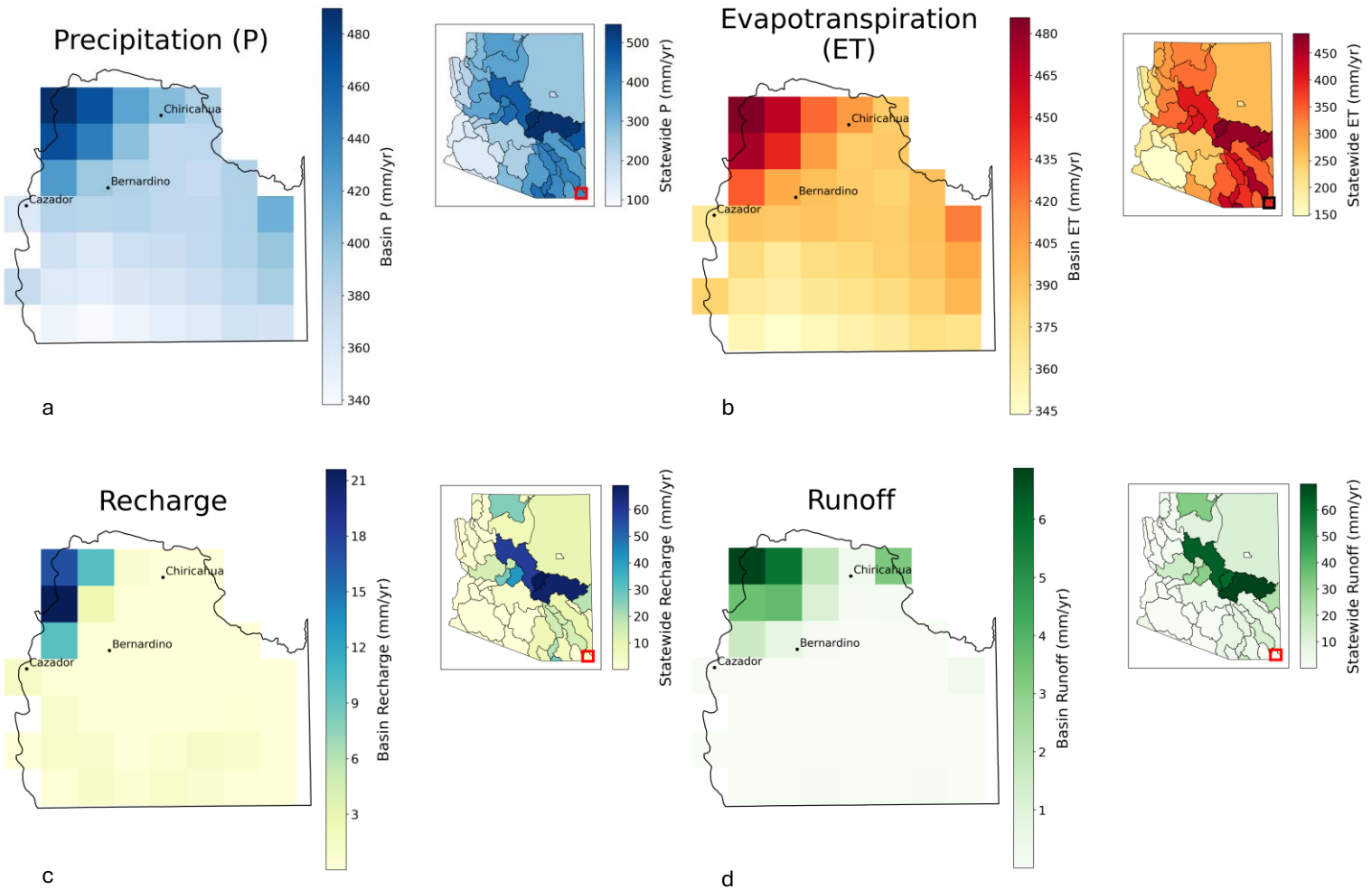
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (1.68 mm) and runoff (0.58 mm). P in the San Bernardino Valley is affected by the North American Monsoon during the summer months. ET tracks with P from June through October and exceeds P from February to June by as much as ~10 mm on average (in May). Soil evaporation makes up 66.8% of total ET in the basin, while transpiration comprises 31.5% and canopy evaporation accounts for the remainder (1.7%).

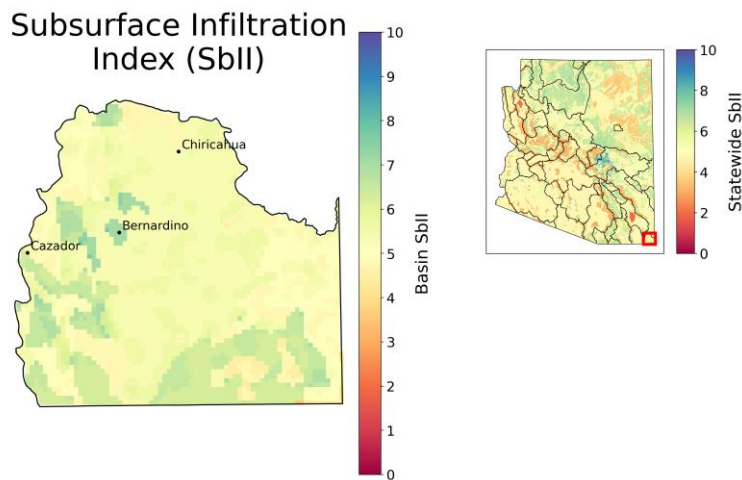
# San Bernardino Valley



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

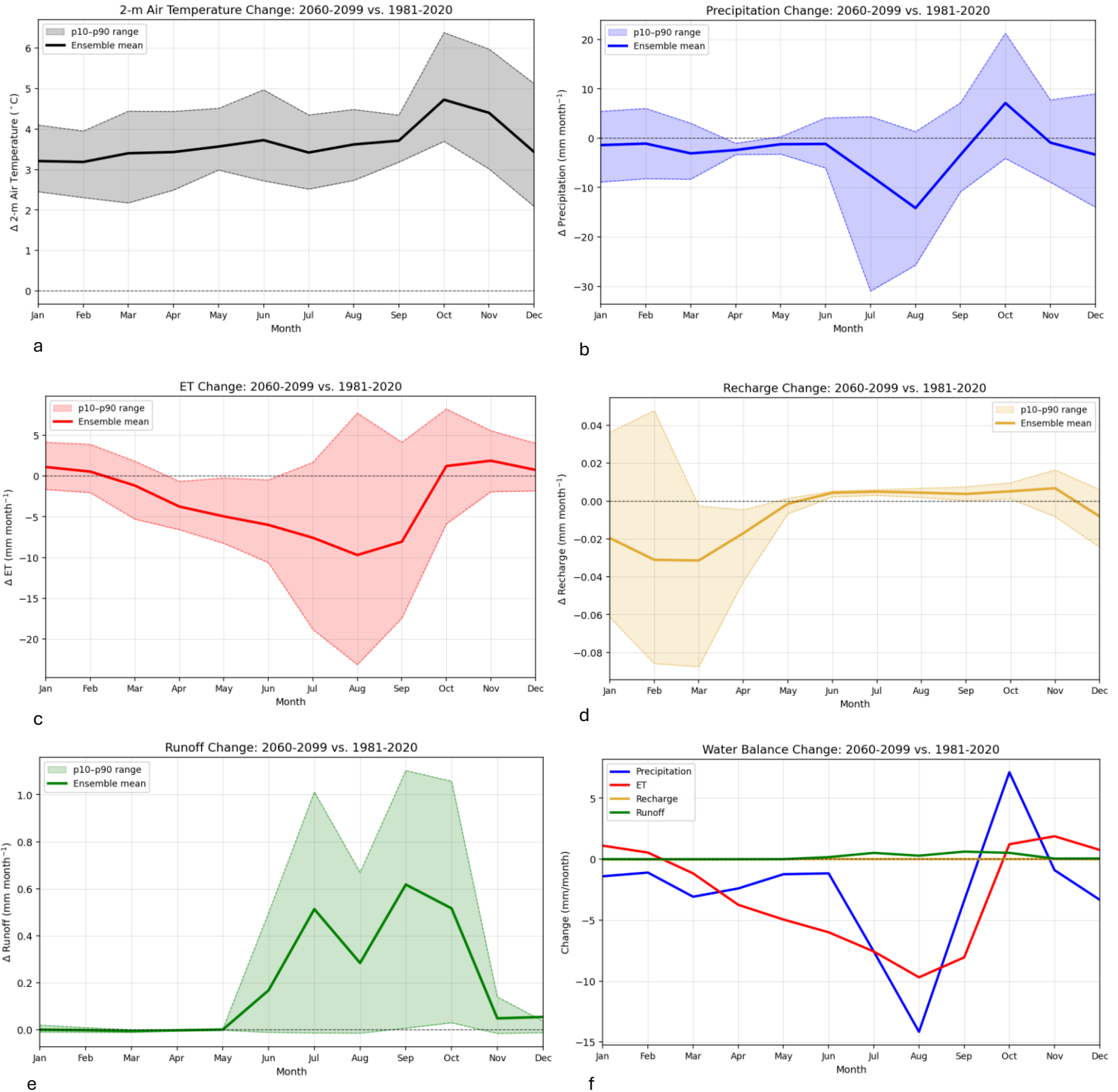


Precipitation (P) in the San Bernardino Valley is greatest to the northwest of the basin in the Pedregosa Mountains, where P can exceed 460 mm/yr. ET (~470 mm/yr), natural recharge (~20 mm/yr), and runoff (~5 mm/yr) are also highest in this region of the basin. Infiltration potential is relatively high across the basin; however, the southern and western portions of the basin have pockets of greater infiltration potential due to the presence of alluvial deposits and karst-type geology in those areas.

# San Bernardino Valley



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the San Bernardino Valley show that most of the year will be drier (3-36%) compared to the baseline, except for October, which is projected to be 25% (7.4 mm) wetter. A wetter October is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity by the end of the century. Natural recharge is projected to remain near zero throughout the year and slightly negative from May through December (-0.01 to -0.02 mm/month).<sup>\*</sup> While remaining below 0.7 mm/month, runoff is projected to increase by 0.29-0.63 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. Higher temperatures lead to a projected 5-11% (0.52 to 1.9 mm/month) increase in evapotranspiration (ET) in October-February compared to the baseline period, while less water availability March to September leads to projected declines in ET (5-22%, or -1.2 to -9.8 mm/month) during the warmer months.

<sup>\*</sup>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.

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1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
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# San Rafael Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 229 square miles

**Elevation<sup>2</sup>:** Range: 4,596-9,098 ft; Median: 5,216 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (59%), Evergreen Forest (24%), Grassland Herbaceous (15%)

**Major surface watershed(s)<sup>4</sup>:** Upper Santa Cruz and Upper San Pedro

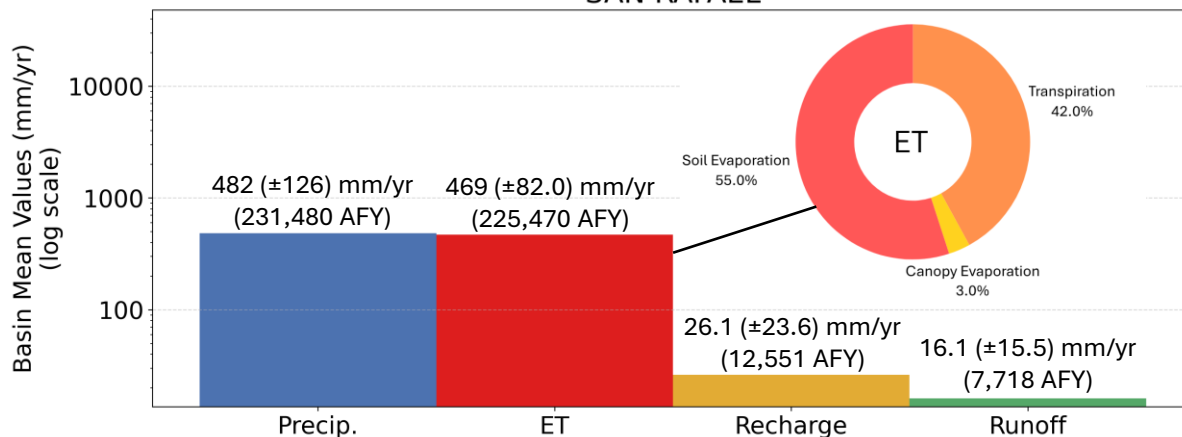
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.67** (Very High)

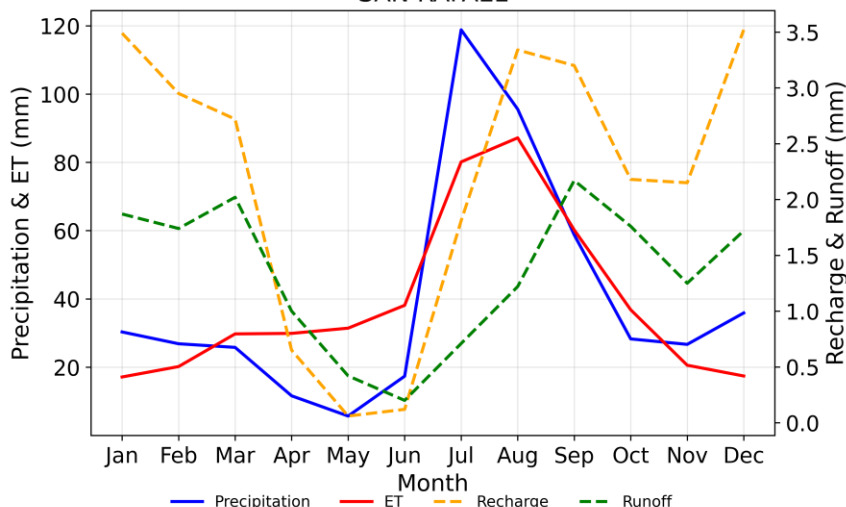


## Mean Annual Hydrologic Cycle Components (1980-2020) SAN RAFAEL



**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.<sup>6</sup> 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) SAN RAFAEL



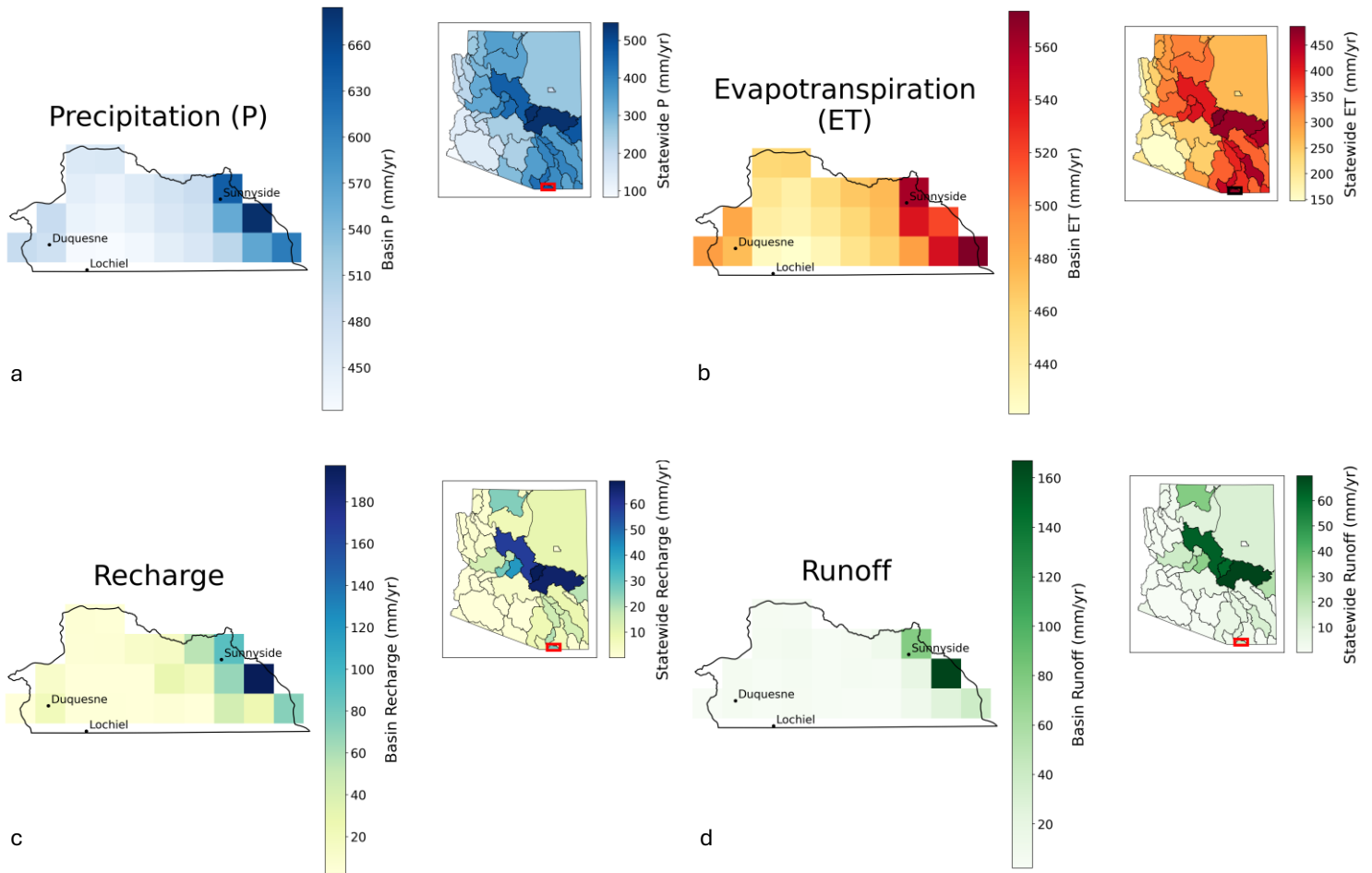
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the San Rafael basin is affected by the North American Monsoon during the summer months and exceeds evapotranspiration (ET) on annual timescales. The greatest atmospheric losses occur during the summer months, and ET is greater than P from mid-February to mid-June. Soil evaporation makes up 55.0% of total ET in the basin, while transpiration comprises 42.0% and canopy evaporation accounts for the remainder (3.0%). Natural recharge (26.1 mm/yr) and runoff (16.1 mm/yr) are highest in the winter months (when evaporative demand is low), and during the late summer as a result of monsoon precipitation. Groundwater supplies an estimated 67% of total streamflow in the San Rafael basin. 1

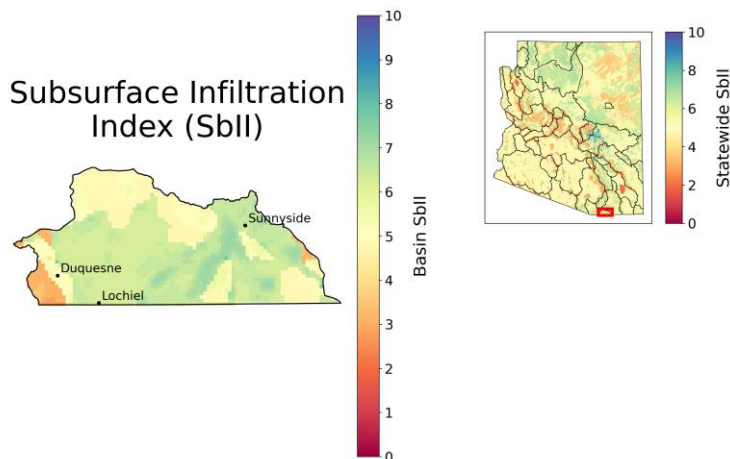
# San Rafael



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



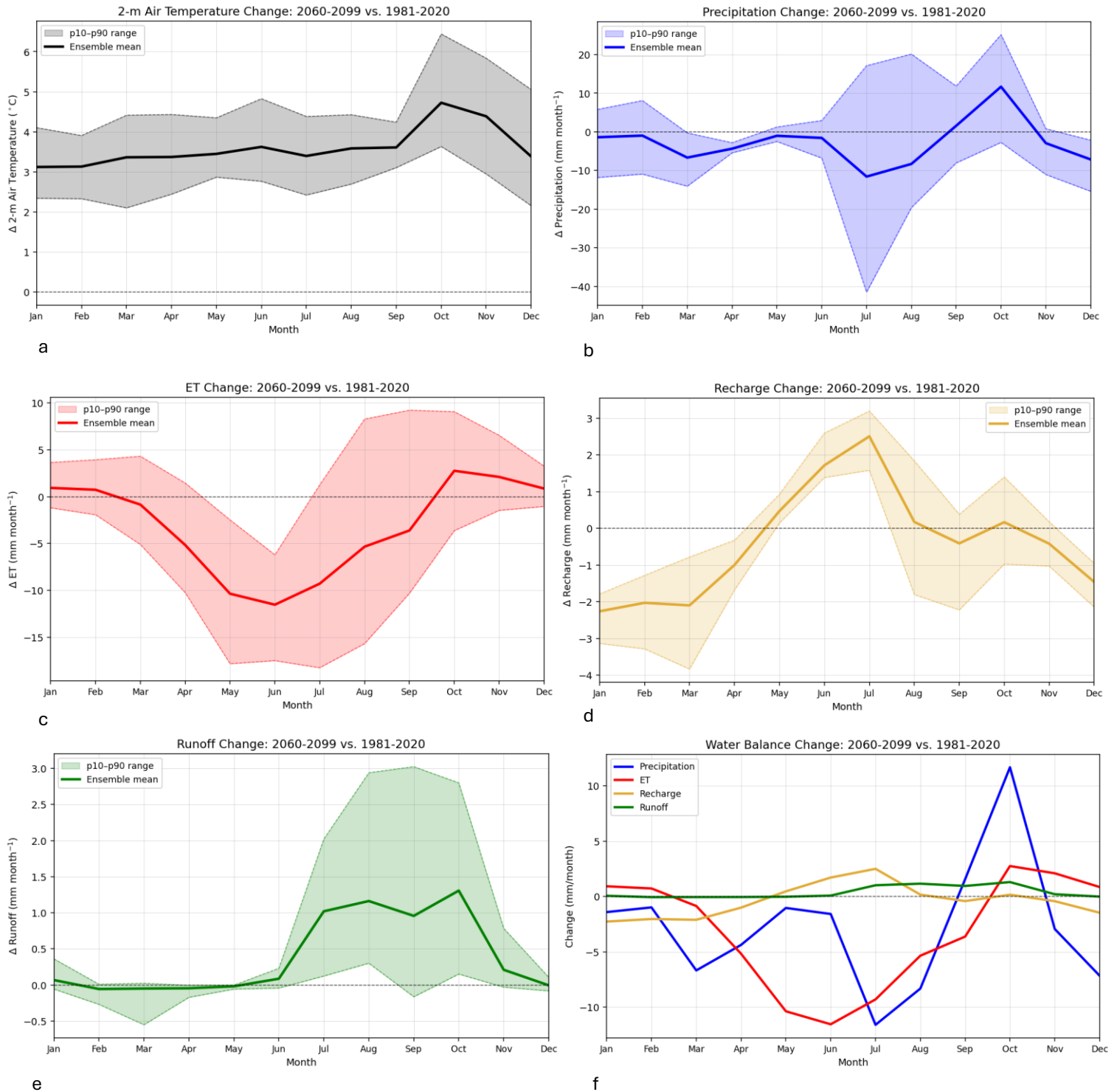
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the San Rafael basin is greatest in the Huachuca Mountains, where P can exceed 650 mm/yr. ET (~530 mm/yr), natural recharge (>100 mm/yr), and runoff (>100 mm/yr) are also highest in this region of the basin. Infiltration potential is relatively high across the basin due to faults near the Huachuca Mountains and generally high permeability of the alluvial deposits across much 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the San Rafael basin show that most of the year will be drier (4-41%) compared to the baseline, except for October, which is projected to be 39% (12 mm) wetter. A wetter October 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 (January-April) are projected to have declines of 46-58% (-1.0 to -2.3 mm/month). Despite less water loss (shown as an increase from the baseline in Figure 8(d)), recharge is projected to be negative from May-June (-0.32 to -0.77 mm/month).<sup>\*</sup> While remaining below 1.5 mm/month, runoff is projected to increase by 0.98 to 1.3 mm/month in July-October by the end of the century. Projected increases in temperature range from approximately 3.2 °C in January-February to 4.8 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 6% (2.8 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability April to September leads to projected declines in ET (14-30%, or -3.7 to -12 mm) during the warmer months.

<sup>\*</sup>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.

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# San Simon Wash Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 2,284 square miles

**Elevation<sup>2</sup>:** Range: 1,675-7,721 ft; Median: 2,192 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (96%), Woody Wetlands (2.2%), Grassland Herbaceous (0.86%)

**Major surface watershed(s)<sup>4</sup>:** San Simon Wash, Rio Sonoyta

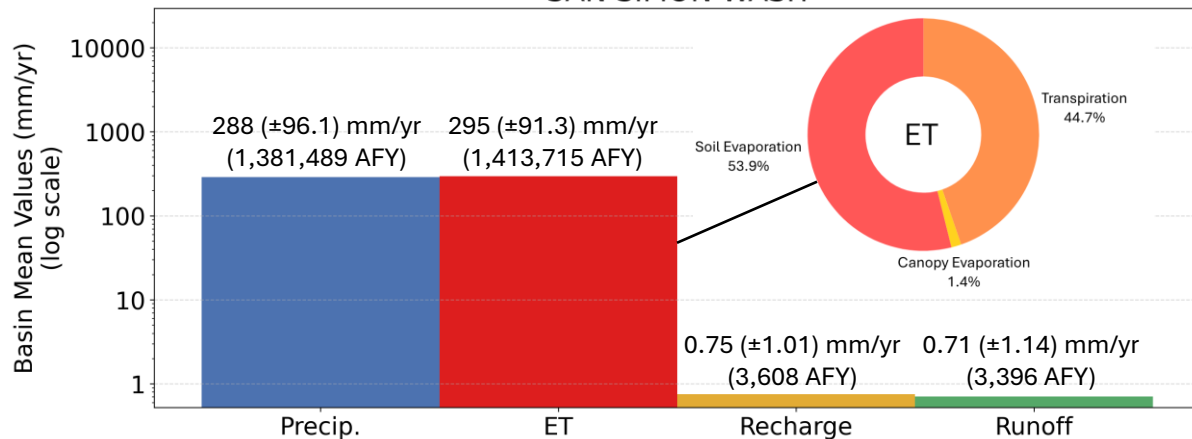
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.42** (Moderate)

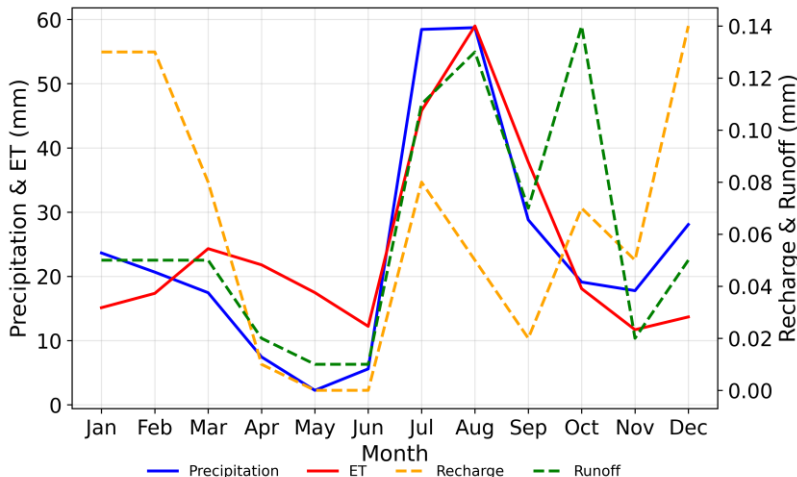


## Mean Annual Hydrologic Cycle Components (1980-2020) SAN SIMON WASH



**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.<sup>6</sup> 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) SAN SIMON WASH



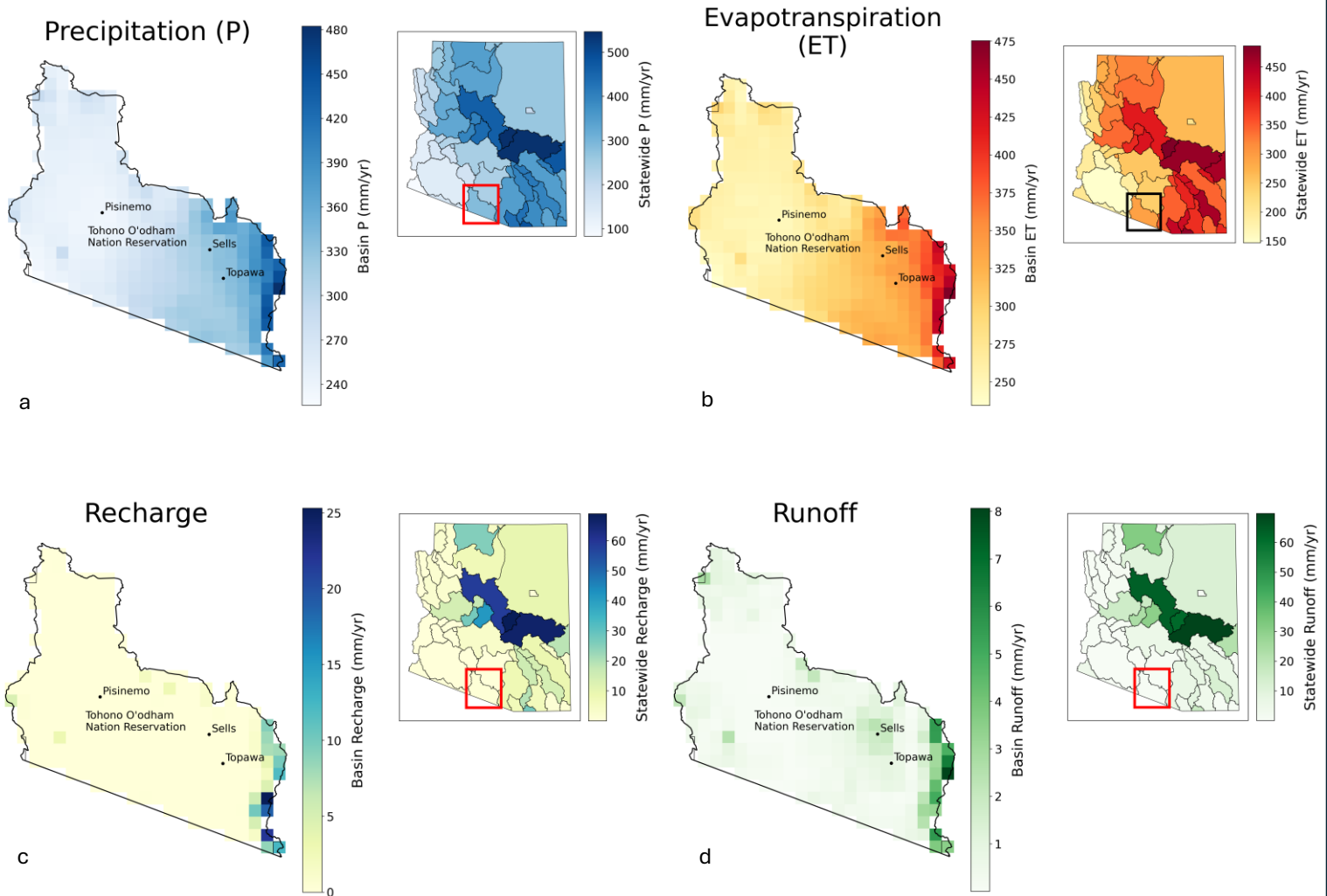
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average across the San Simon Wash basin, yielding near zero annual averages for natural recharge (0.75 mm) and runoff (0.71 mm). Seasonally, P in the San Simon Wash basin is affected by the North American Monsoon during the summer months. ET is greater P from mid-February to June and tracks with P from June to October. Soil evaporation makes up 53.9% of total ET in the basin, while transpiration comprises 44.7% and canopy evaporation accounts for the remainder (1.4%).

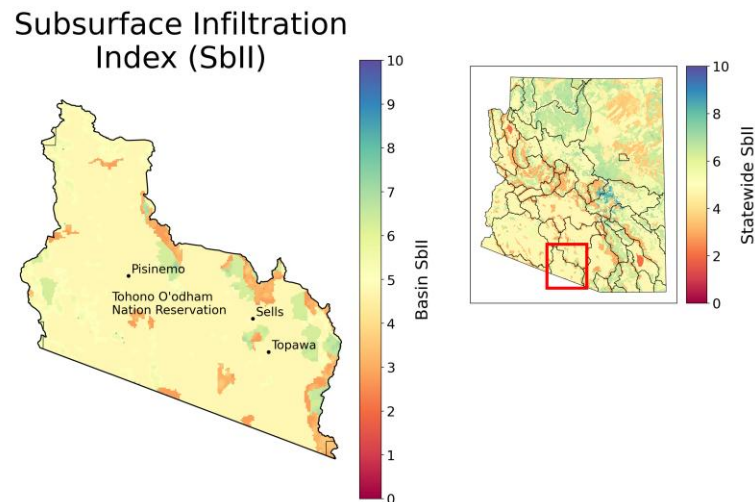
# San Simon Wash



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

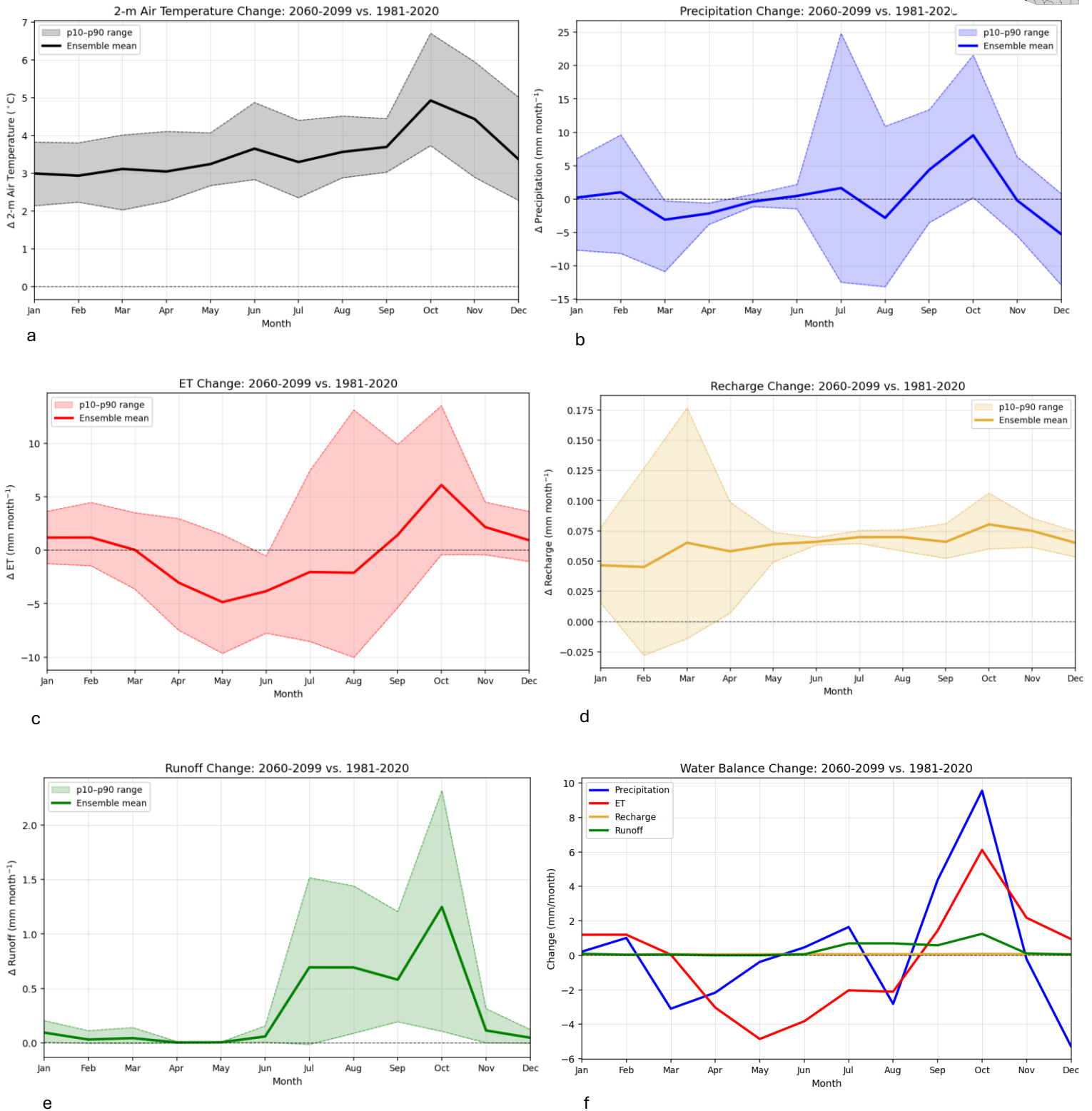


Precipitation in the San Simon Wash basin is highest in the Baboquivari Mountains to the southeast, which receive over 450 mm/yr on average. Evapotranspiration (ET, ~450 mm/yr) is also highest in this area. Natural recharge and runoff are generally minimal across the basin; however, in the Baboquivari Mountains, recharge can exceed 20 mm/yr and runoff exceeds 6 mm/yr. Subsurface infiltration potential is low to moderate across the basin; however, the presence of karst-type geology in the mountains creates pockets of higher infiltration potential.

# San Simon Wash



## Climatic 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the San Simon Wash basin show drier springs (16-37% drier March through May) and a drier August (4%) and December (18%). July (3%), September (15%), and October (47%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (4.4-9.8 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (-0.01 to -0.05 mm/month) from April through January.\* While runoff is projected to remain below 1.7 mm/month, minor increases of 0.59-1.3 mm/month are projected for July-October. Projected increases in temperature range from approximately 3.0 °C in February to 5.0 °C in October. Less water availability from March to May leads to projected declines (13-26% or -3.1 to -5.0 mm/month) in evapotranspiration (ET) during the warmer months, while higher temperatures and greater precipitation are consistent with a projected 30% (6.2 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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4. USGS HUC8 Watersheds. Retrieved from: <https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer>
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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Santa Cruz AMA

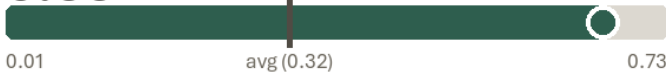
## Groundwater Basin Profile



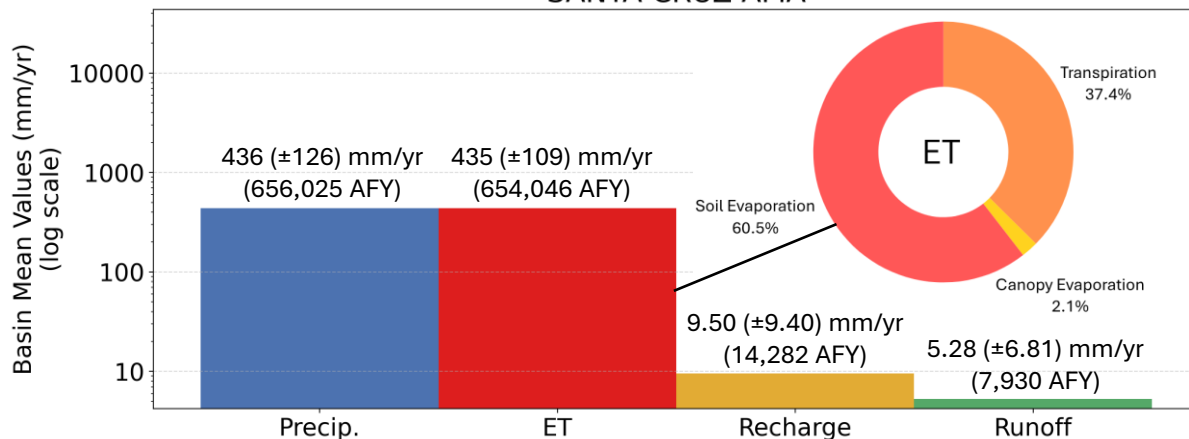
### Basin Summary Statistics

**Size<sup>1</sup>:** 716 square miles  
**Elevation<sup>2</sup>:** Range: 2,999-9,457 ft; Median: 3,881 ft  
**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (91%), Evergreen Forest (3.3%), Developed – Low Density (2.2%)  
**Major surface watershed(s)<sup>4</sup>:** Santa Cruz River  
**Groundwater subbasins<sup>1</sup>:** None  
**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.66** (Very High)



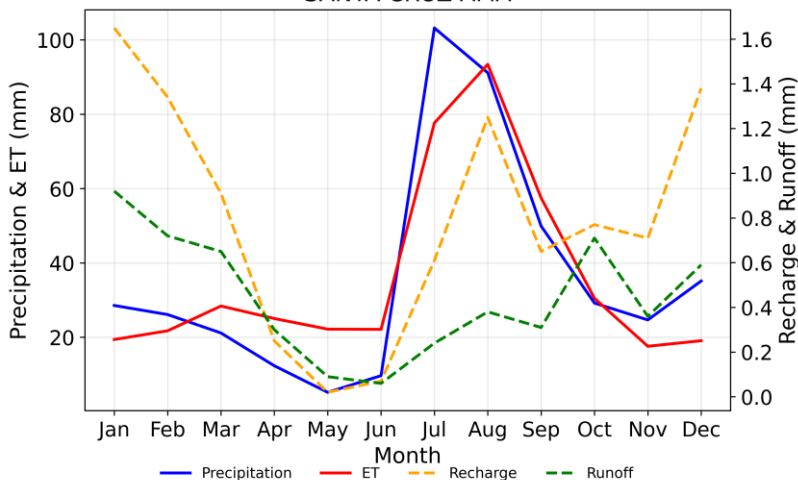
Mean Annual Hydrologic Cycle Components (1980-2020)  
SANTA CRUZ AMA



**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.<sup>6</sup> 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.

On annual timescales, evapotranspiration (ET) is approximately equal to precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (9.50 mm) and runoff (5.28 mm). P in the Santa Cruz AMA is affected by the North American Monsoon during the summer months. ET tracks with P from June through October and exceeds P from mid-February to June. Soil evaporation makes up 60.5% of total ET in the basin, while transpiration comprises 37.4% and canopy evaporation accounts for the remainder (2.1%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months. Natural recharge also increases in August as a result of high intensity monsoon storms.

Mean Monthly Hydrologic Cycle Components (1980-2020)  
SANTA CRUZ AMA

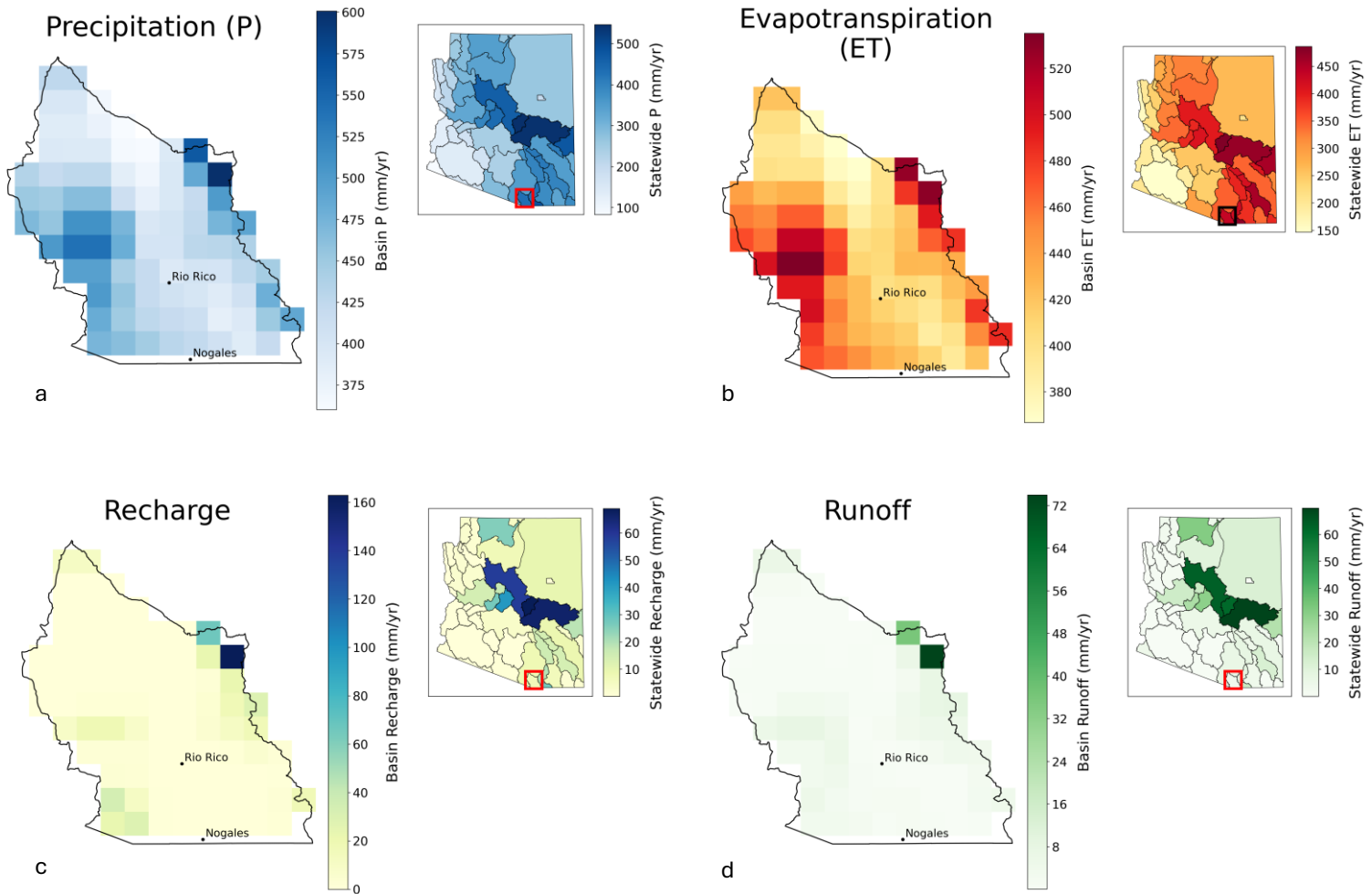


**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

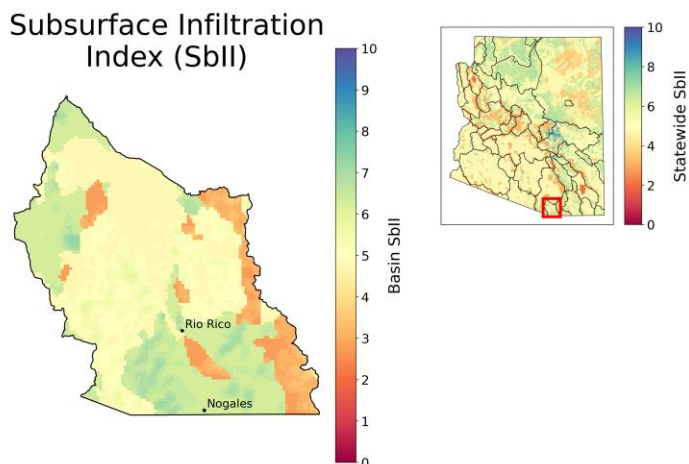
# Santa Cruz AMA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



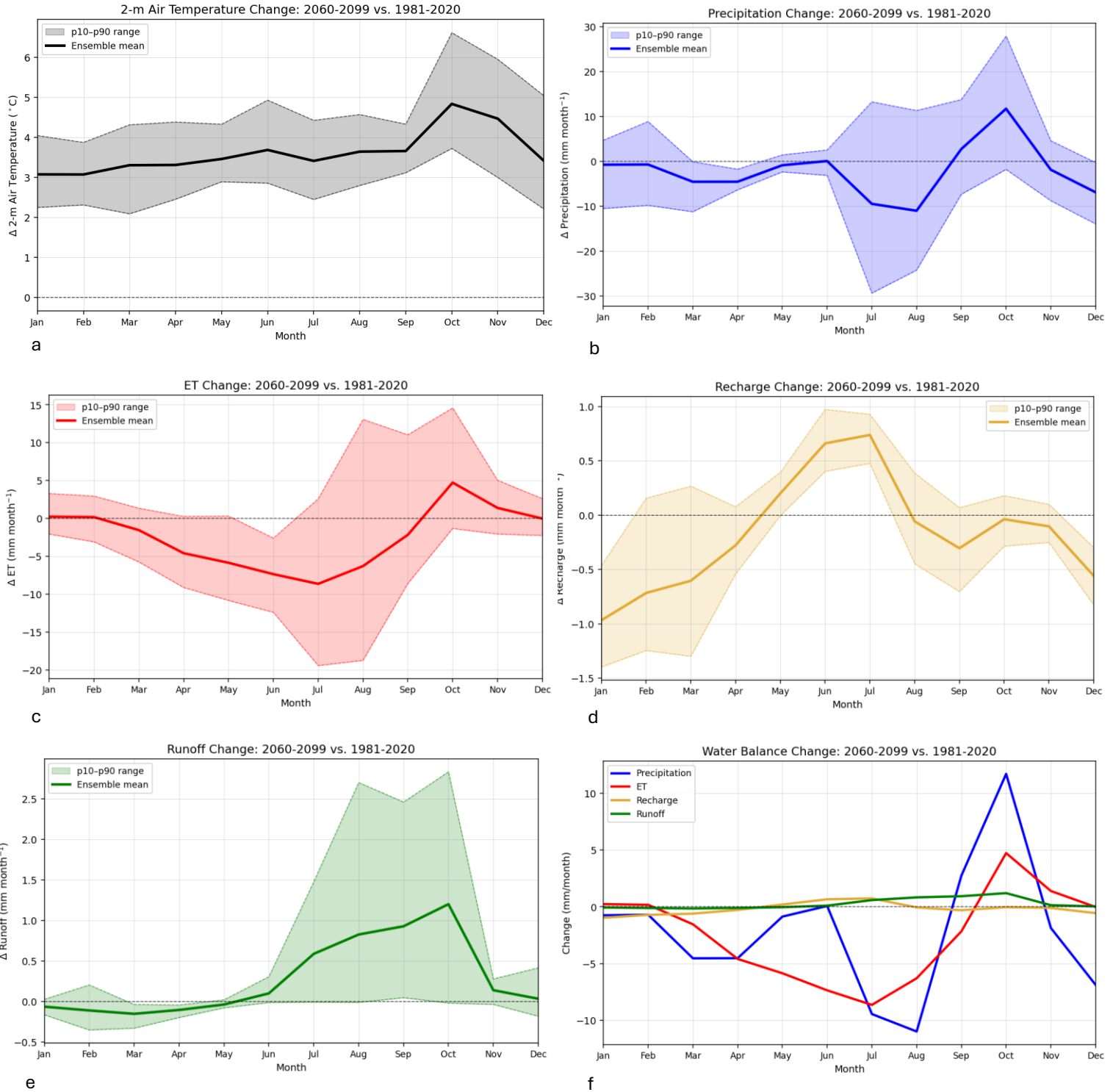
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Santa Cruz AMA is greatest near Mt. Wrightson in the Santa Ritas to the northeast of the basin, where P can exceed 600 mm/yr. ET is also higher in the mountainous regions of the basin (>500 mm/yr on average). Runoff (>70 mm/yr) and natural recharge (>150 mm/yr) are highest at the mountain front of Mt. Wrightson. Infiltration potential varies across the basin; however, the southern and northwestern portions of the basin show greater infiltration potential due to alluvial deposits and limestone lithologies in the northwest.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Santa Cruz AMA show drier springs (19-41% drier March through May) and a drier July-August (9-12%), November (10%), and December (19%). October is projected to be 40% (12 mm) 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 (January-March) are projected to have declines of 36-63% (-0.60 to -1.0 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 May-August (-0.03 to -0.36 mm/month).<sup>\*</sup> While remaining below 1.5 mm/month, runoff is projected to increase by 0.10 to 1.2 mm/month from June through November by the end of the century. Projected increases in temperature range from approximately 3.1 °C in February to 4.9 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 14% (4.8 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability March to September leads to projected declines in ET (4-27%, or -1.6 to -8.5 mm/month) during the warmer months.

<sup>\*</sup>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/>
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# Shiwits Plateau Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 1,821 square miles

**Elevation**<sup>2</sup>: Range: 1,140-7,865 ft; Median: 5,041 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (82%), Evergreen Forest (16%), Barren Land (0.69%)

**Major surface watershed(s)**<sup>4</sup>: Fort Pearce Wash, Colorado River

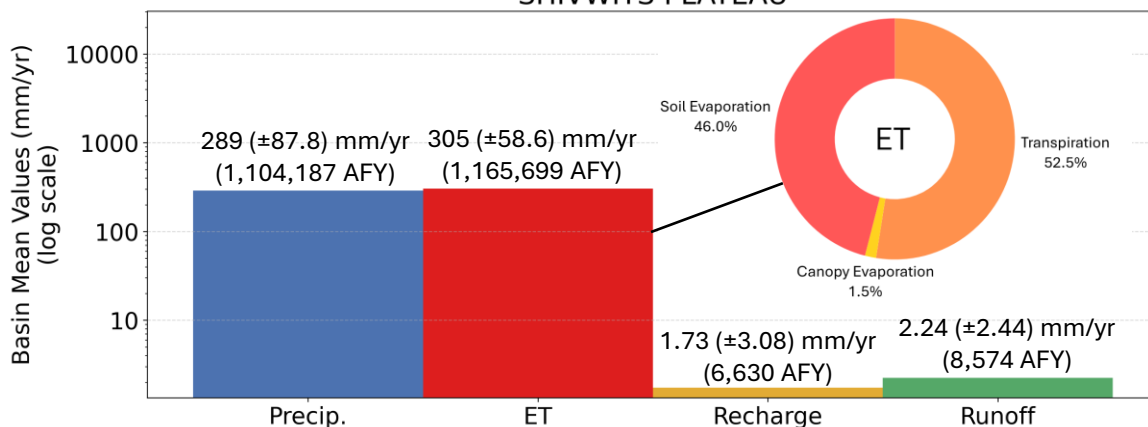
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.53** (High)



Mean Annual Hydrologic Cycle Components (1980-2020)  
SHIWITS PLATEAU



**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.<sup>6</sup> 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)  
SHIWITS PLATEAU



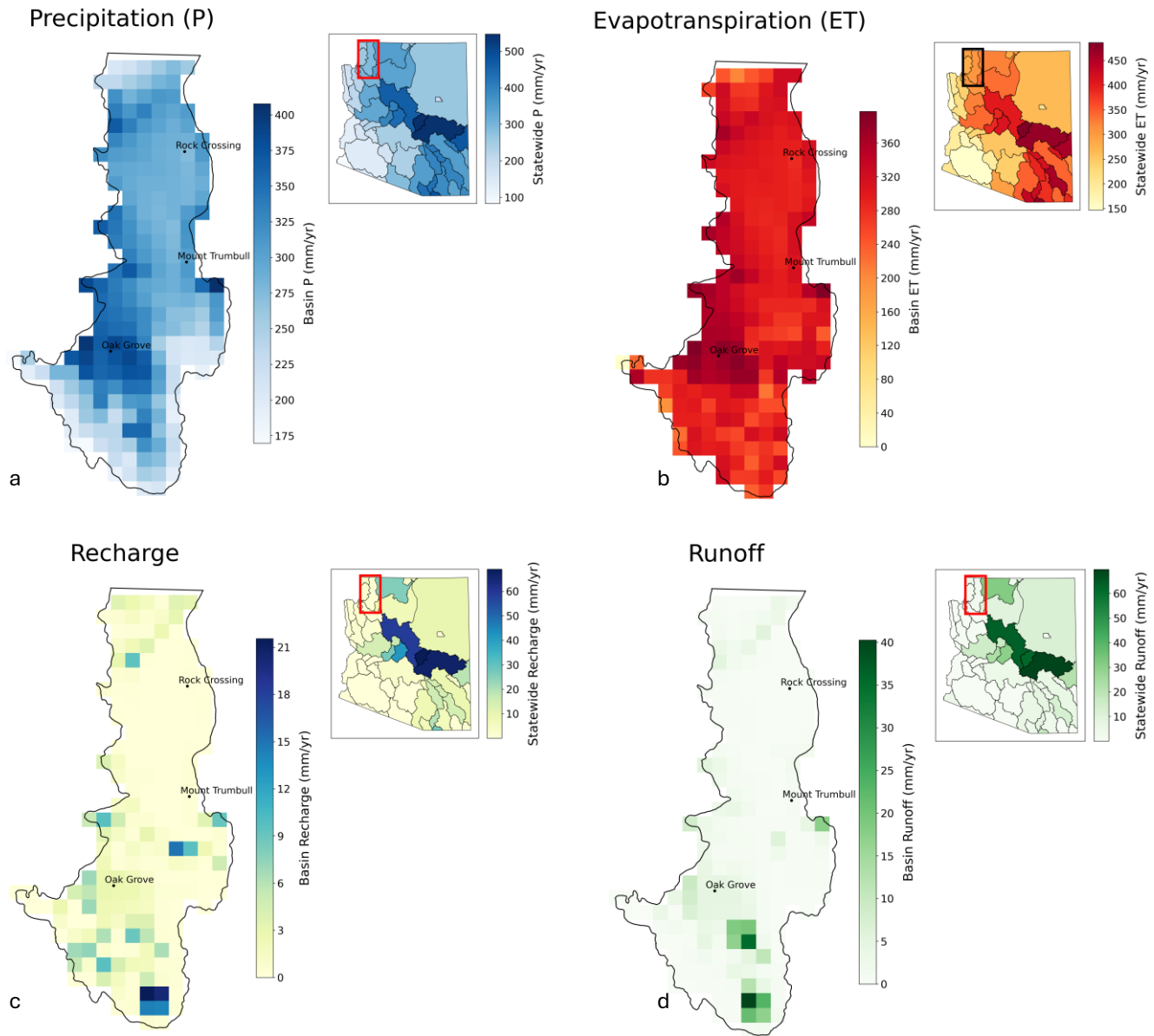
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (1.73 mm) and runoff (2.24 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 (52.5%) of total ET in the basin, while soil evaporation comprises 46.0% and canopy evaporation accounts for the remainder (1.5%). Groundwater is estimated to supply 53% of total streamflow in the Shivwits Plateau.

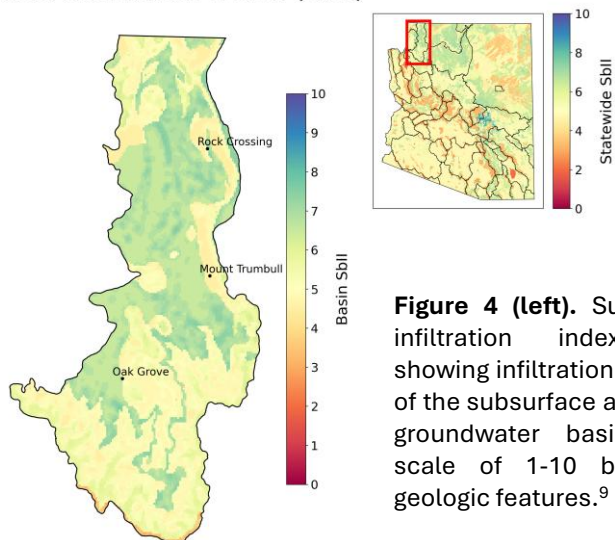
# Shiwits Plateau



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



## Subsurface Infiltration Index (SbII)



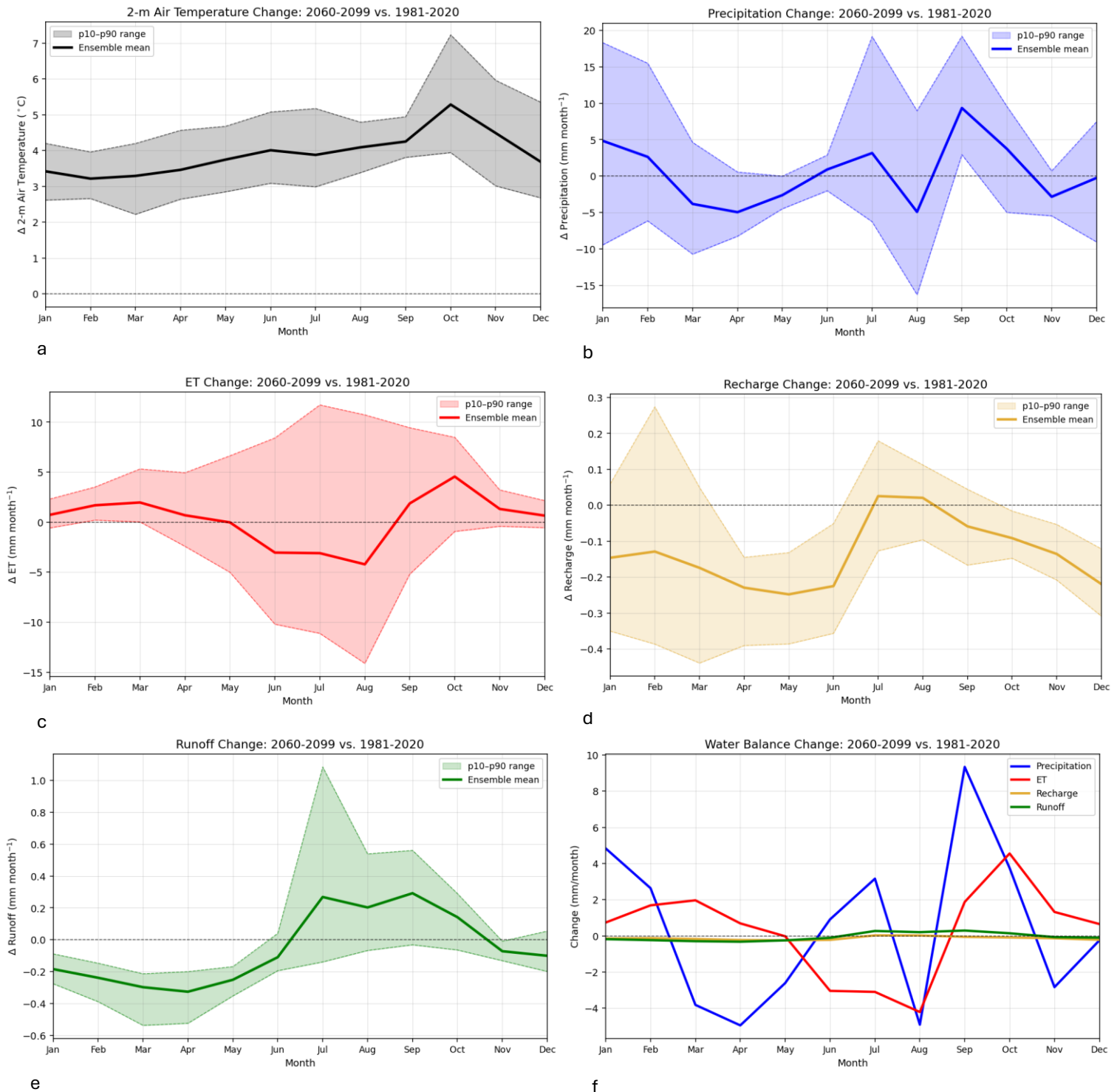
**Figure 4 (left).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

Precipitation (P) in the Shiwits Plateau is greatest in southeast portion of the basin, where P exceeds 380 mm/yr on average. ET is also highest in this region (~370 mm/yr). Natural recharge (~20 mm/yr) and runoff (~30 mm/yr) are both highest in the southern region of the basin. The basin has relatively high infiltration potential due to the presence of karst-type geology and faults.

# Shiwits Plateau



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Shivwits Plateau show drier springs (12-28% drier March through May), and a drier August (12%) and November (14%). September and October are projected to be 15-36% (3.7-9.4 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 (January-May) are projected to have declines of 26-140% (-0.13 to -0.25 mm/month)\*. Recharge is projected to be negative May-November (-0.03 to -0.43 mm/month). While remaining below 0.5 mm/month, runoff is projected to increase by 0.15-0.30 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 25% (4.6 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 (9% or -4.0 mm).

\*Recharge projections can show declines of over 100% when modeled recharge decreases so much as to become negative. 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/>
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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Tiger Wash Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 74 square miles

**Elevation**<sup>2</sup>: Range: 1,944-4,964 ft; Median: 2,284 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (99.6%), Developed – Open Space (0.40%), Developed – Low Intensity (0.03%)

**Major surface watershed(s)**<sup>4</sup>: Tiger Wash

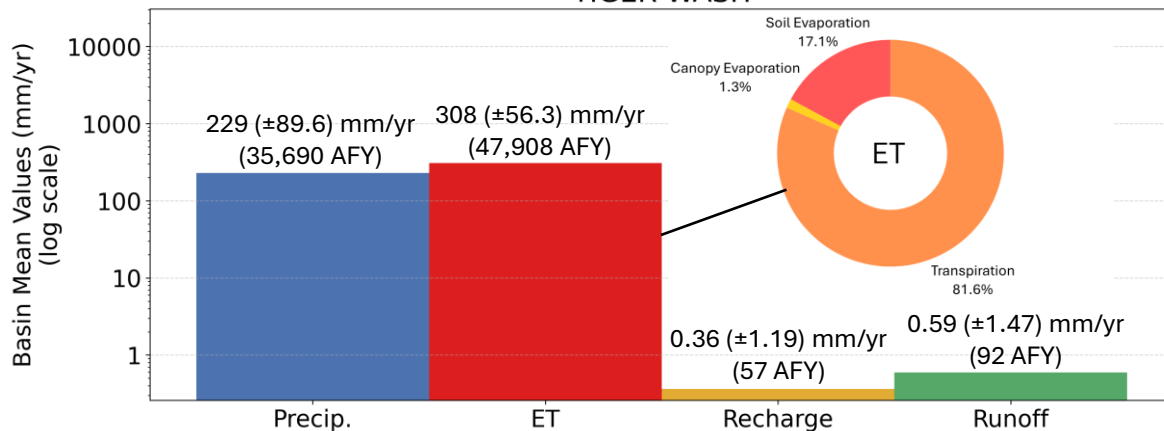
**Groundwater subbasins**<sup>1</sup>: None

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.68** (Very High)

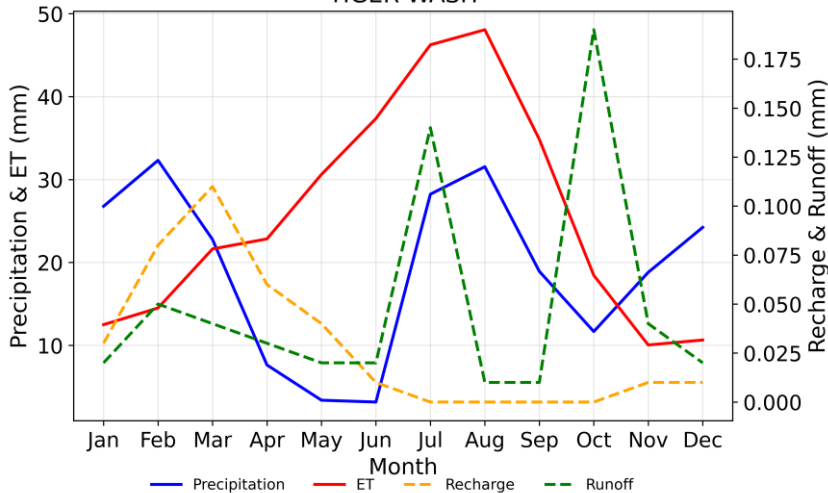


Mean Annual Hydrologic Cycle Components (1980-2020)  
TIGER WASH



**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.<sup>6</sup> 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)  
TIGER WASH



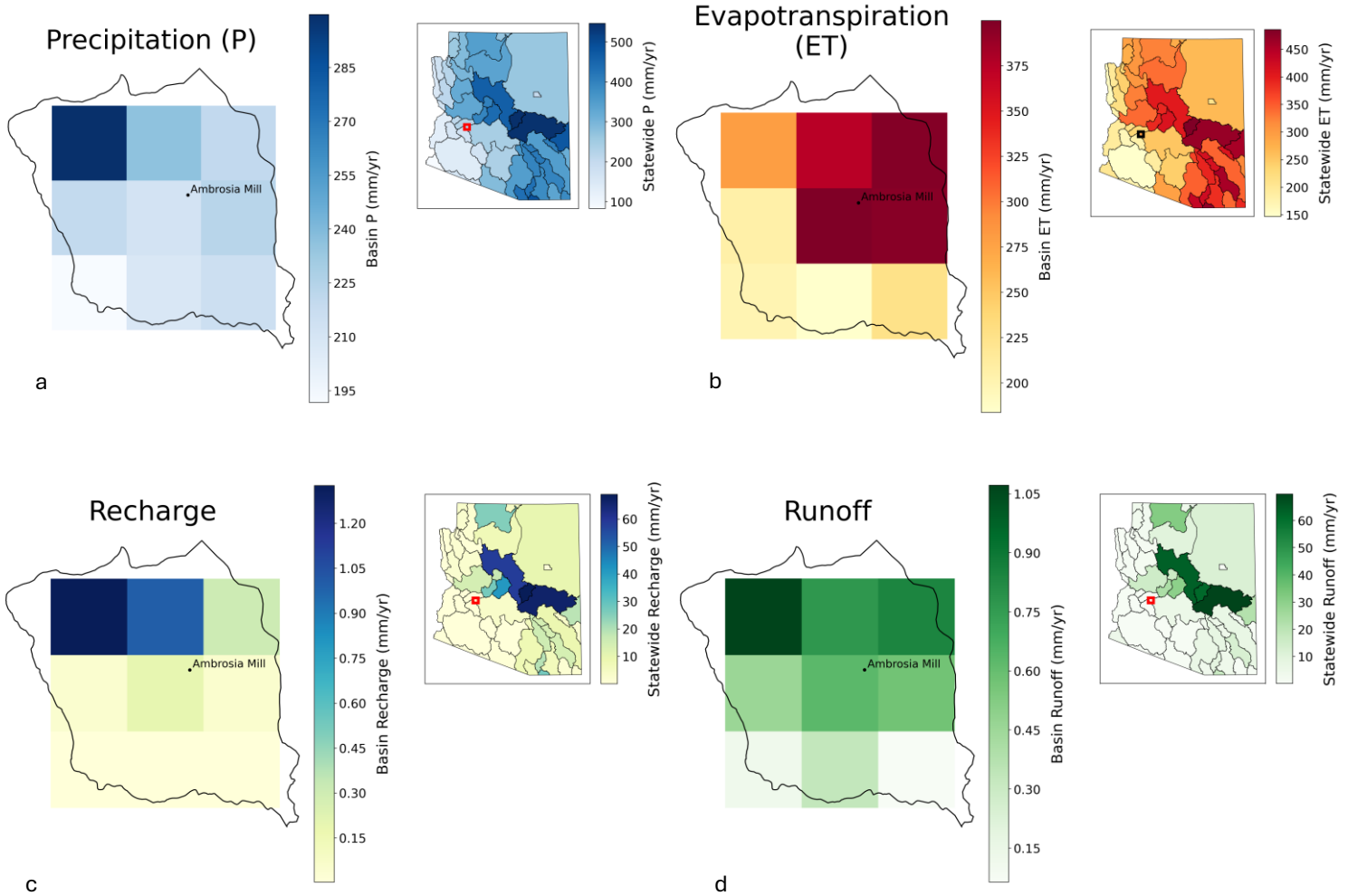
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) across the basin, resulting in near zero basin-wide annual averages for natural recharge (0.36 mm) and runoff (0.59 mm). The greatest atmospheric losses occur during the summer months, and ET is greater than P from March through mid-October. Transpiration makes up the majority (81.6%) of total ET in the basin, while soil evaporation comprises 17.1% and canopy evaporation accounts for the remainder (1.3%).

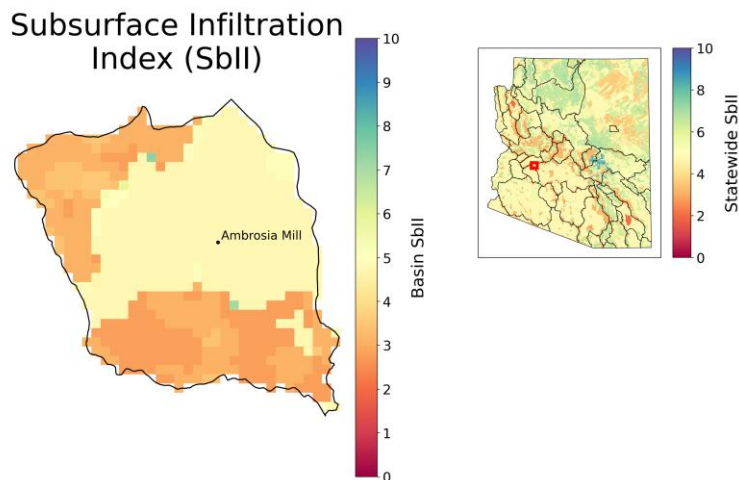
# Tiger Wash



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



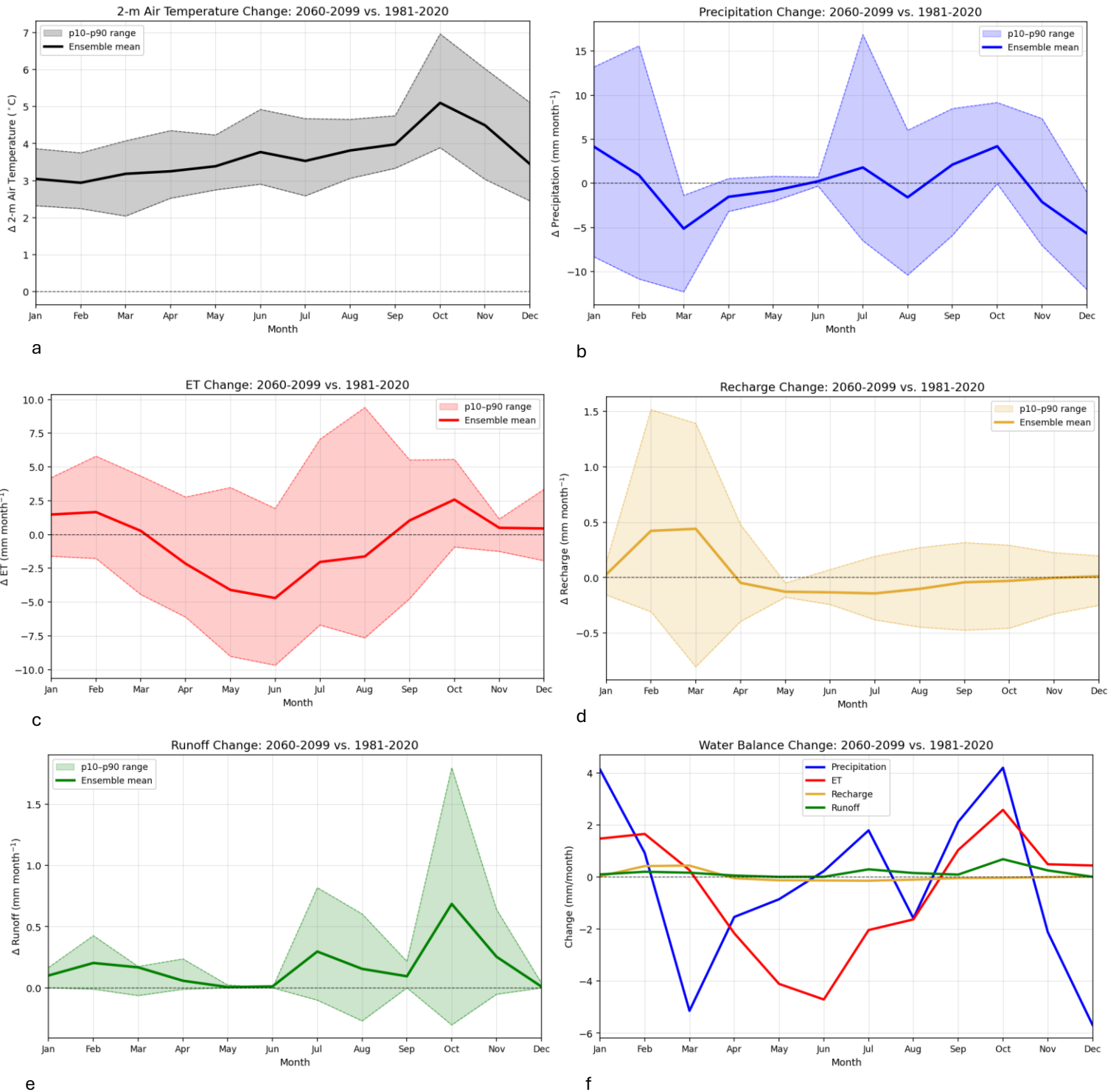
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation (P) in the Tiger Wash basin is greatest in the Harquahala Mountains Wilderness, where P can exceed 300 mm/yr. ET is generally higher in the eastern portion of the basin (~400 mm/yr). Natural recharge and runoff are both minimal across the basin due to low water availability. Infiltration potential is low in the Harquahala Mountains and in the south of the basin due to the granitic geology of these areas. Infiltration potential is moderate in the alluvial areas around Tiger Wash.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Tiger Wash basin show drier springs (20-26% drier March through May), and a drier August (4%), November (12%), and December (22%). September and October are projected to be 11-26% (2.1-4.2 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-March) are projected to have increases of 0.41-0.43 mm/month by the end of the century; however, from May through December, recharge is projected to be negative (-0.04 to -0.33 mm/month)\*. While remaining below 1.0 mm/month, runoff is projected to increase for most months of the year, particularly January-March (0.10-0.21 mm/month) and July-November (0.10-0.68 mm/month). Projected increases in temperature range from approximately 3.0 °C in February to 5.1 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 18% (2.6 mm) increase in evapotranspiration (ET) in October compared to the baseline period, while less water availability April to August leads to projected declines in ET (4-18%, or -1.5 to -4.8 mm/month) during the warmer 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/>
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# Tonto Creek Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 955 square miles

**Elevation<sup>2</sup>:** Range: 2,150-7,956 ft; Median: 4,905 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (53%), Evergreen Forest (43%), Grassland Herbaceous (1.8%)

**Major surface watershed(s)<sup>4</sup>:** Tonto Creek

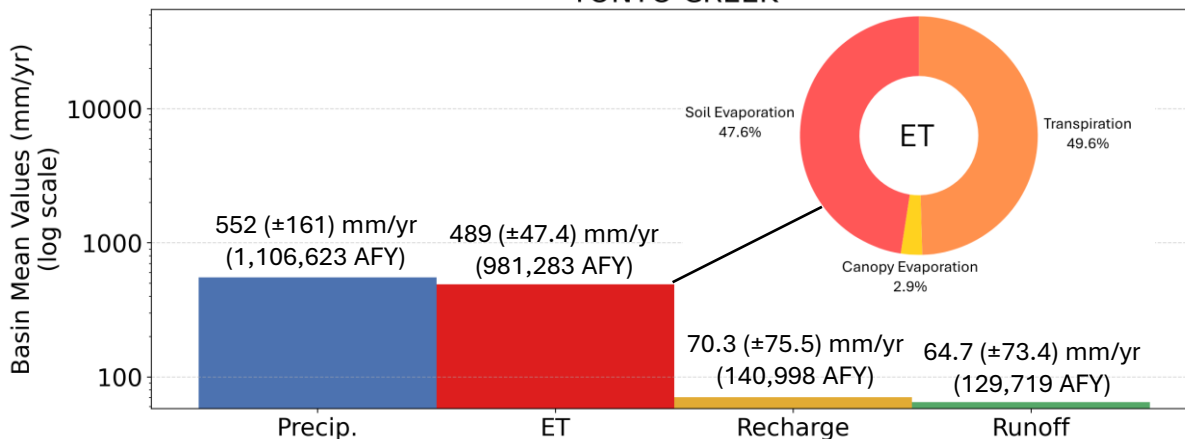
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.47** (Moderate)

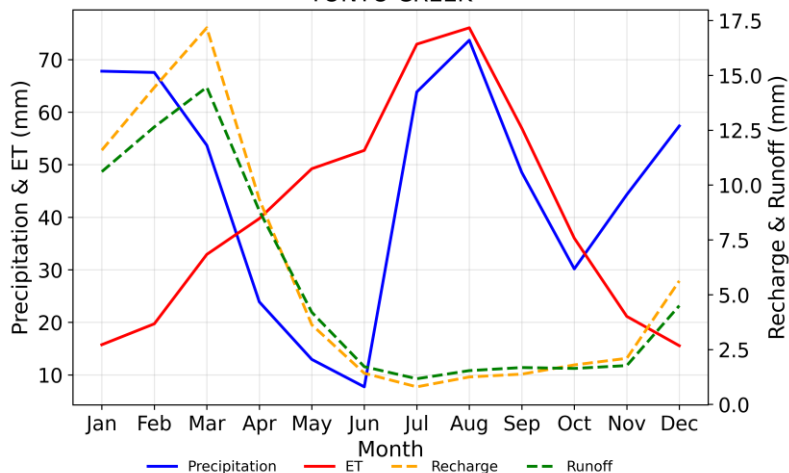


Mean Annual Hydrologic Cycle Components (1980-2020)  
TONTA CREEK



**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.<sup>6</sup> 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)  
TONTA CREEK



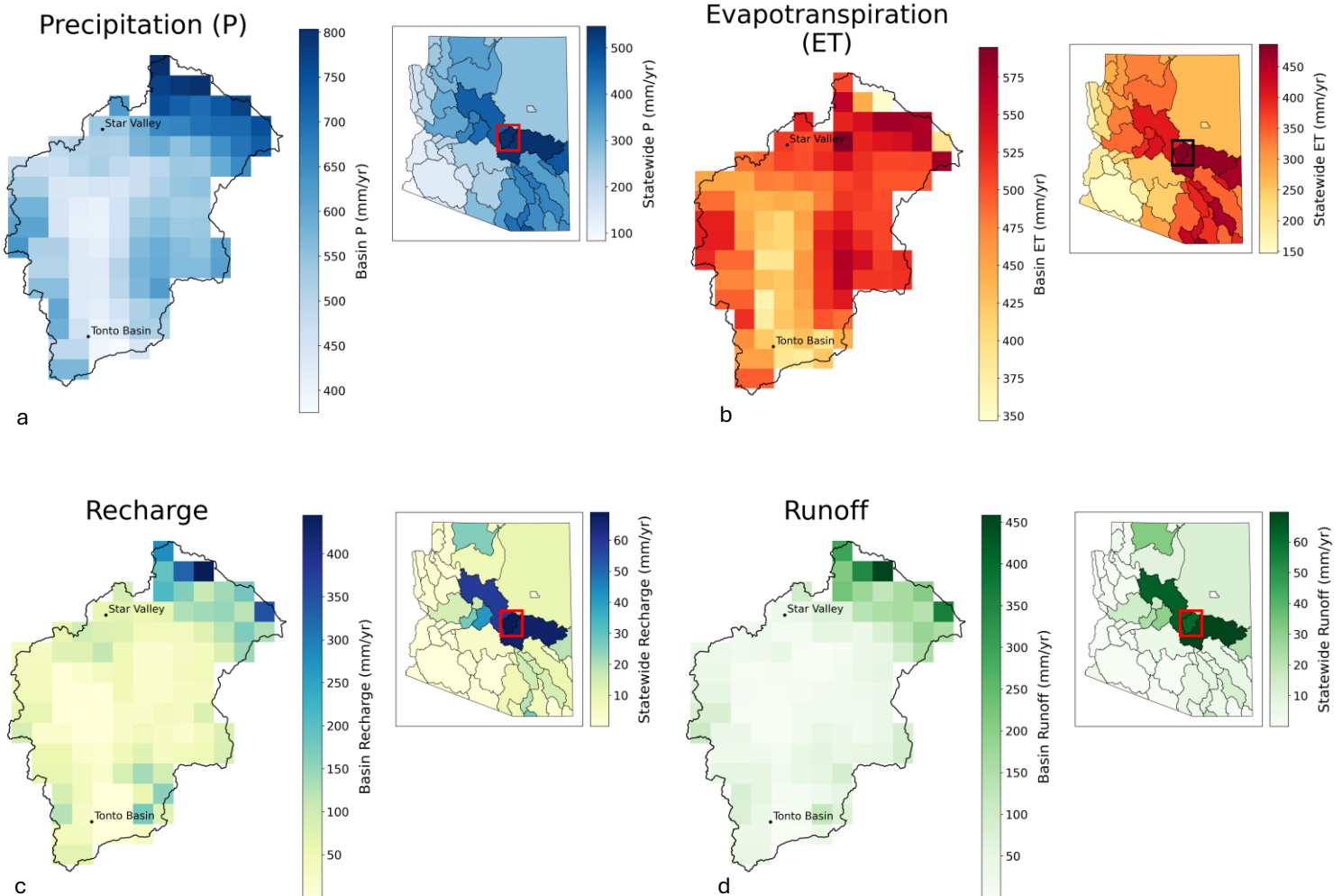
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Tonto Creek 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. The Tonto Creek basin has the highest annual natural recharge (70.3 mm/yr) and second highest runoff (64.7 mm/yr) in the state. Both recharge and runoff are highest in March due to springtime snowmelt and low evaporative demand. Soil evaporation makes up 47.6% of total ET in the basin, while transpiration comprises 49.6% and canopy evaporation accounts for the remainder (2.9%). Groundwater is estimated to supply 47% of total streamflow in the basin.

# Tonto Creek

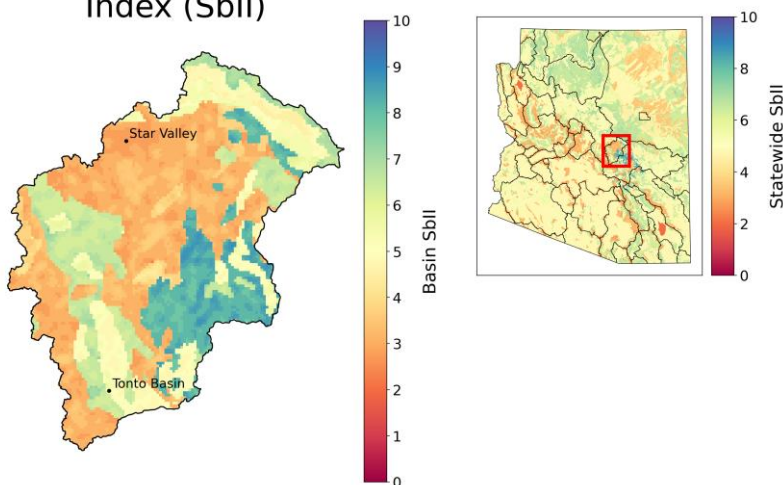


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

## Subsurface Infiltration Index (SbII)

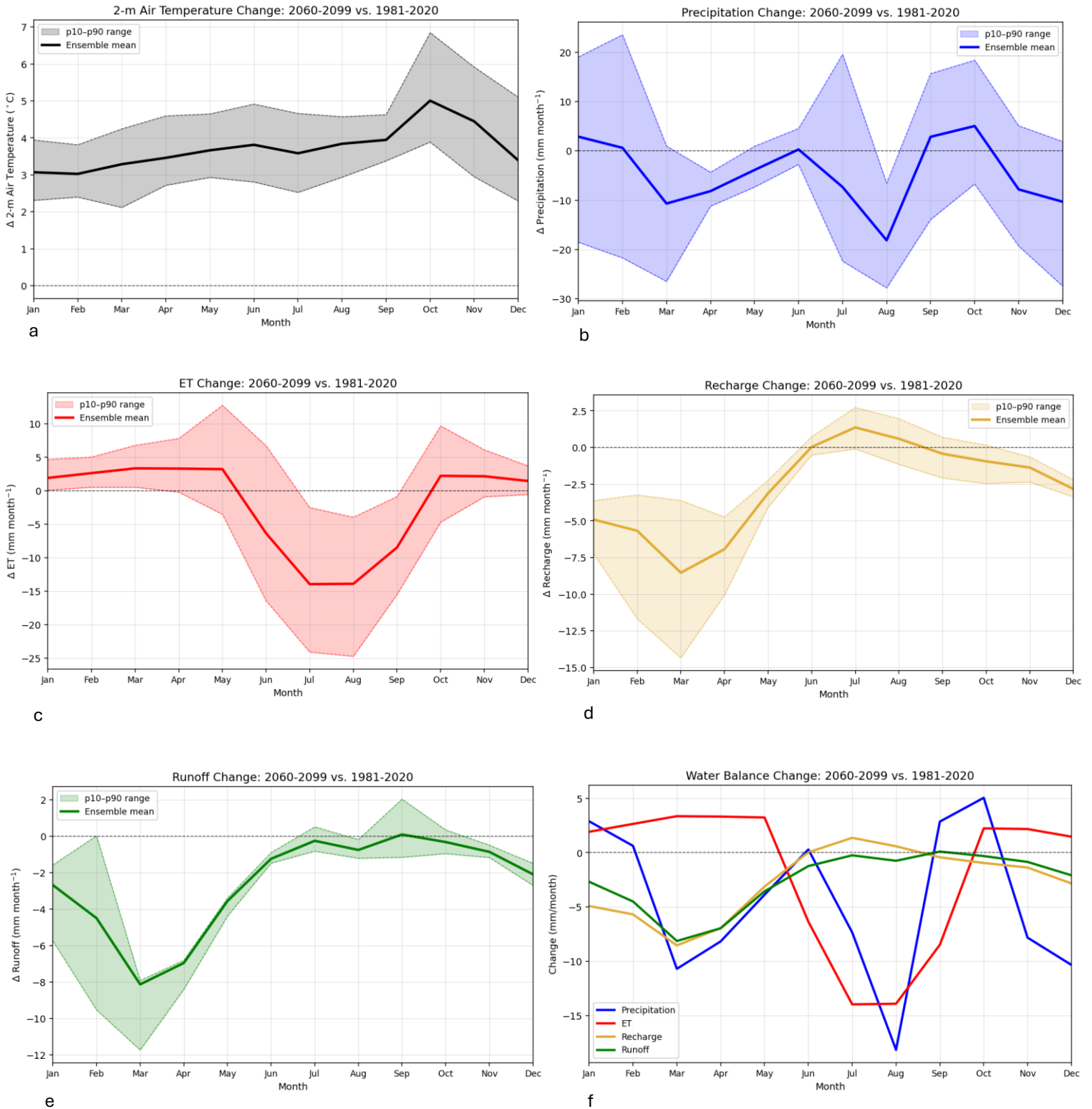


Precipitation (P) in the Tonto Creek basin is greatest on the Mogollon Rim at the northern portion of the basin, where P can exceed 800 mm/yr on average. Evapotranspiration (ET, ~570 mm/yr), natural recharge (300-400 mm/yr) and runoff (300-400 mm/yr) are also greatest in this region. The Tonto Creek basin contains pockets of high infiltration potential due to carbonate (limestone) dominated formations northeast of Tonto Basin and east of Star Valley below the Mogollon Rim.

# Tonto Creek



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Tonto Creek basin show drier springs (18-38% drier March through May) and a drier July (11%), August (23%), November (19%), and December (18%). September and October are projected to be 5-15% (2.6-5.2 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 52-59% (-5.9 to -8.6 mm/month) are projected for the highest recharge months (February-April), while projections for June-December show negative recharge (-0.45 to -2.5 mm/month)\*. Negative recharge is projected despite less water loss in the system from June through August (shown as an increase from the baseline in Figure 8(d)). Runoff is projected to decrease during most months of the year, with declines of 55-77% (-4.7 to -8.2 mm/month) during the highest runoff months (February-April). Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Less precipitation in August leads to a projected 17% (-14 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

1. ADWR Groundwater Basin and Subbasin shapefiles. Retrieved from: <https://gisdata2016-11-18t150447874z-azwater.opendata.arcgis.com/>
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# Tucson AMA

## Groundwater Basin Profile



### Basin Summary Statistics

**Size<sup>1</sup>:** 3,870 square miles

**Elevation<sup>2</sup>:** Range: 1,772-9,347 ft; Median: 3,112 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (84%), Developed Low Intensity (4.6%), Developed Medium Intensity (3.0%)

**Major surface watershed(s)<sup>4</sup>:** Santa Cruz River, Rillito River

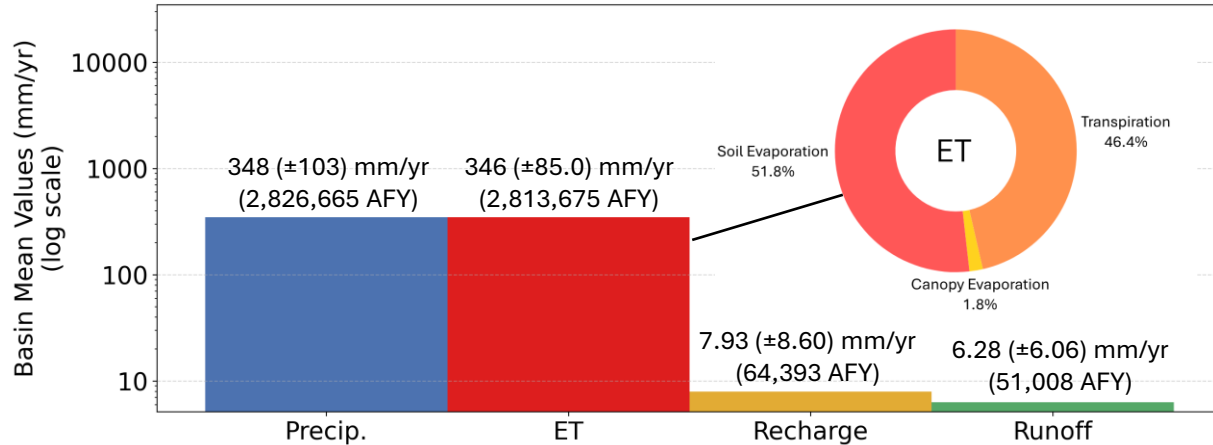
**Groundwater subbasins<sup>1</sup>:** Avra Valley, Upper Santa Cruz

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.50** (Moderate)

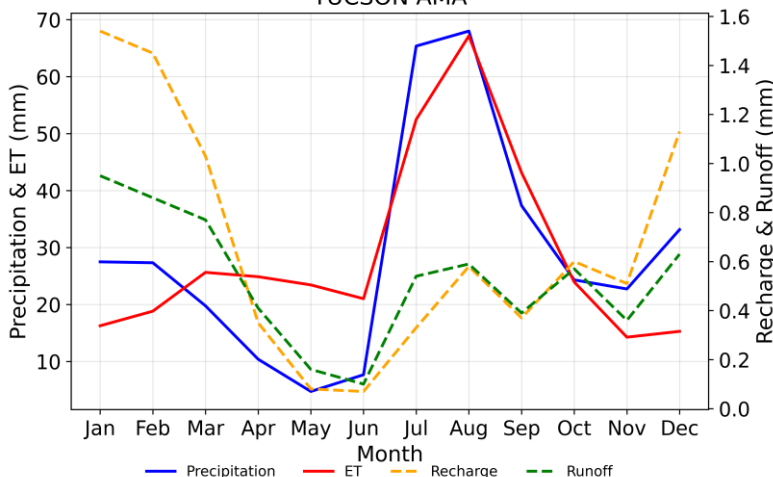


Mean Annual Hydrologic Cycle Components (1980-2020)  
TUCSON AMA



**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.<sup>6</sup> 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)  
TUCSON AMA



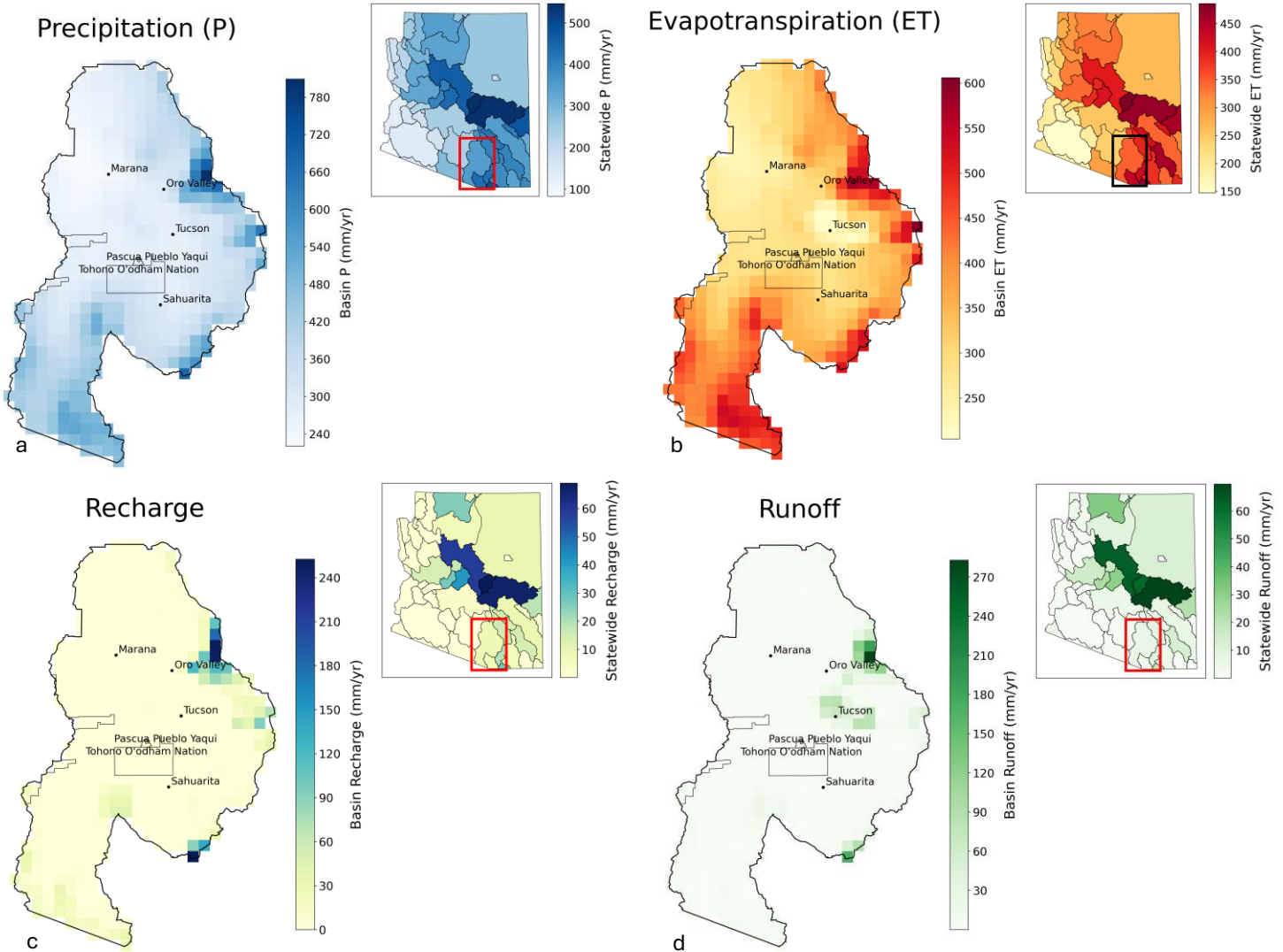
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (7.93 mm) and runoff (6.28 mm). P in the Tucson AMA is affected by the North American Monsoon during the summer months. ET tracks with P from mid-June through October and exceeds P from mid-February to mid-June by as much as ~20 mm on average (in May). Soil evaporation makes up 51.8% of total ET in the basin, while transpiration comprises 46.4% and canopy evaporation accounts for the remainder (1.8%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months.

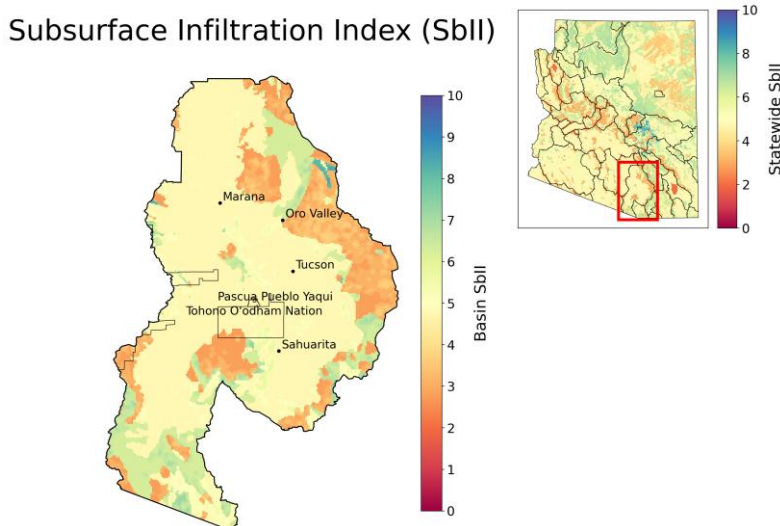
# Tucson AMA



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>



The Catalina, Rincon, and Santa Rita mountains account for the highest precipitation in the Tucson basin, all of which receive over 700 mm/year. Runoff is also greatest in these regions, exceeding 250 mm/year in the Catalinas. These mountain forests account for the highest evapotranspiration in the basin. Natural recharge is highest at the Catalina and Santa Rita mountain fronts. Infiltration potential varies across the basin, but is generally greater along the eastern and southern mountain fronts.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Tucson AMA show drier springs (15-40% drier March through May), a drier July-August (5-10%), and a drier November-December (7-14%). September and October are projected to be 7-35% (2.5-8.8 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. Declines in recharge ranging from 28-47% (-0.20 to -0.34 mm/month) are projected for the highest recharge months (January to April). Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections are slightly negative (-0.09 to -0.10 mm/month) in June and July.\* Runoff is projected to increase by 0.53 to 0.81 mm/month from July through October by the end of the century. Projected increases in temperature range from approximately 3.1 °C in February to 5.0 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 19% (4.8 mm) increase in evapotranspiration (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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# Upper Hassayampa Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 787 square miles

**Elevation<sup>2</sup>:** Range: 1,896-7,971 ft; Median: 3,506 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (84%), Evergreen Forest (11%), Grassland Herbaceous (2.5%)

**Major surface watershed(s)<sup>4</sup>:** Hassayampa River

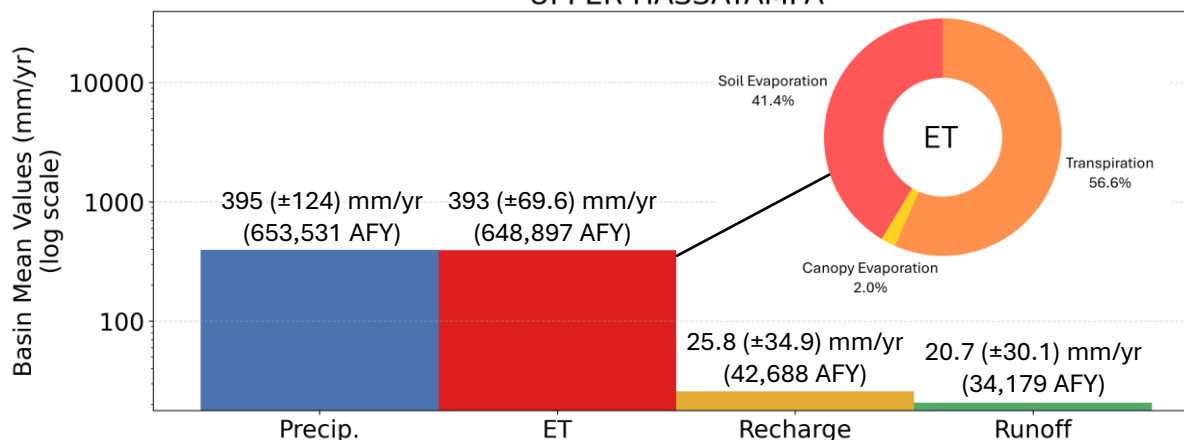
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.40** (Moderate)

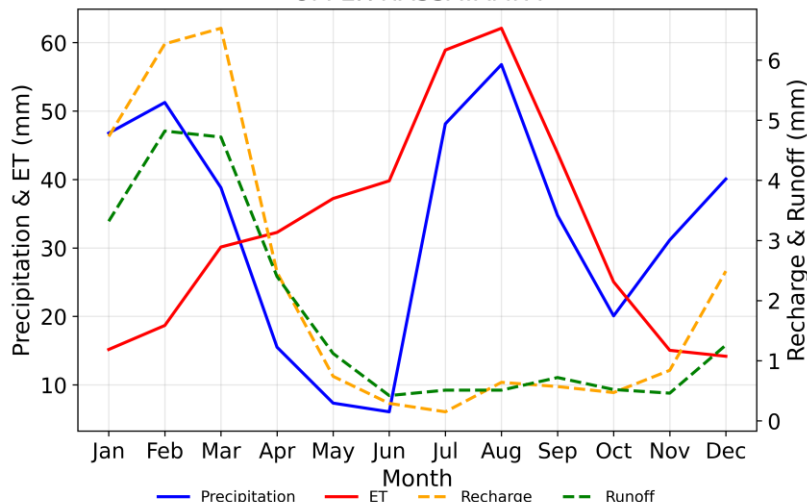


Mean Annual Hydrologic Cycle Components (1980-2020)  
UPPER HASSAYAMPA



**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.<sup>6</sup> 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)  
UPPER HASSAYAMPA



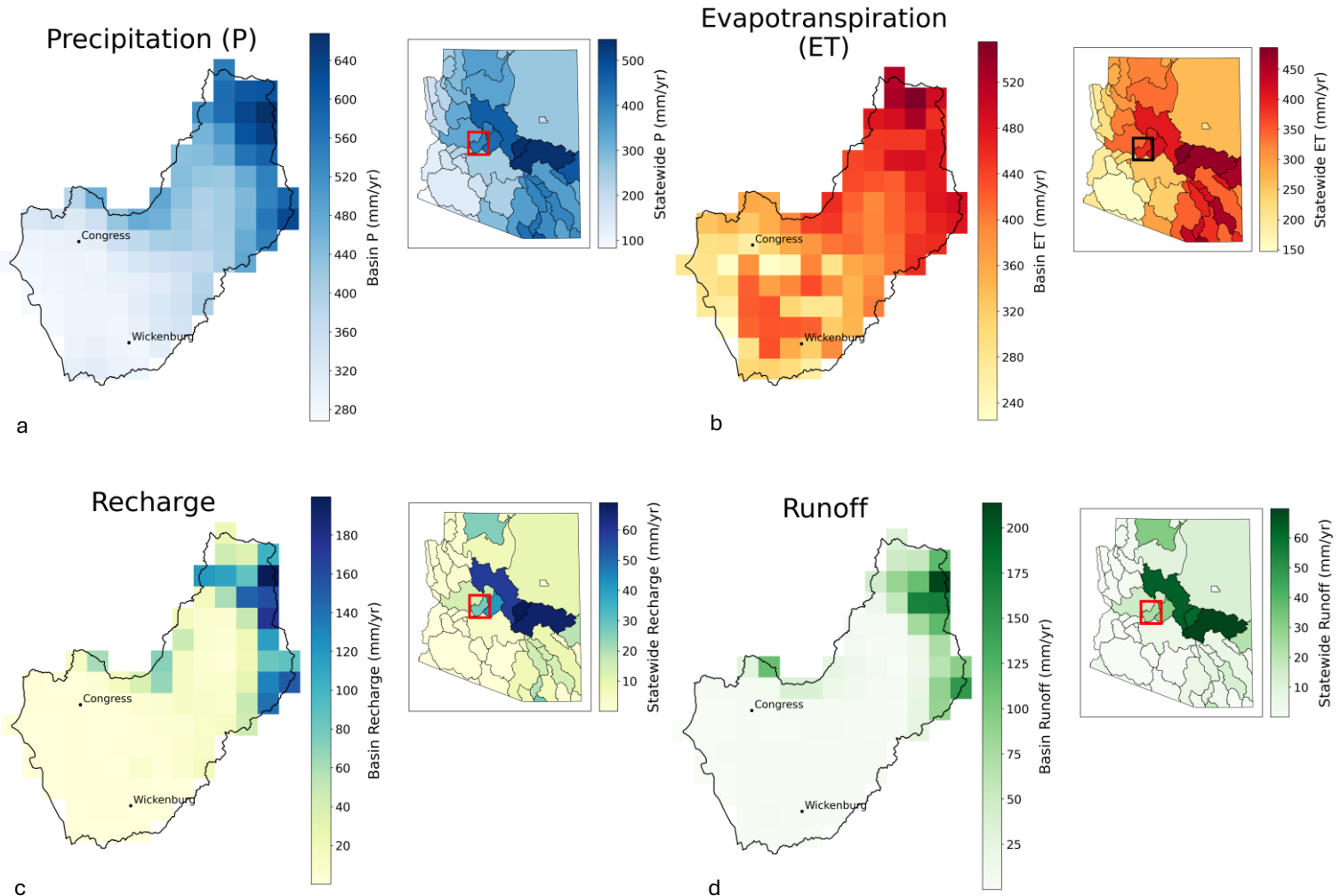
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

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.

# Upper Hassayampa

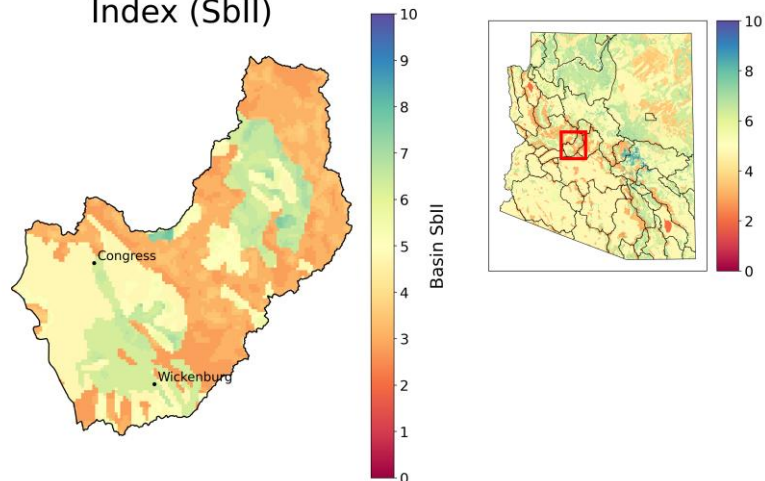


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

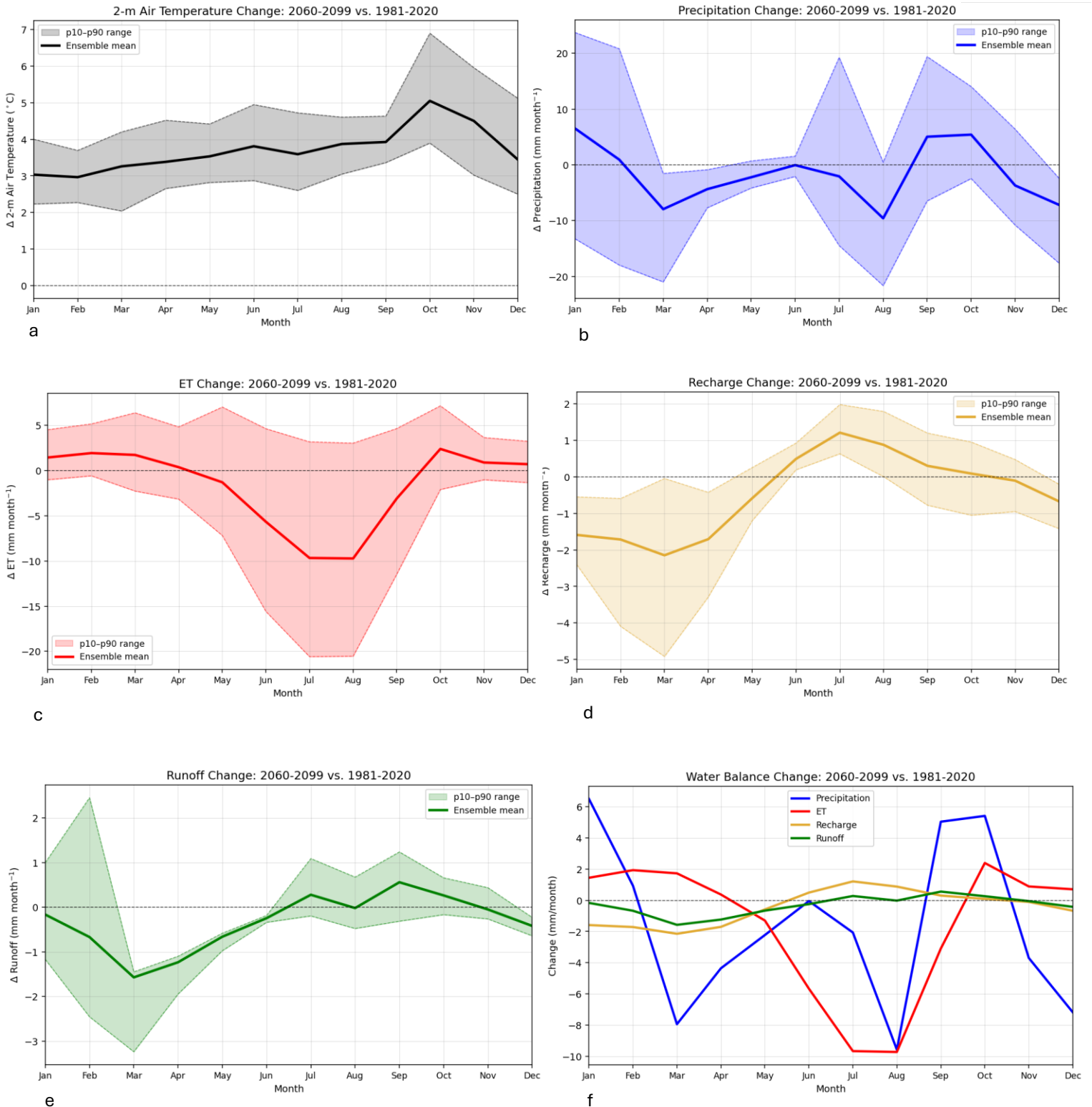
## Subsurface Infiltration Index (SbII)



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.

# Upper Hassayampa

## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.

# Upper Hassayampa



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).<sup>\*</sup> 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.

<sup>\*</sup>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/>
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# Upper San Pedro Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 1,820 square miles

**Elevation**<sup>2</sup>: Range: 3,309-9,453 ft; Median: 4,540 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (89%), Evergreen Forest (6.1%), Developed Open Space (1.8%)

**Major surface watershed(s)**<sup>4</sup>: San Pedro River

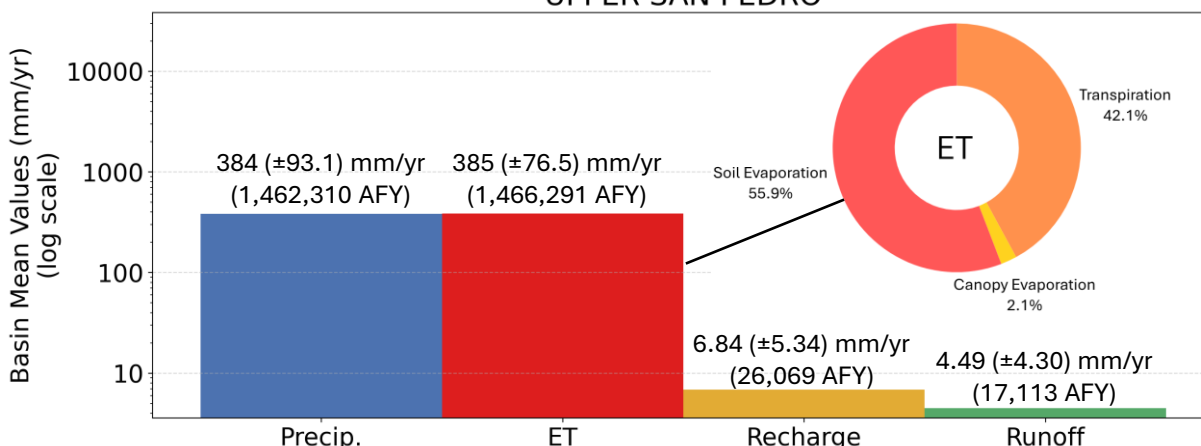
**Groundwater subbasins**<sup>1</sup>: Allen Flat, Sierra Vista

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.51** (Moderate)

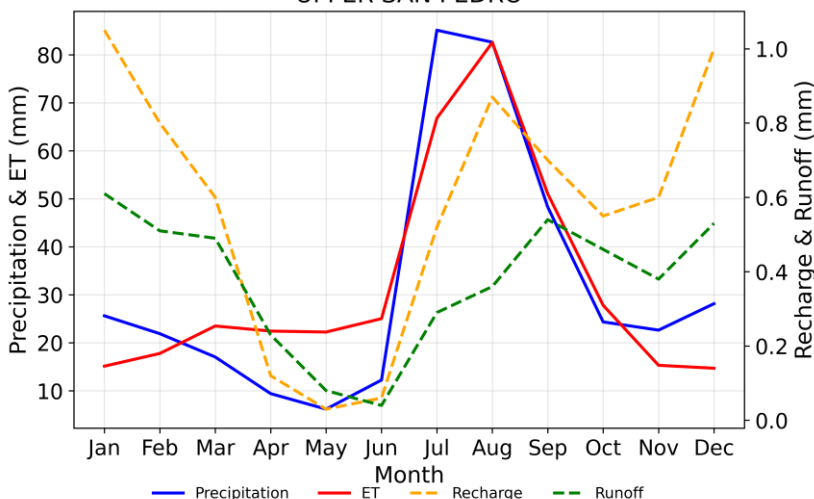


Mean Annual Hydrologic Cycle Components (1980-2020)  
UPPER SAN PEDRO



**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.<sup>6</sup> 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)  
UPPER SAN PEDRO



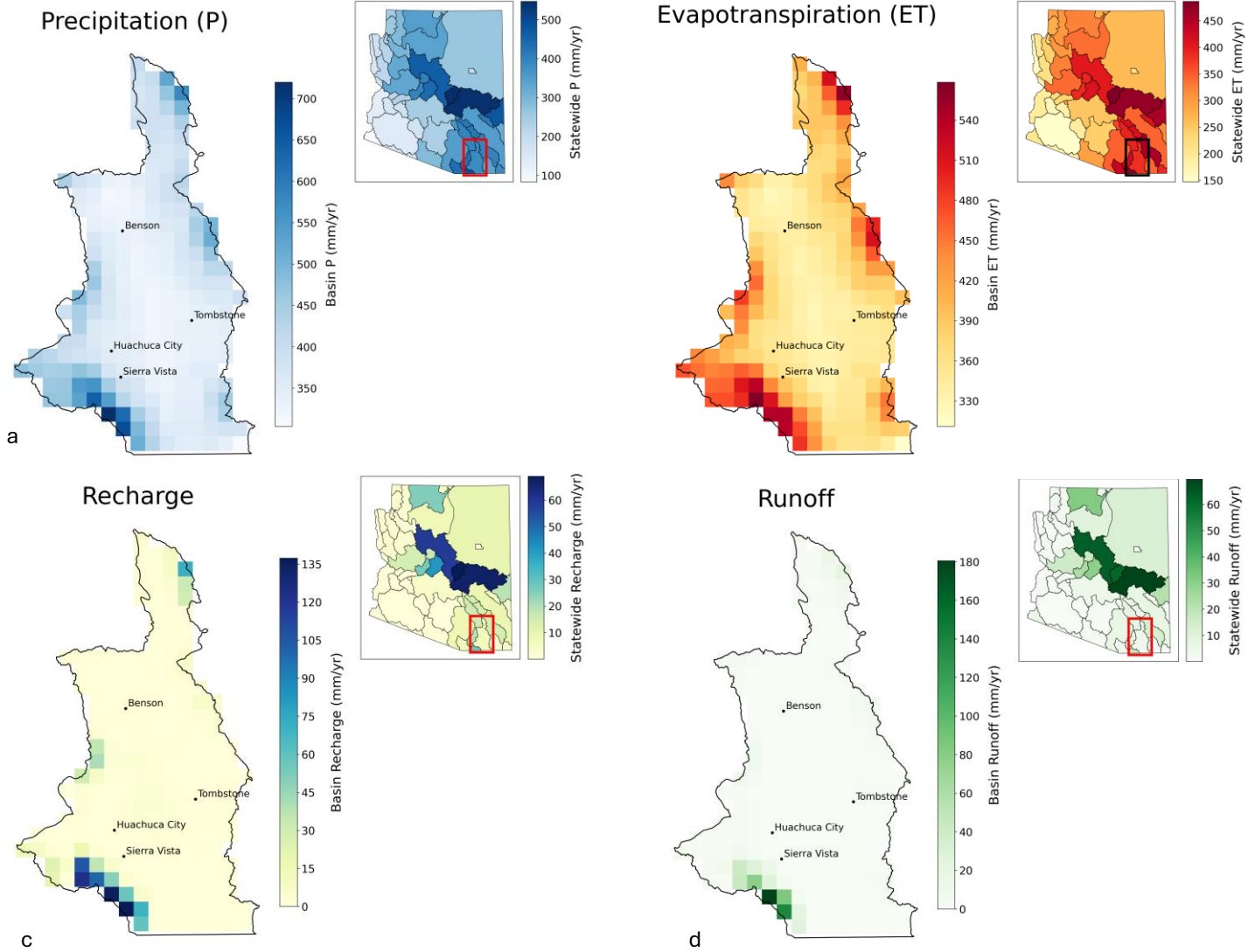
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) is approximately equal to annual precipitation (P) across the basin, resulting in low basin-wide annual averages for natural recharge (6.84 mm) and runoff (4.49 mm). P in the Upper San Pedro basin is affected by the North American Monsoon during the summer months. ET approximately tracks with P throughout the year, although it exceeds P from mid-February to mid-June by as much as ~15 mm on average (in May). Soil evaporation makes up 55.9% of total ET in the basin, while transpiration comprises 42.1% and canopy evaporation accounts for the remainder (2.1%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months.

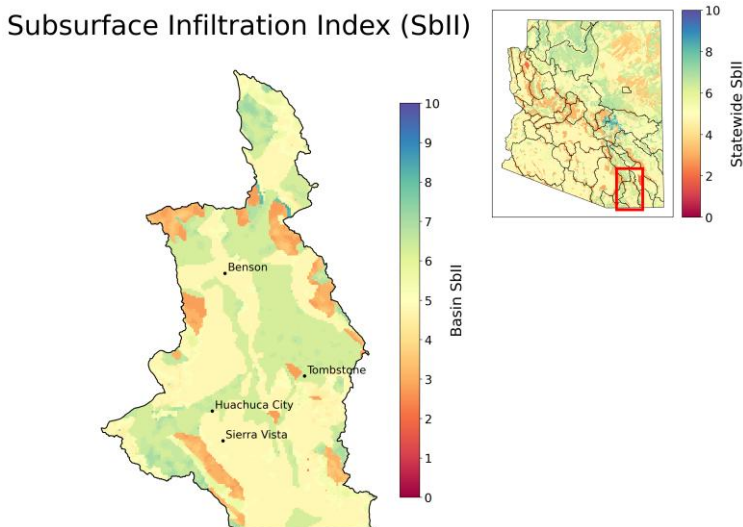
# Upper San Pedro



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

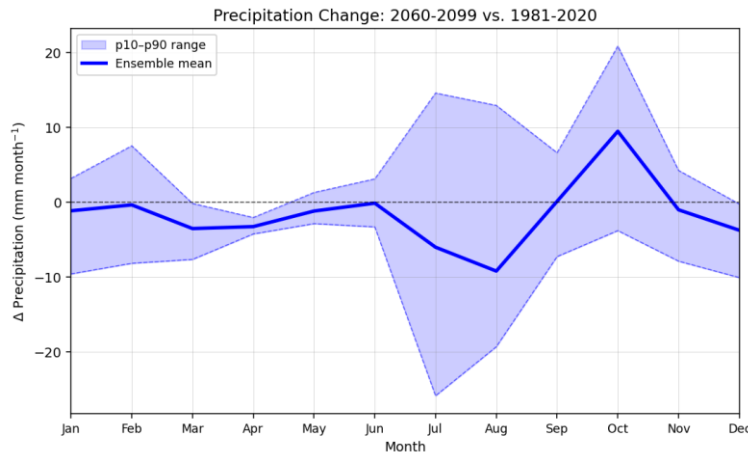
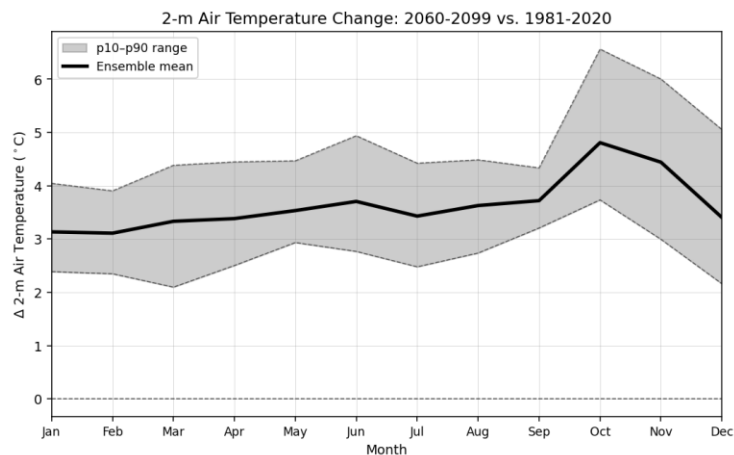


The Huachuca Mountains account for the highest precipitation in the Upper San Pedro basin, receiving ~700 mm/year. These mountain woodlands also account for the highest evapotranspiration in the basin. Natural recharge and runoff are higher near the Huachuca mountain front than elsewhere in the basin (both greater than 120 mm/year). Infiltration potential varies throughout the basin, but is generally greater along the high permeability tributary alluvial fan deposits to the east and west of the San Pedro River.

# Upper San Pedro

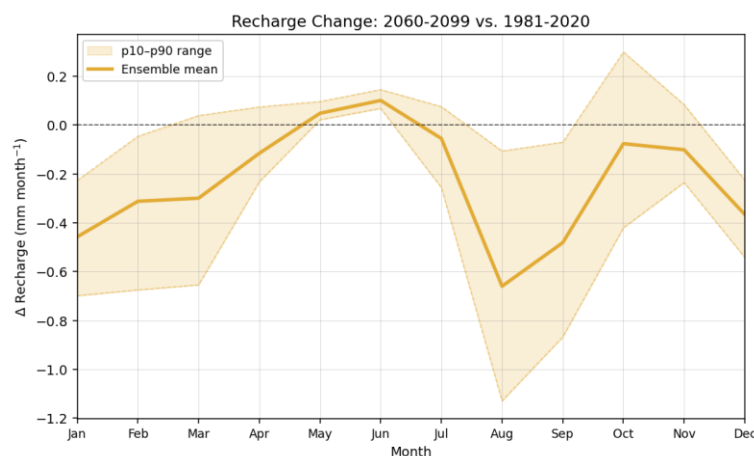
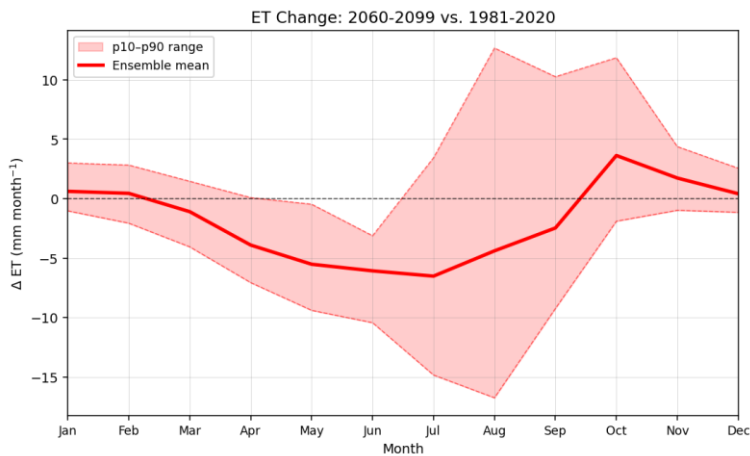


## Climate Change Projections: Changes in Temperature, Precipitation, ET, Recharge, and Runoff (2060-2099 vs. 1981-2020)



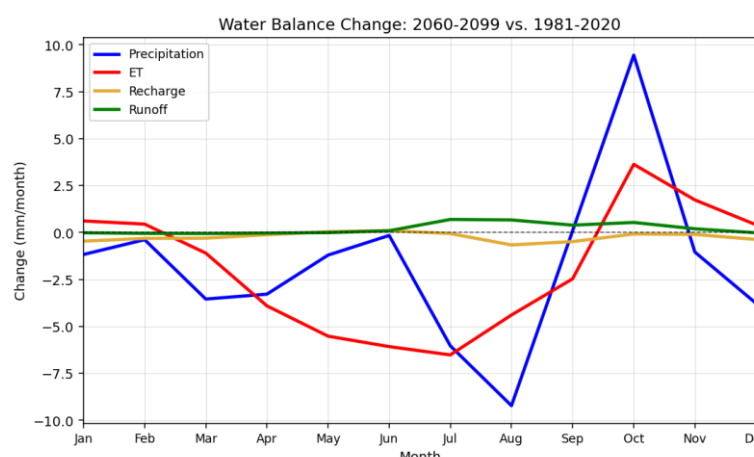
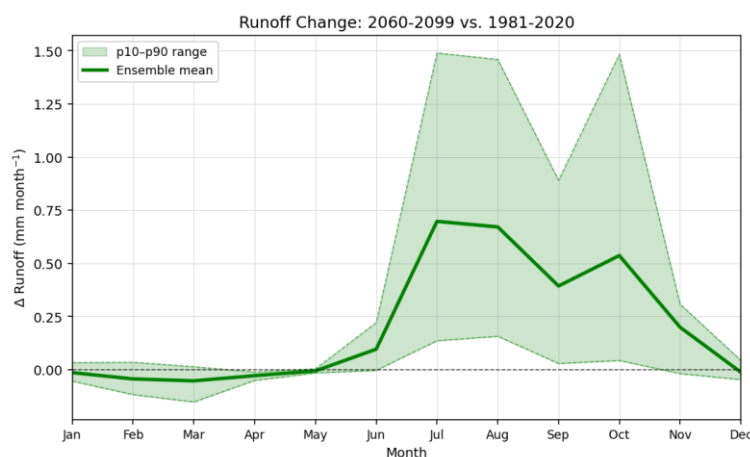
a

b



c

d



e

f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Upper San Pedro basin show drier springs (19-38% drier March through May), a drier July-August (7-11%), and a drier November-December (5-12%). October is projected to be 37% (9.6 mm) 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. Declines in recharge ranging from 32-50% are projected for highest recharge months, from January to March (-0.30 to -0.47 mm/month) and August to September (-0.49 to -0.67 mm/month). Despite showing less water loss from the system (i.e., a positive increase in Figure 8(d)), recharge projections are slightly negative (-0.04 mm/month) in June.\* Runoff is projected to decrease slightly January through April (-0.01 to -0.05 mm/month), while increasing by 0.10 to 0.70 mm/month from June through November. Projected increases in temperature range from approximately 3.1 °C in February to 4.8 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 12% (3.6 mm) increase in evapotranspiration (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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# Verde River Groundwater Basin Profile



## Basin Summary Statistics

**Size**<sup>1</sup>: 5,662 square miles

**Elevation**<sup>2</sup>: Range: 1,731-12,621 ft; Median: 5,293 ft

**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (59%), Evergreen Forest (37%), Grassland Herbaceous (1.2%)

**Major surface watershed(s)**<sup>4</sup>: Upper and Lower Verde River

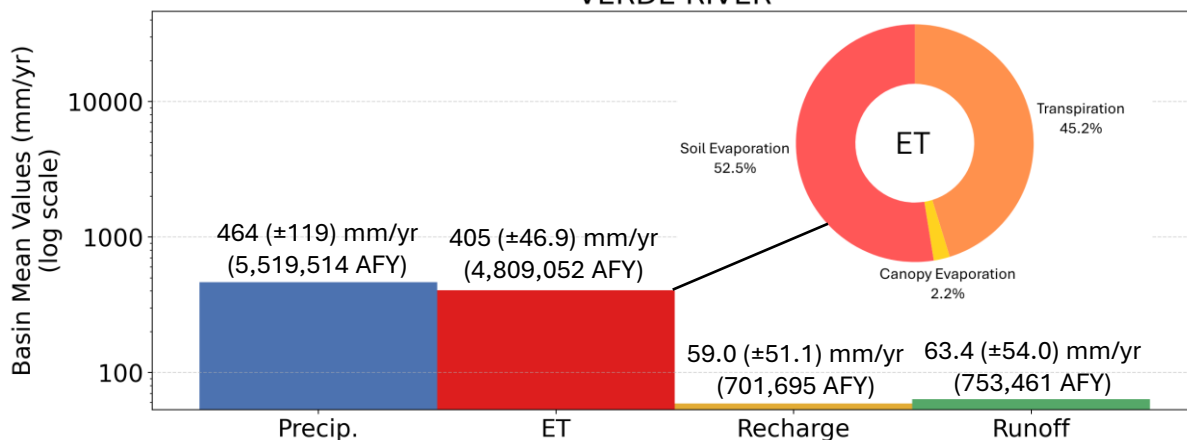
**Groundwater subbasins**<sup>1</sup>: Big Chino, Verde Valley, Verde Canyon

**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.45** (Moderate)

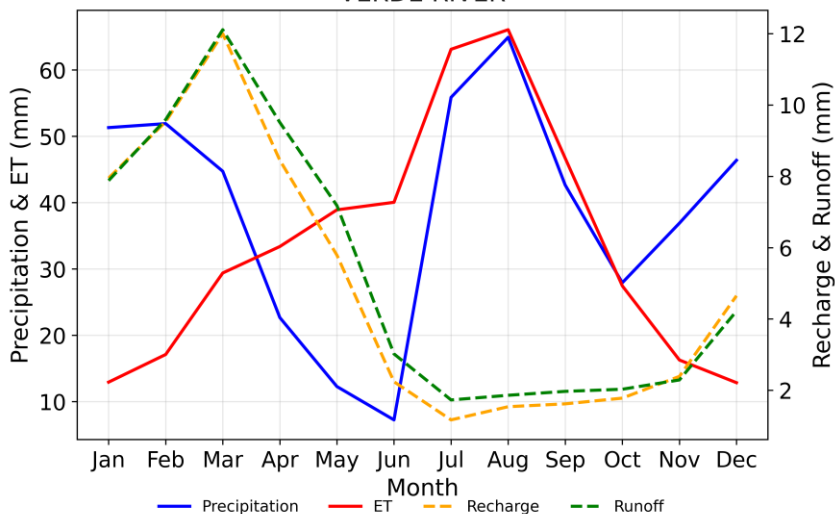


## Mean Annual Hydrologic Cycle Components (1980-2020) VERDE RIVER



**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.<sup>6</sup> 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) VERDE RIVER



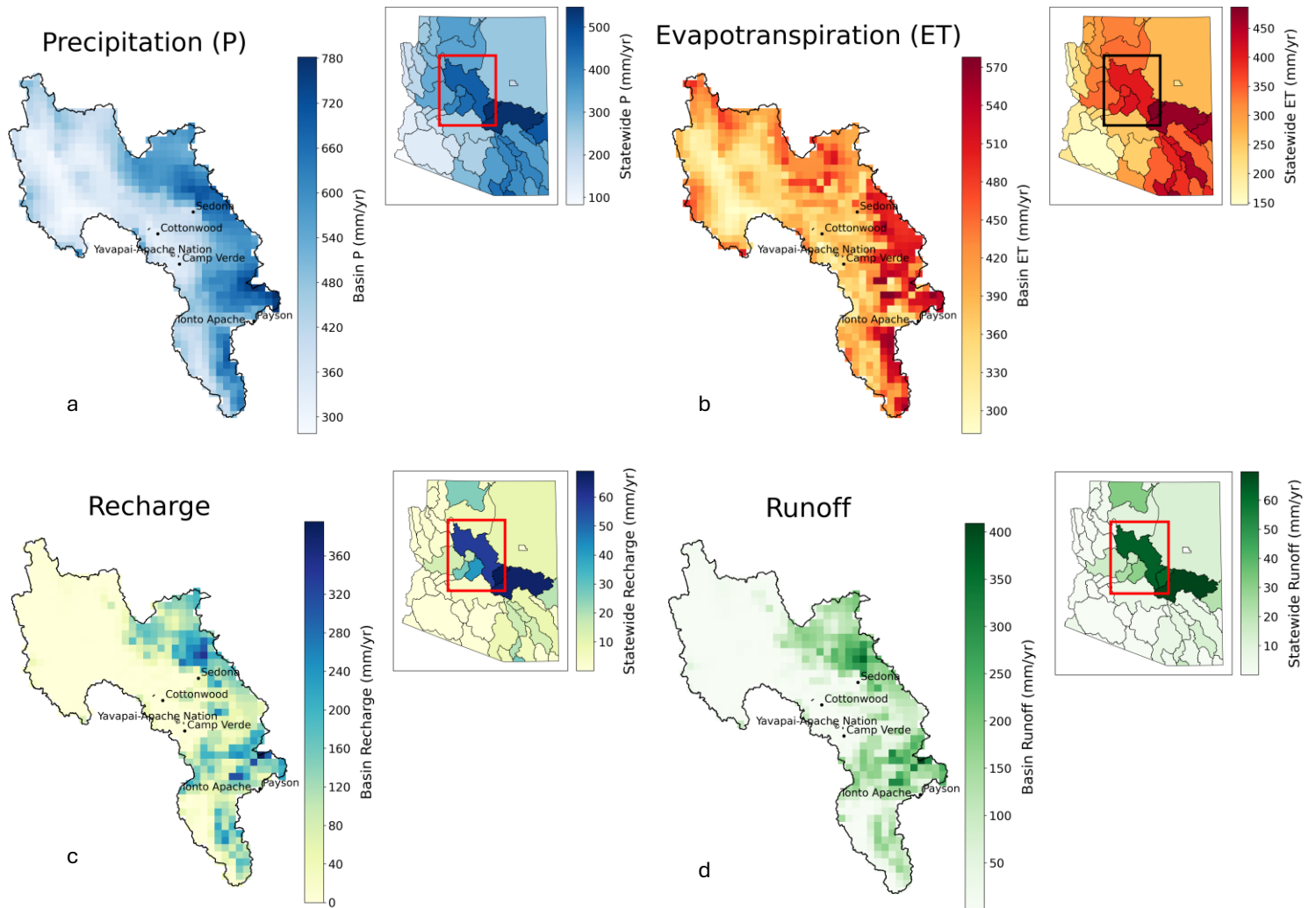
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

Precipitation (P) in the Verde River basin is affected by the North American Monsoon during the summer months and large frontal systems during the winter. P exceeds evapotranspiration (ET) from October through mid-March, leading to higher amounts of recharge and surface runoff than other nearby basins during the cooler months. Natural recharge (59.0 mm/yr) and runoff (63.4 mm/yr) are highest in March as a result of springtime snowmelt and low evaporative demand. Soil evaporation makes up 52.5% of total ET in the basin, while transpiration comprises 45.2% and canopy evaporation accounts for the remainder (2.2%). Groundwater is estimated to supply 45% of total streamflow in the Verde River basin. 1

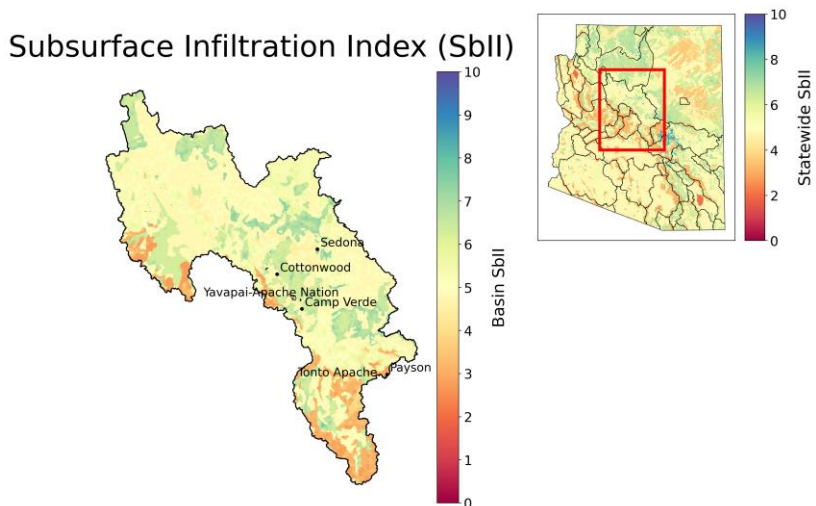
# Verde River



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> 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.<sup>9</sup>

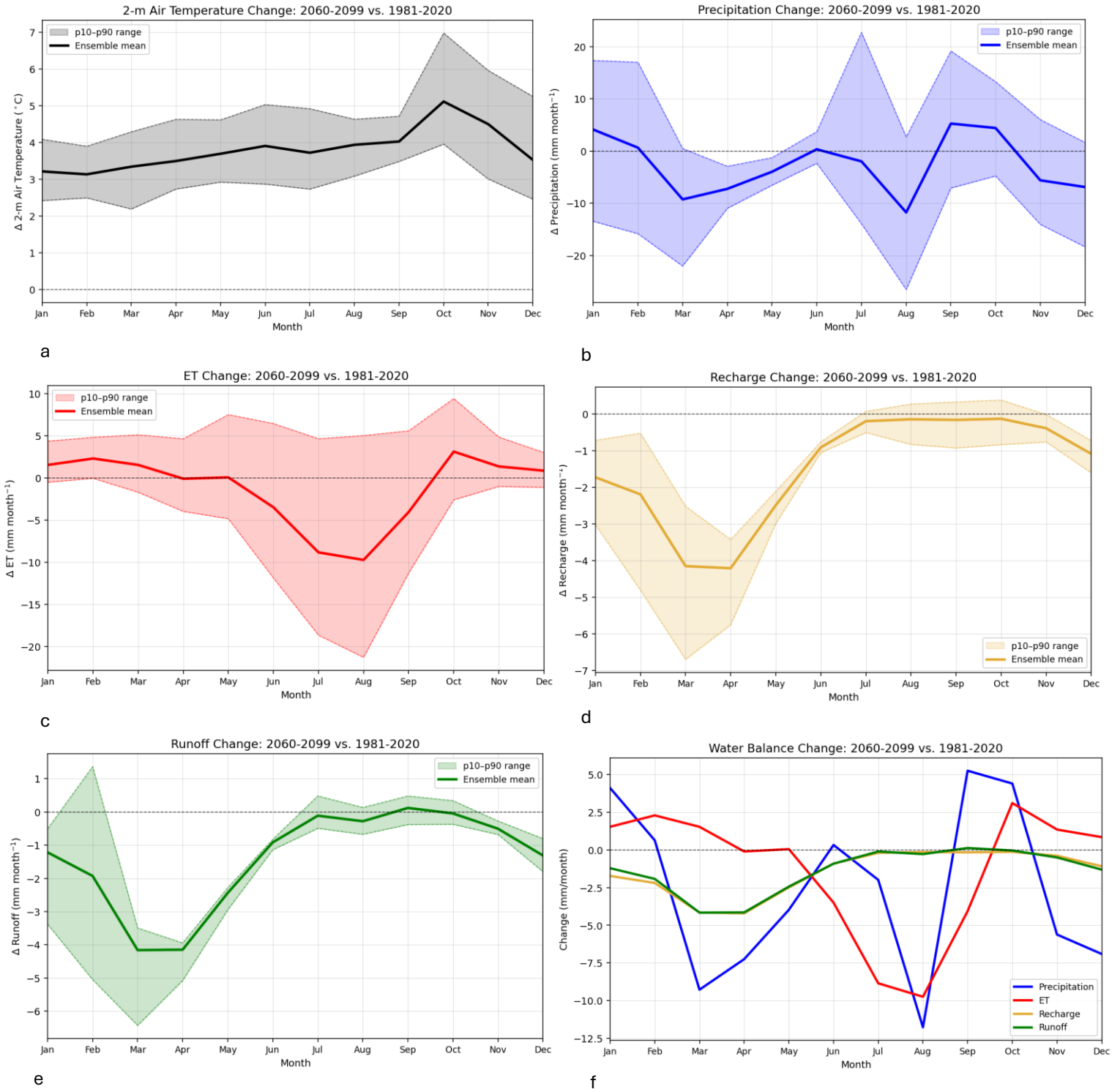


Precipitation (P) in the Verde River basin is greatest at the higher elevations along the Mogollon Rim, where P can exceed 700 mm/yr on average. ET (>520 mm/yr), natural recharge (>300 mm/yr), and runoff (>300 mm/yr) are also highest in along the Rim and the Mazatzal Mountains. Overall, the basin has moderate infiltration potential with pockets of higher potential. Areas with higher potential result from presence of faults and karst-type geology as well as alluvial deposits along the Verde River.

# Verde 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Verde River basin show drier springs (19-34% drier March through May) and a drier August (17%), November (16%), and December (14%). September and October are projected to be 12-14% (4.3-5.1 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. Declines in natural recharge are projected for most months of the year, with the highest recharge months (February-April) showing declines of 44-64% (-2.3 to -4.3 mm/month), and June-November showing negative recharge (-0.11 to -0.82 mm/month)\*. Similarly, runoff is also projected to decrease throughout most months of the year, particularly during the highest runoff months (February-April, -2.0 to -4.2 mm/month). Projected increases in temperature range from approximately 3.2 °C in February to 5.2 °C in October. Less precipitation in August leads to a projected 13% (-9.8 mm) decrease in evapotranspiration (ET), while higher temperatures and greater water availability lead to a projected 10% (3.1 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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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Virgin River Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 434 square miles

**Elevation<sup>2</sup>:** Range: 1,586-7,977 ft; Median: 3,224 ft

**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (71%), Evergreen Forest (17%), Grassland Herbaceous (9.2%)

**Major surface watershed(s)<sup>4</sup>:** Virgin River

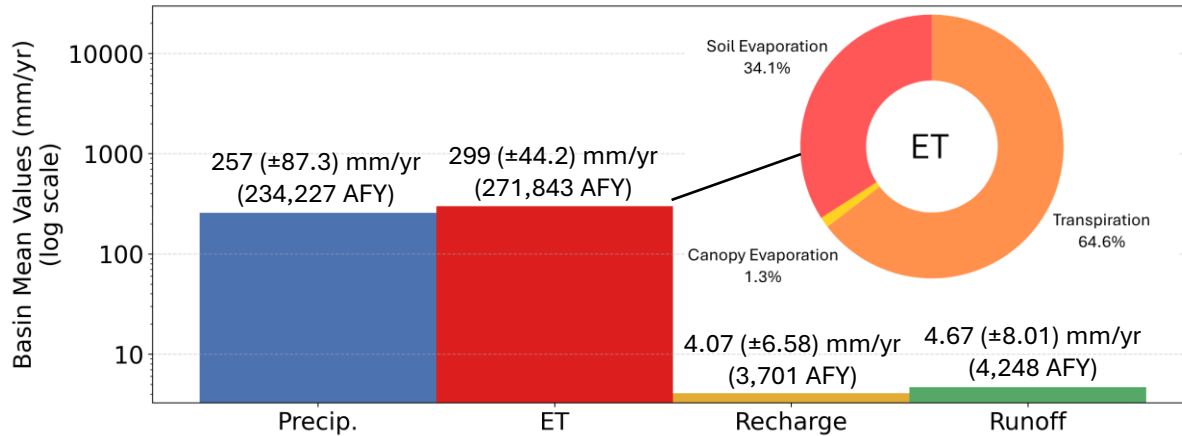
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.42 (Moderate)**

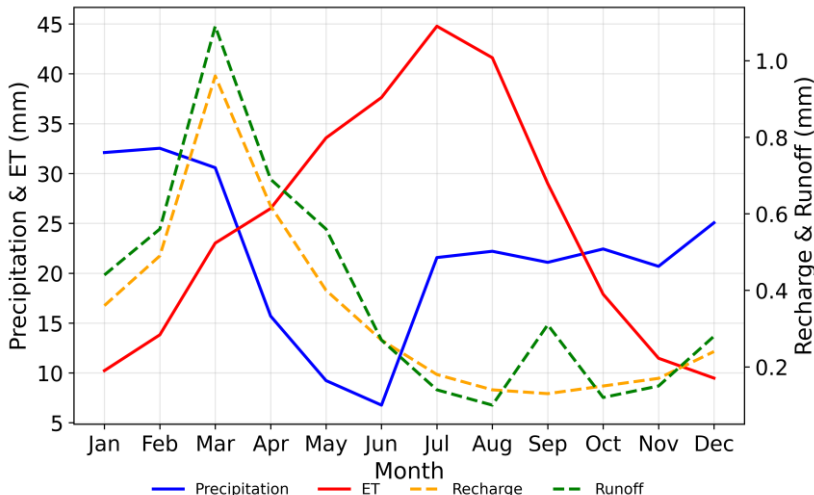


Mean Annual Hydrologic Cycle Components (1980-2020)  
VIRGIN RIVER



**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.<sup>6</sup> 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)  
VIRGIN RIVER



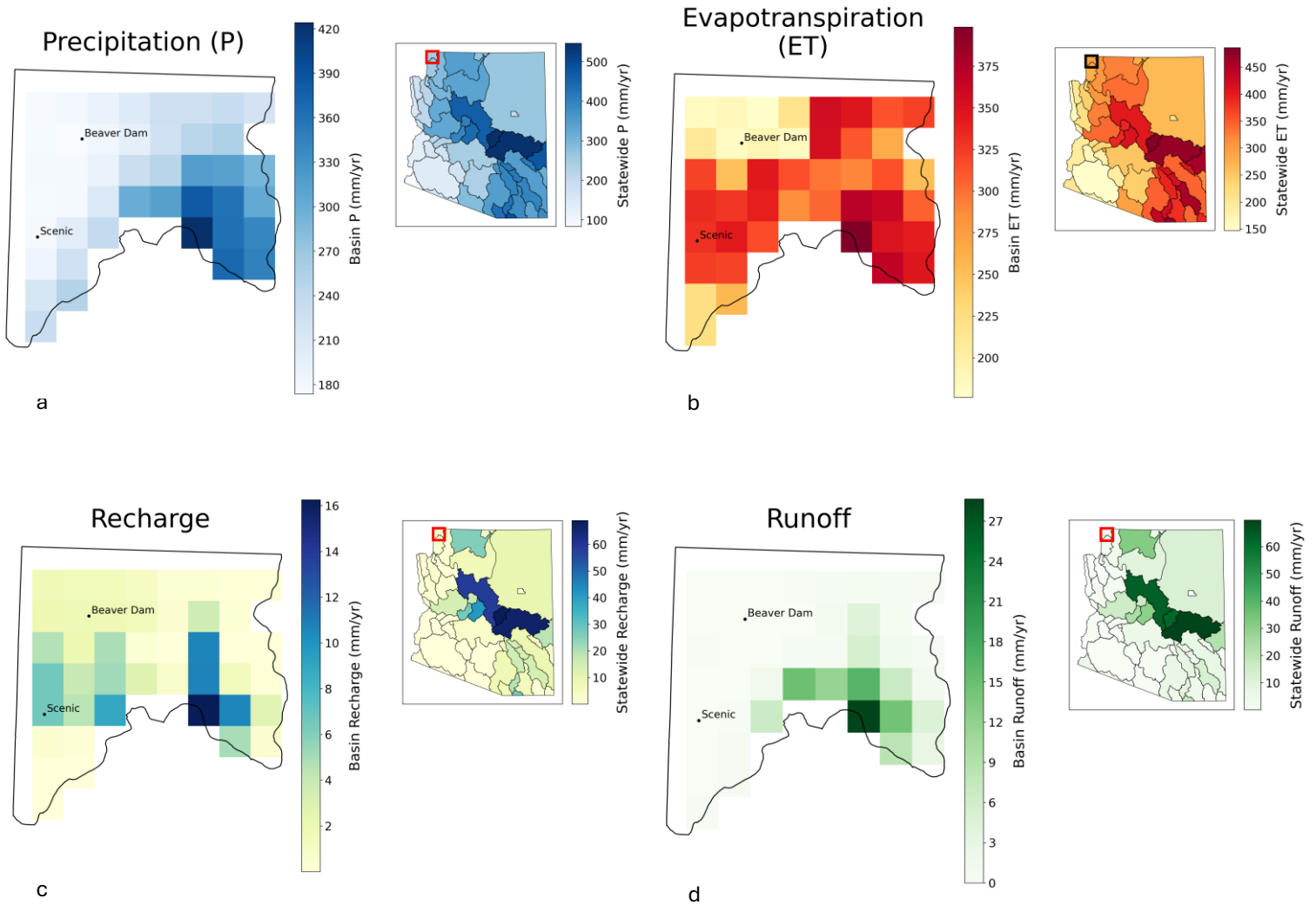
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

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.

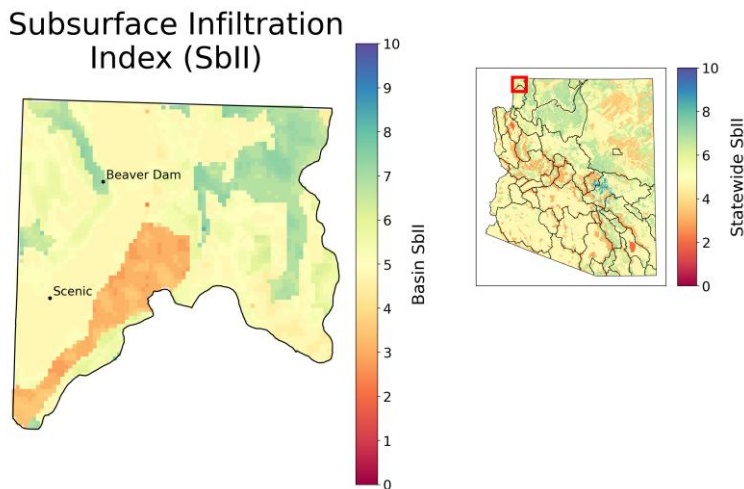
# Virgin River



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



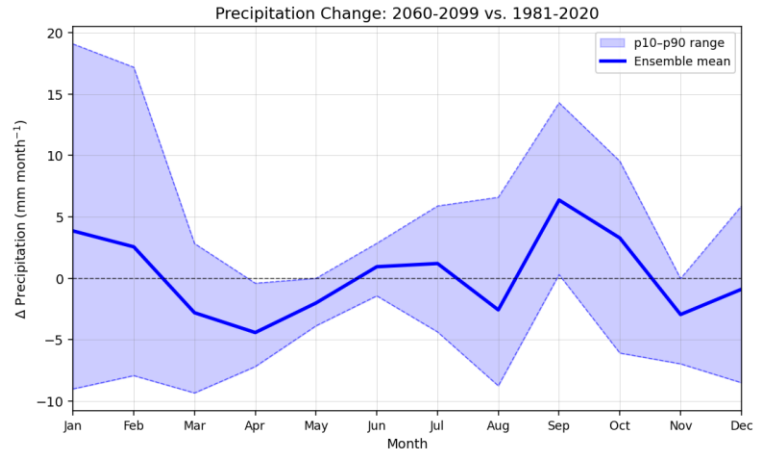
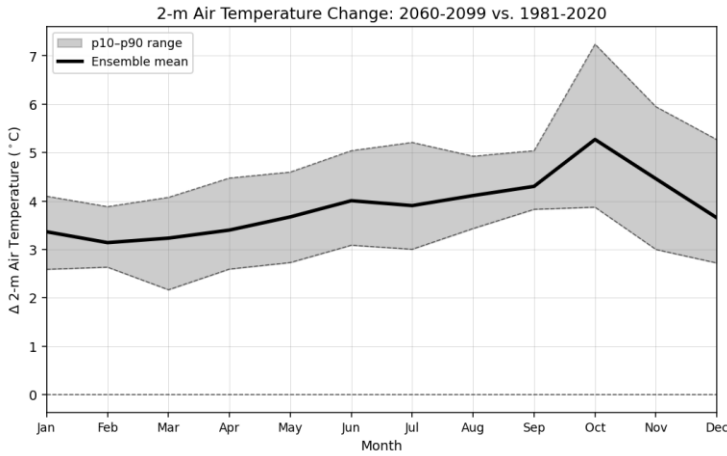
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



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 in the northeast region of the basin due to the presence of karst-type geology.

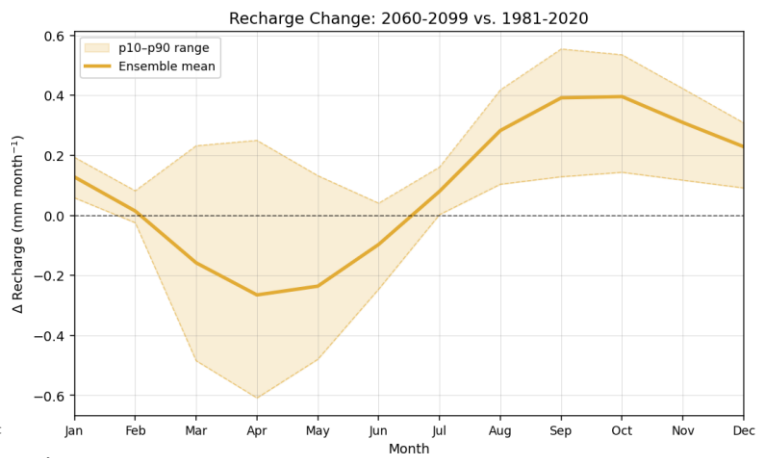
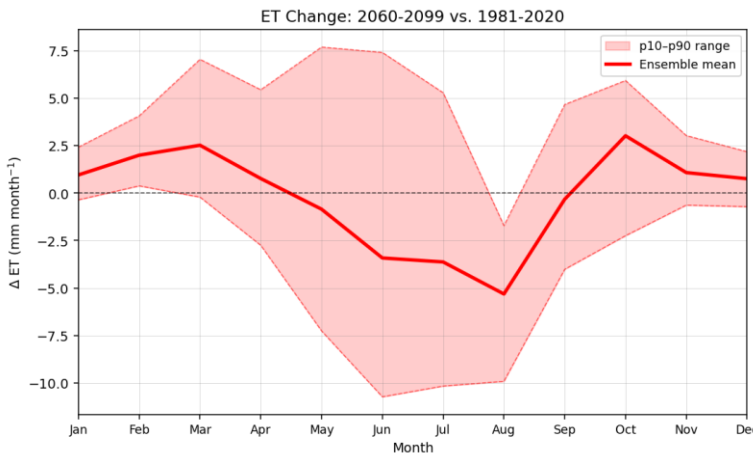


## Climate Change Projections: Changes in Temperature, Precipitation, ET, Recharge, and Runoff (2060-2099 vs. 1981-2020)



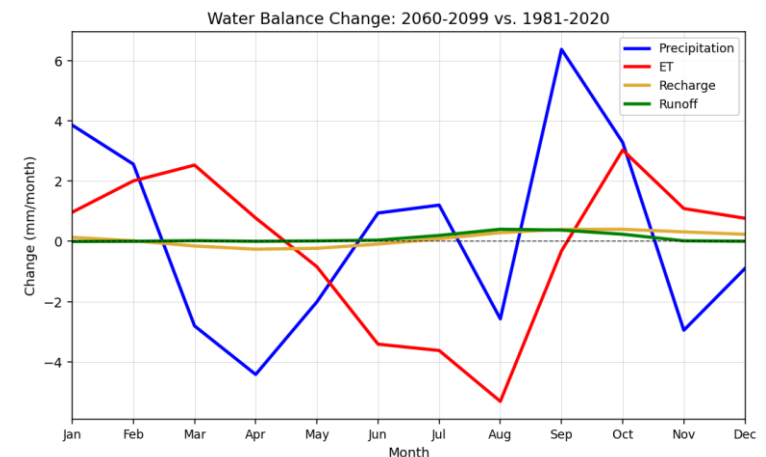
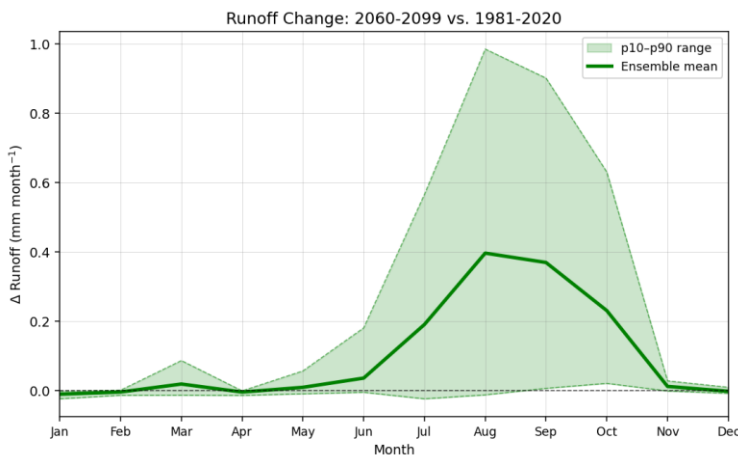
a

b



c

d



e

f

**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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



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).<sup>\*</sup> 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).

<sup>\*</sup>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/>
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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>
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8. Federal American Indian Reservation boundaries shapefile. Retrieved from: [https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/Federal\\_American\\_Indian\\_Reservations\\_v1/FeatureServer](https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/Federal_American_Indian_Reservations_v1/FeatureServer)
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10. Qiu, Y. (2026). Future Projection of Hydroclimate over Arizona Version 2, HydroShare, <https://doi.org/10.4211/hs.a5751f0af305483682501f79d9af0bd7>



# Western Mexican Drainage Groundwater Basin Profile



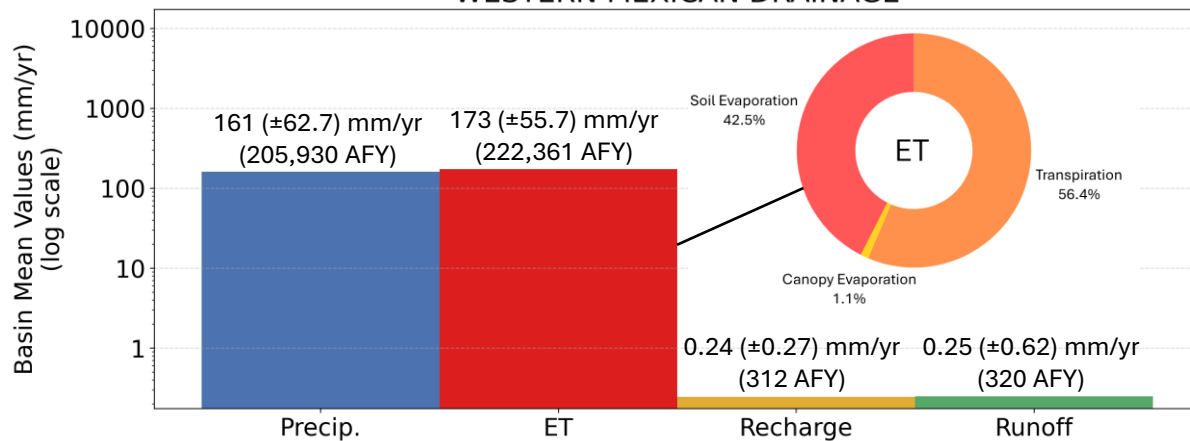
## Basin Summary Statistics

**Size<sup>1</sup>:** 610 square miles  
**Elevation<sup>2</sup>:** Range: 682-4,799 ft; Median: 1,180 ft  
**Top 3 land cover types by area<sup>3</sup>:** Shrub/Scrub (95%), Grassland Herbaceous (2.3%), Barren Land (2.2%)  
**Major surface watershed(s)<sup>4</sup>:** Rio Sonoyta, Tule Desert  
**Groundwater subbasins<sup>1</sup>:** None  
**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.36** (Moderate)

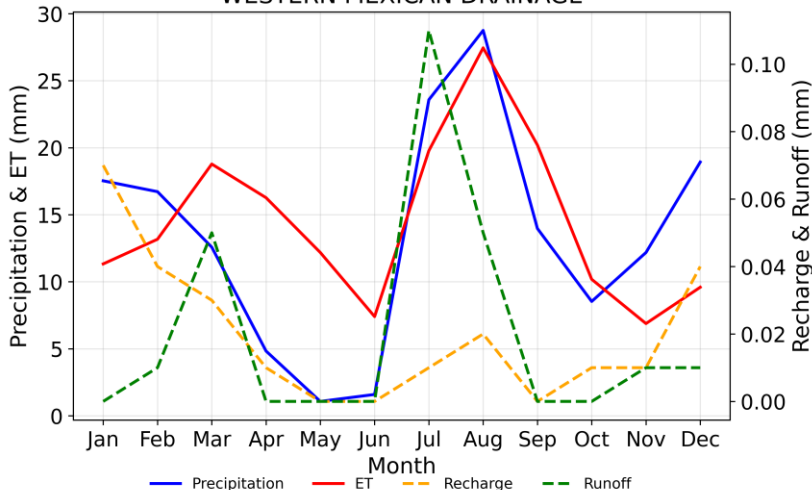


Mean Annual Hydrologic Cycle Components (1980-2020)  
WESTERN MEXICAN DRAINAGE



**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.<sup>6</sup> 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.

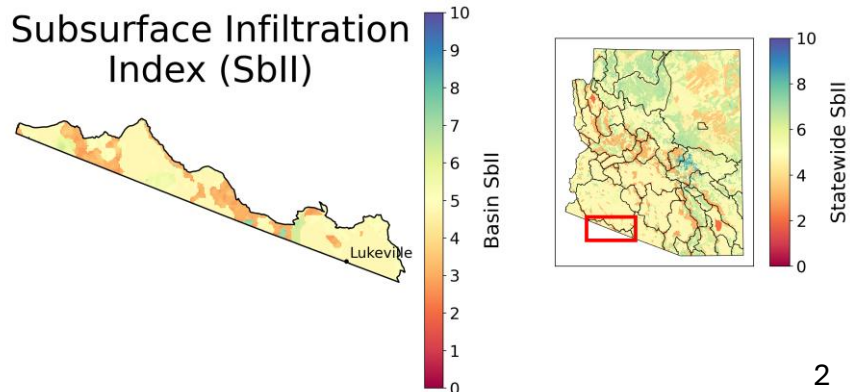
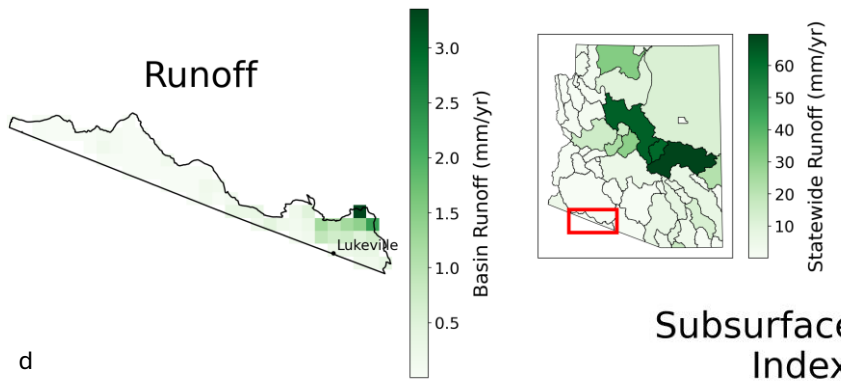
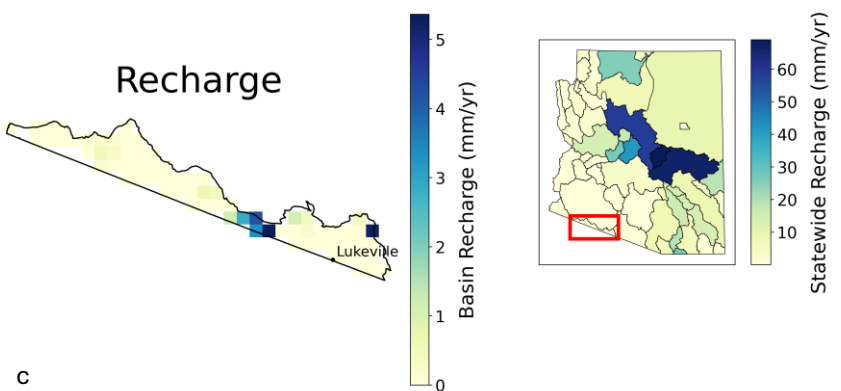
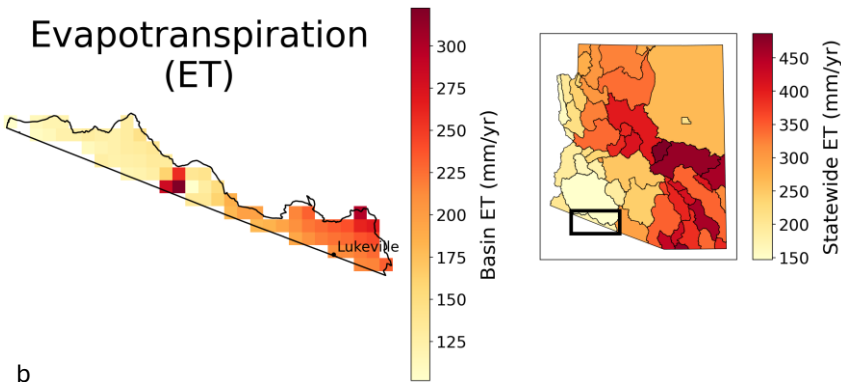
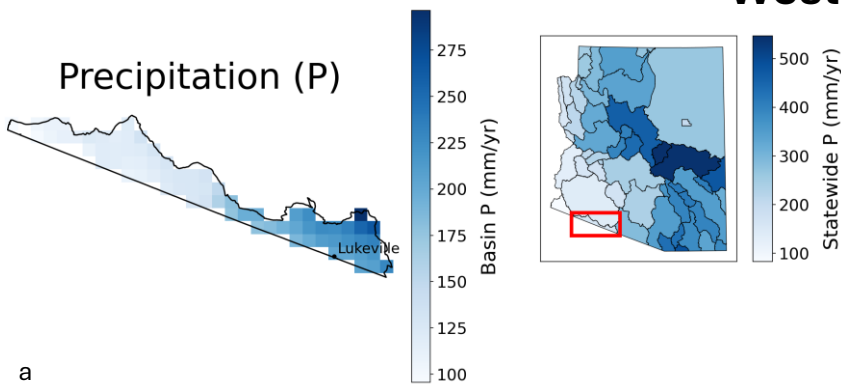
Mean Monthly Hydrologic Cycle Components (1980-2020)  
WESTERN MEXICAN DRAINAGE



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

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average across the Western Mexican Drainage basin, yielding near zero annual averages for natural recharge (0.24 mm) and runoff (0.25 mm). Seasonally, P in the Western Mexican Drainage basin 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 42.5% of total ET in the basin, while transpiration comprises 56.4% and canopy evaporation accounts for the remainder (1.1%).

# Western Mexican Drainage



**Figure 4 (right).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>

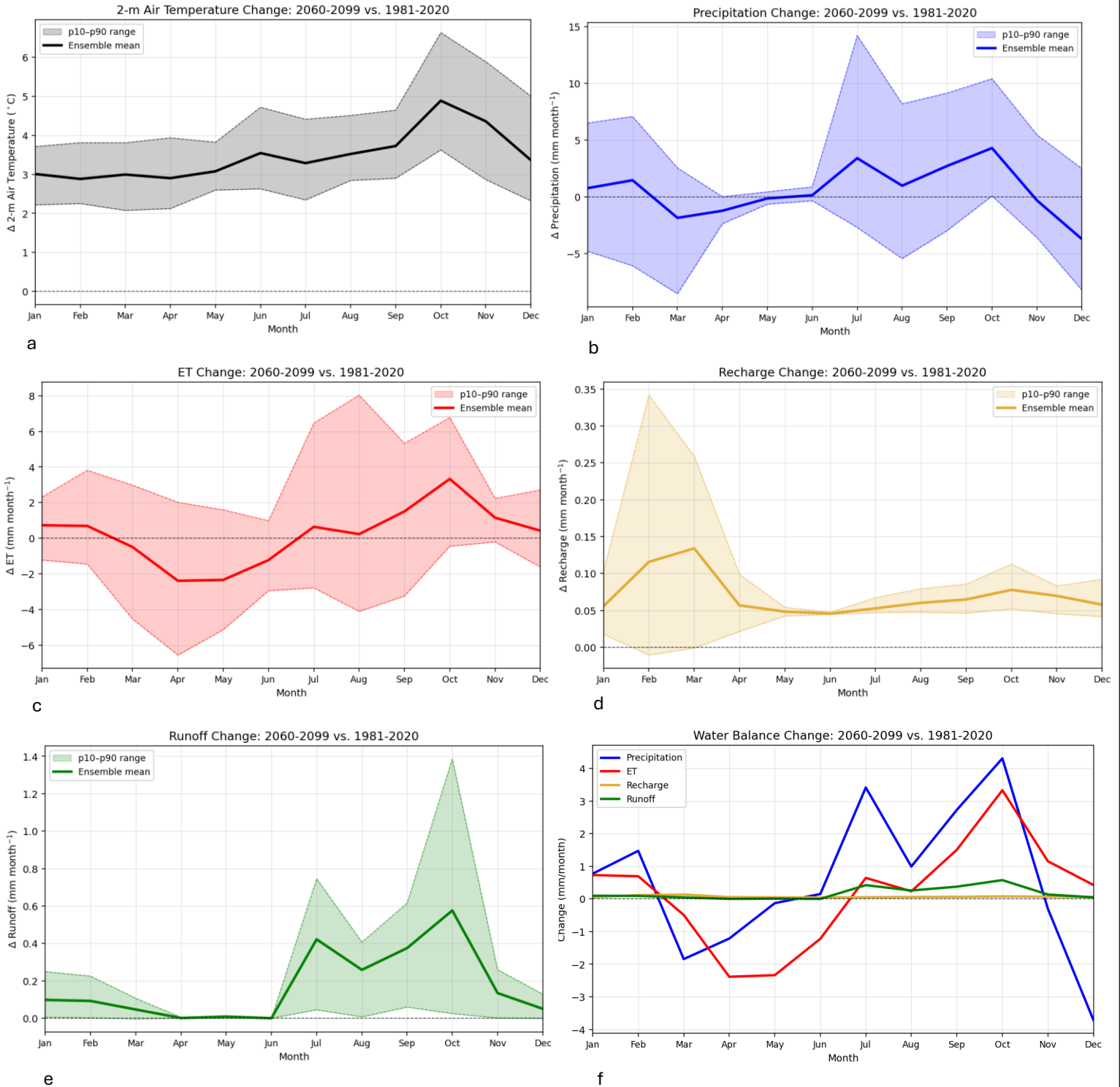
**Figure 3 (left).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are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

Precipitation in the Western Mexican Drainage basin is highest in the Ajo Range to the east, which receives over 250 mm/yr on average. Evapotranspiration (ET, ~260 mm/yr) is also highest in this area. Natural recharge and runoff are generally minimal across the basin; however, in the Ajo Range, recharge can exceed 5 mm/yr and runoff exceeds 3 mm/yr. The Agua Dulce Mountains west of Lukeville also have ~5 mm/yr of natural recharge. Subsurface infiltration potential is generally low to moderate across the basin; however, the presence of karst-type geology in the mountains and coarse-grained alluvial deposits north of the Sonoyta River create pockets of higher infiltration potential.

# Western Mexican Drainage



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.

# Western Mexican Drainage



Climate change projections across the Western Mexican Drainage basin show drier springs (9-36% drier March through May) and a drier December (18%). January-February (4-8%) and June-October (3-48%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.8-4.4 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (-0.01 to -0.03 mm/month) from April through September, and November-December.\* While runoff is projected to remain below 0.7 mm/month, minor increases of 0.31-0.65 mm/month are projected for July-October. Projected increases in temperature range from approximately 2.9 °C in February to 4.9 °C in October. Evapotranspiration (ET) is projected to generally track with precipitation throughout the year, showing increases of 1-33% (0.15-3.4 mm/month) from July through October due to high temperatures and greater water availability.

\*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/>
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# Willcox AMA

## Groundwater Basin Profile



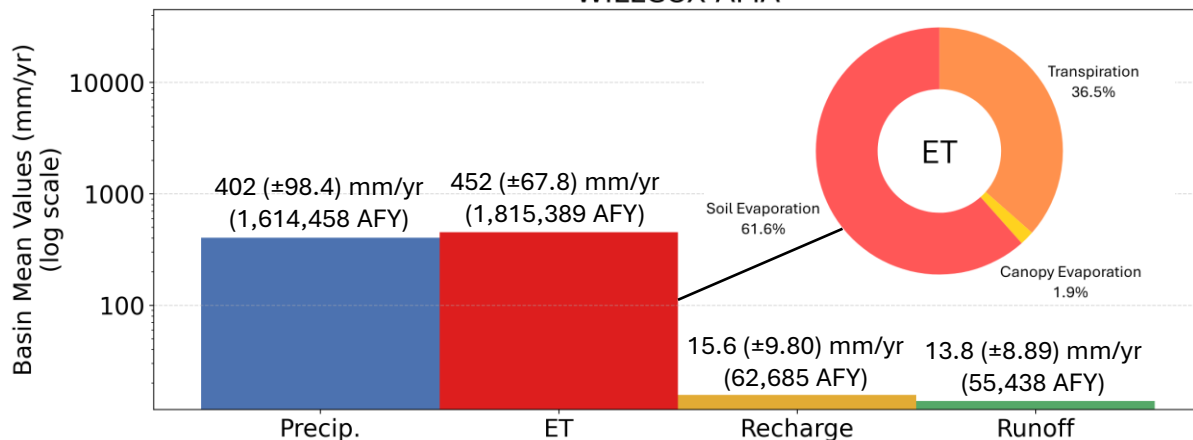
### Basin Summary Statistics

**Size**<sup>1</sup>: 1,911 square miles  
**Elevation**<sup>2</sup>: Range: 4,134-10,690 ft; Median: 4,645 ft  
**Top 3 land cover types by area**<sup>3</sup>: Shrub/Scrub (79%), Evergreen Forest (8.8%), Cultivated Crops (6.4%)  
**Major surface watershed(s)**<sup>4</sup>: Willcox Playa, Whitewater Draw  
**Groundwater subbasins**<sup>1</sup>: None  
**Groundwater-derived streamflow fraction**<sup>5</sup>:

**0.65** (Very High)

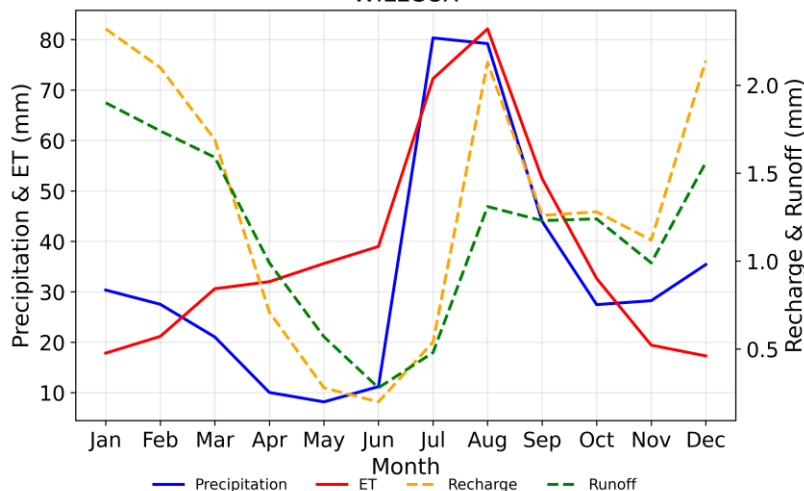


Mean Annual Hydrologic Cycle Components (1980-2020)  
WILLCOX AMA



**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.<sup>6</sup> 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)  
WILLCOX



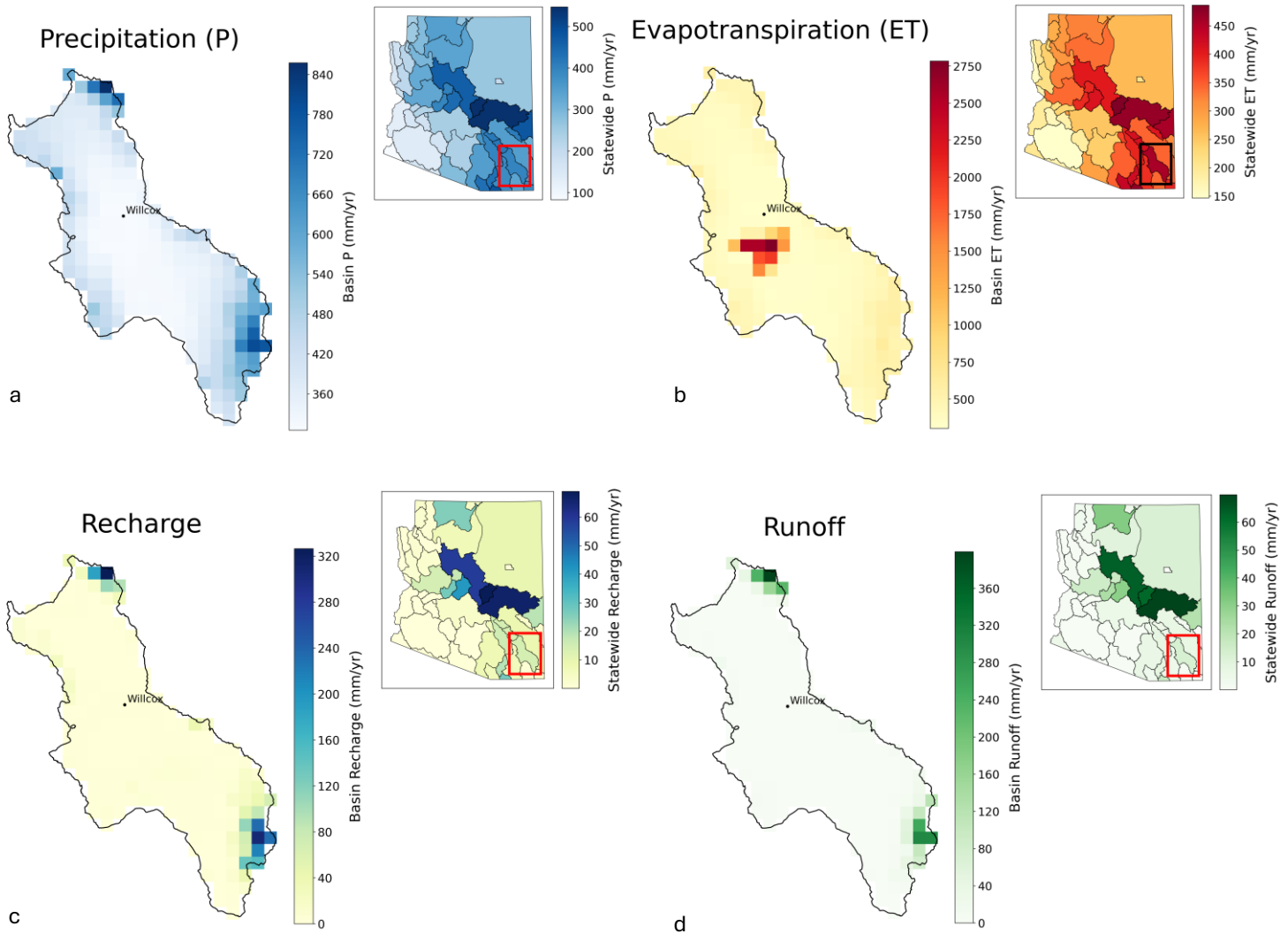
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>

On annual timescales, evapotranspiration (ET) exceeds annual precipitation (P) across the basin, resulting in relatively low basin-wide annual averages for natural recharge (15.6 mm) and runoff (13.8 mm). P in the Willcox AMA is affected by the North American Monsoon during the summer months. ET tracks with P from mid-June through October and exceeds P from mid-February to mid-June. Soil evaporation makes up 61.6% of total ET in the basin, while transpiration comprises 36.5% and canopy evaporation accounts for the remainder (1.9%). Natural recharge and runoff are highest in January due to winter precipitation and relatively low atmospheric demand during the cooler months. Natural recharge also increases in August as a result of high intensity monsoon storms.

# Willcox AMA

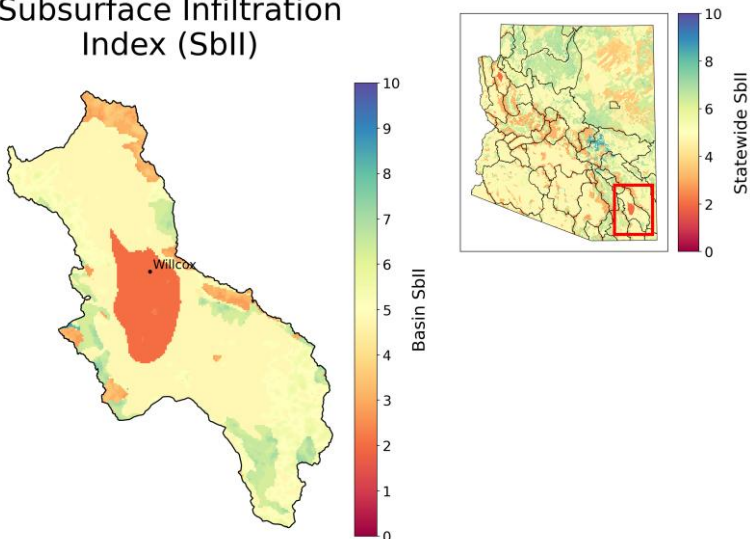


**Figure 3 (below).** Gridded depiction of mean annual water fluxes across the groundwater basin from Noah-MP modeling (1980-2020): (a) precipitation, (b) evapotranspiration, (c) recharge, (d) runoff.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are 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.<sup>9</sup>

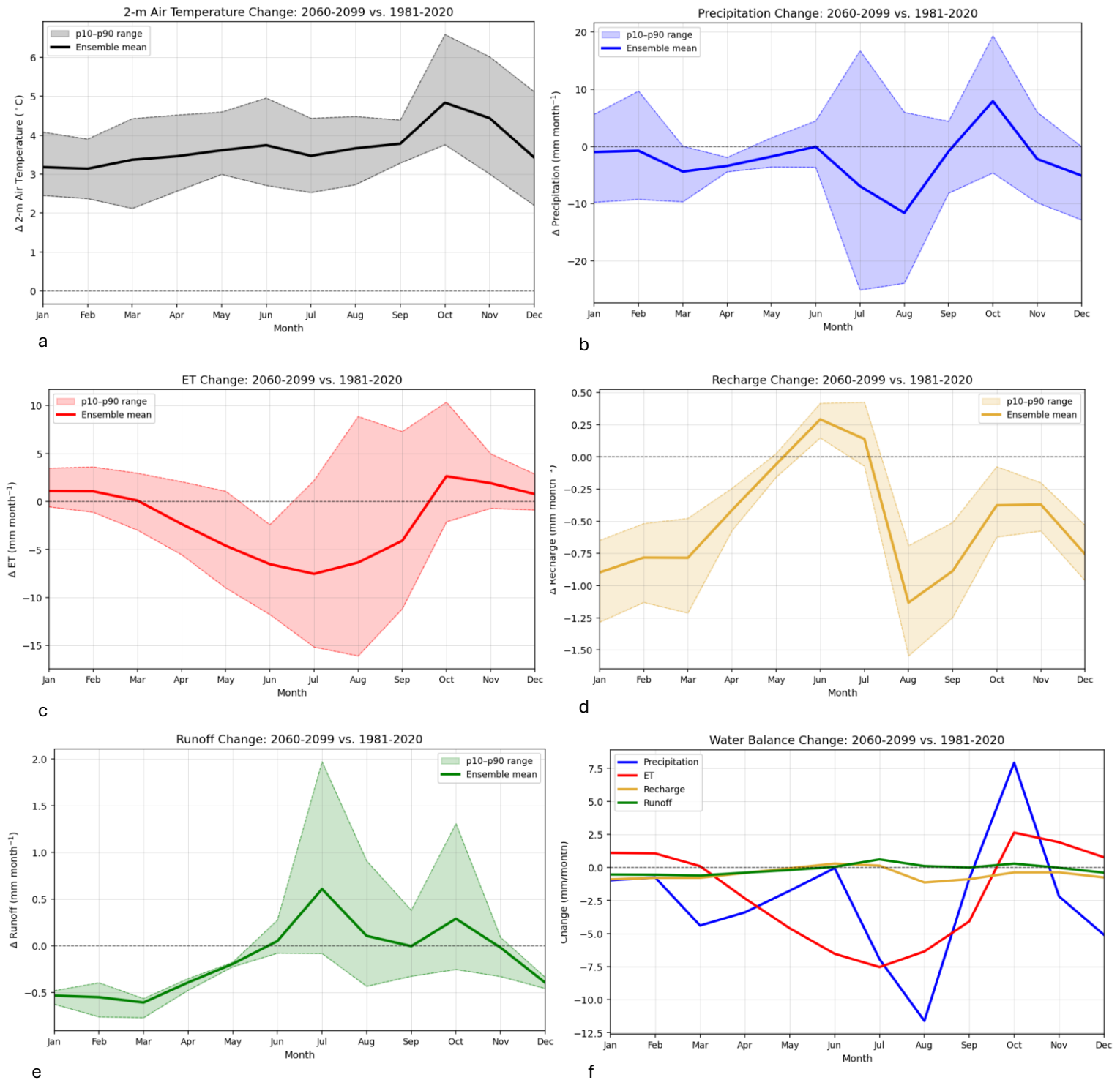
## Subsurface Infiltration Index (SbII)



Precipitation (P) in the Willcox AMA is greatest near Mount Graham to the north and in the Chiricahua Mountains to the southeast. In these regions, P can exceed 800 mm/yr. ET is highest over the Willcox Playa, where it exceeds 2,000 mm/yr on average. Runoff (>300 mm/yr) and natural recharge (>250 mm/yr) are highest at the mountain front regions of the basin. Infiltration potential varies across the basin; however, the Willcox Playa is highlighted as an area of particularly low infiltration potential due to the presence of low permeability, fine-grained sediment.



## 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Willcox AMA show drier springs (19-39% drier March through May) and a drier July-August (8-15%), November (9%), and December (14%). October is projected to be 29% (8.0 mm) 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 (January and August) are projected to have declines of 57% (-0.93 mm) and 76% (-1.1 mm), respectively. Recharge is projected to be slightly negative\* (-0.03 to -0.22 mm/month) from May through July. While remaining below 1 mm/month, runoff is projected to increase in July (0.61 mm), August (0.11 mm), and October (0.30 mm) by the end of the century. Projected increases in temperature range from approximately 3.2 °C in February to 4.9 °C in October. Higher temperatures and greater water availability from precipitation lead to a projected 8-10% (1.8-2.6 mm) increase in evapotranspiration (ET) in October-November compared to the baseline period, while less water availability April to September leads to projected declines in ET (7-17%, or -2.4 to -7.5 mm/month) during the warmer 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/>
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# Yuma Groundwater Basin Profile



## Basin Summary Statistics

**Size<sup>1</sup>:** 792 square miles

**Elevation<sup>2</sup>:** Range: 71-3,113 ft; Median: 296 ft

**Top 3 land cover types by area<sup>3</sup>:** Barren Land (43%), Shrub/Scrub (25%), Cultivated Crops (19%)

**Major surface watershed(s)<sup>4</sup>:** Lower Colorado, Lower Gila, Yuma Desert

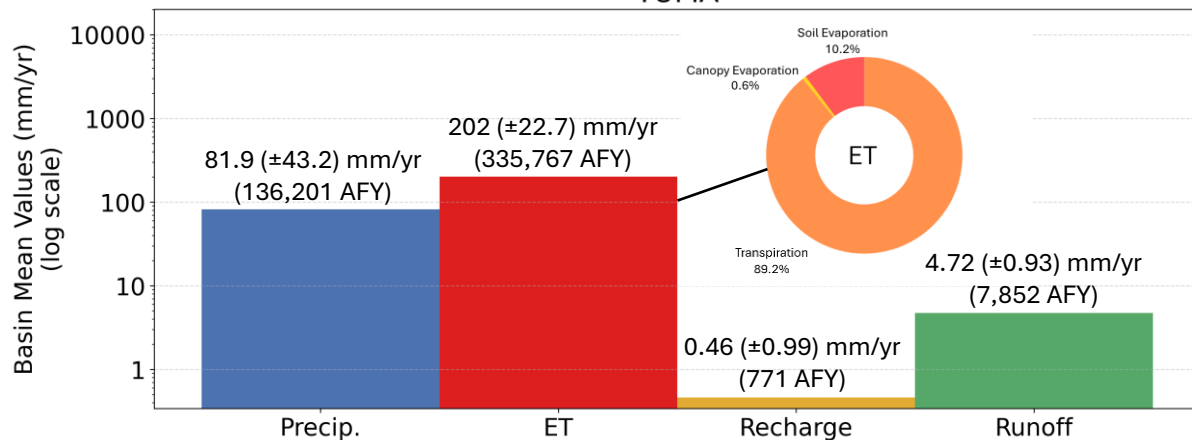
**Groundwater subbasins<sup>1</sup>:** None

**Groundwater-derived streamflow fraction<sup>5</sup>:**

**0.02** (Very Low)



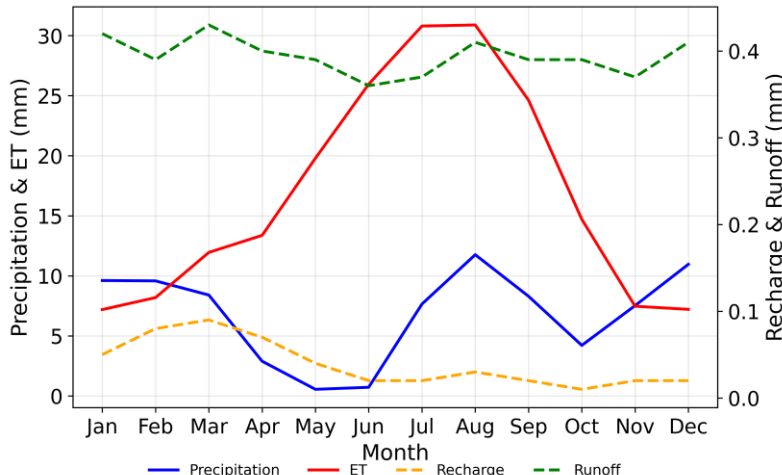
Mean Annual Hydrologic Cycle Components (1980-2020)  
YUMA



**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.<sup>6</sup> 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.

On annual timescales, evapotranspiration (ET) exceeds precipitation (P) on average across the Yuma basin, yielding near zero annual values for natural recharge (0.46 mm) and runoff (4.72 mm). Seasonally, ET is greater P for most months of the year, with the exception of the cooler months from mid-November through mid-February. Due to large areas of cultivated crops, transpiration makes up the vast majority (89.2%) of total ET in the basin, while soil evaporation comprises 10.2% and canopy evaporation accounts for the remainder (0.6%). Any ephemeral streamflow in the basin is derived almost entirely from surface runoff; groundwater is estimated to supply only 2% of total streamflow in the Yuma basin.

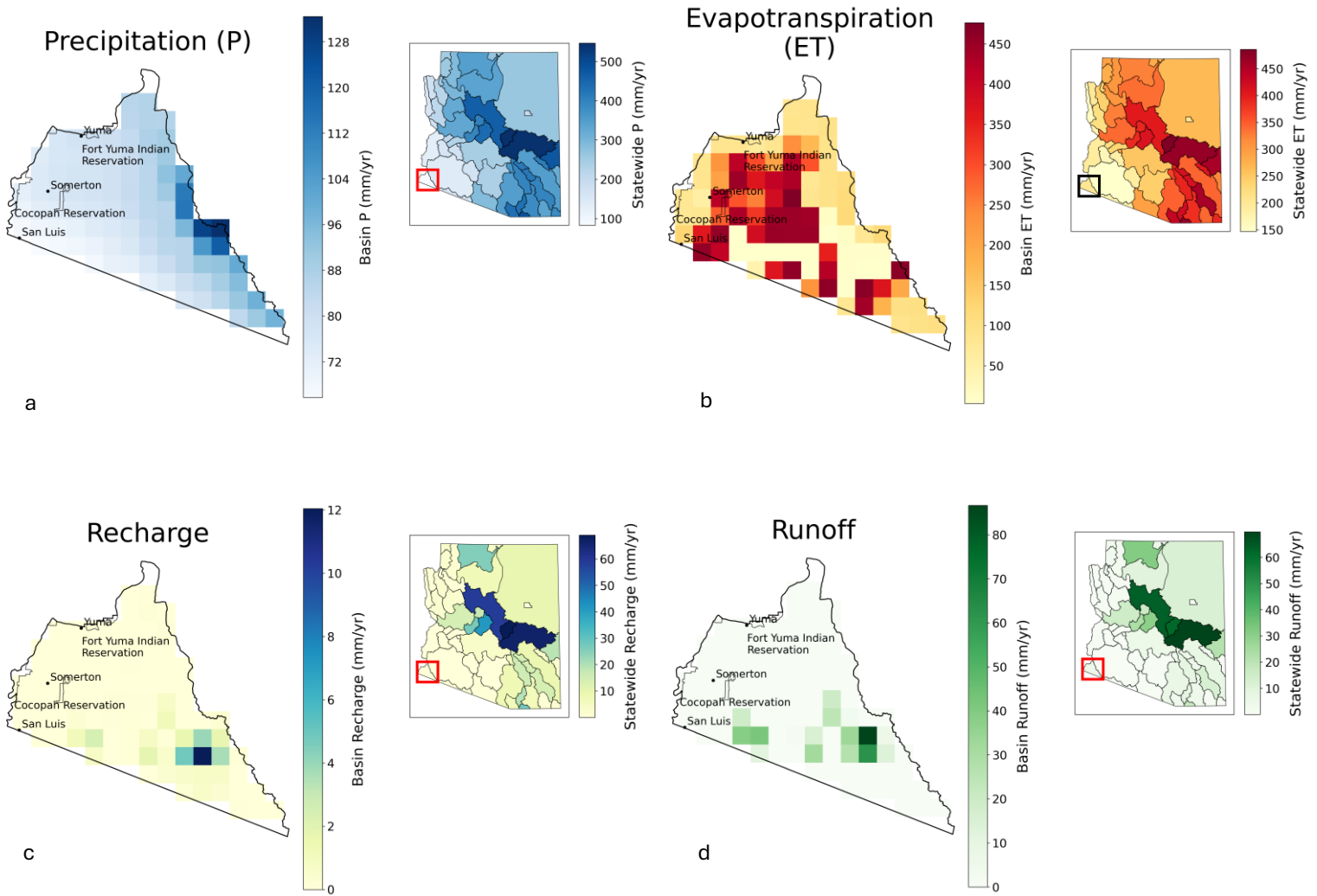
Mean Monthly Hydrologic Cycle Components (1980-2020)  
YUMA



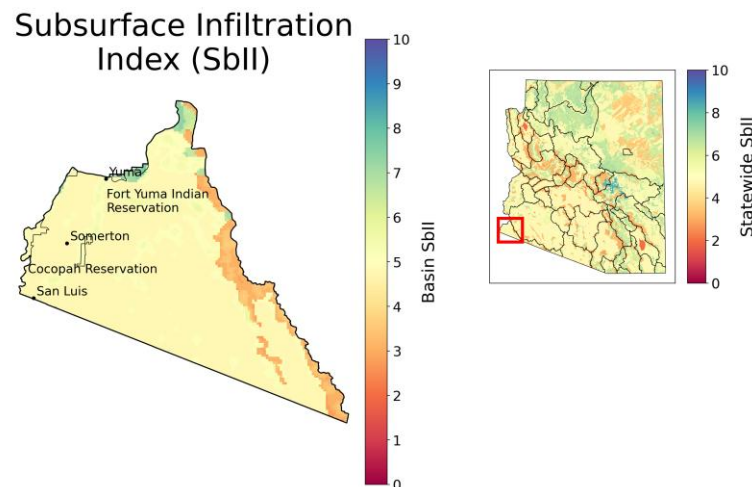
**Figure 2.** Graph showing monthly mean precipitation, ET, recharge, and runoff for the groundwater basin (1980-2020) from Noah-MP modeling results.<sup>6</sup>



**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.<sup>6</sup> Major cities/towns<sup>7</sup> and Native American Reservation boundaries<sup>8</sup> are shown (as applicable) to help orient the reader.



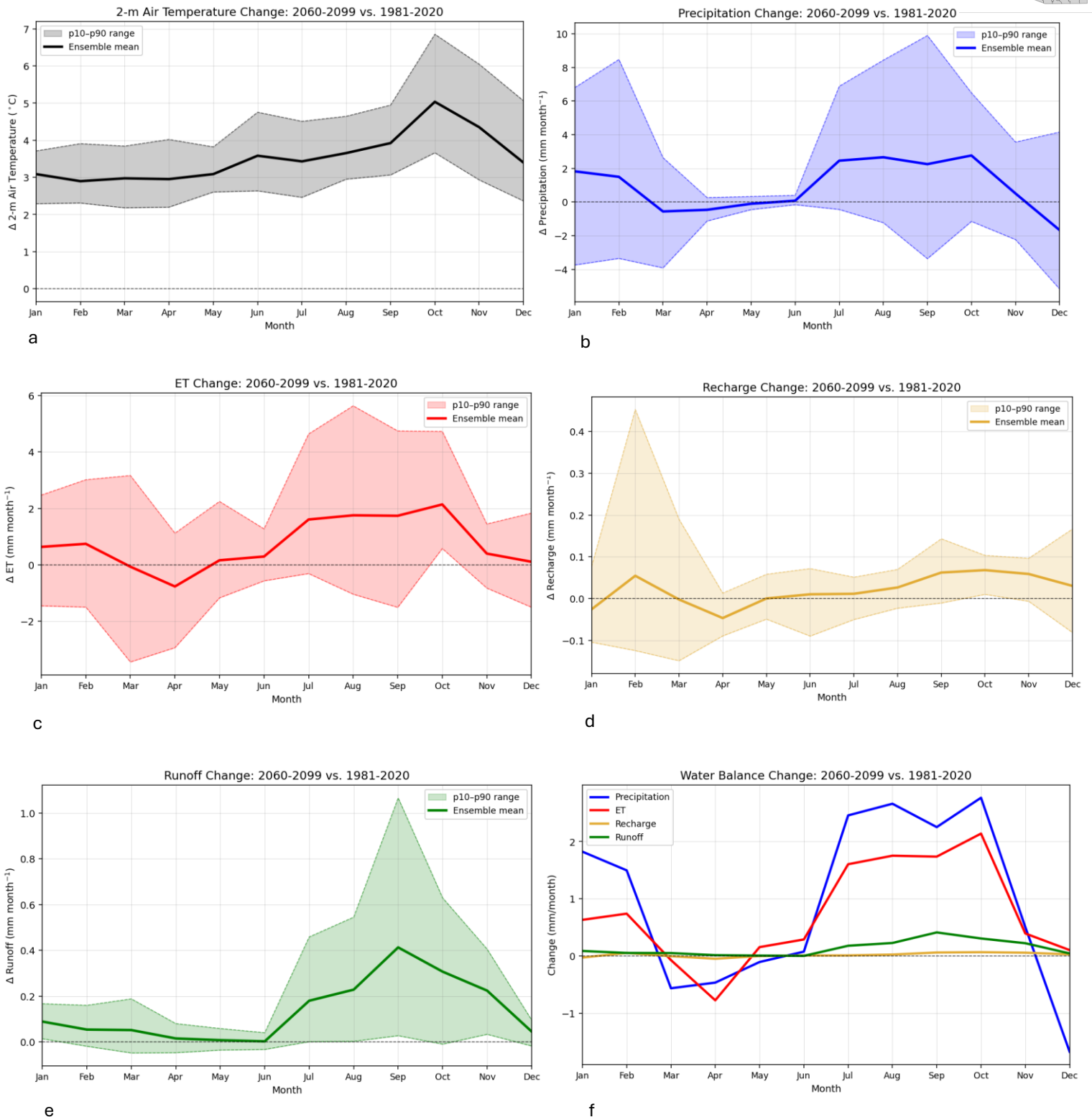
**Figure 4 (below).** Subsurface infiltration index (SbII) showing infiltration potential of the subsurface across the groundwater basin on a scale of 1-10 based on geologic features.<sup>9</sup>



Precipitation in the Yuma basin is highest in the Gila Mountains to the southeast, which receive over 120 mm/yr on average. Evapotranspiration (ET) is highest (over 400 mm/yr) over cultivated croplands and in the Yuma Desert. Natural recharge and runoff are generally minimal across the basin; however, both are highest in the southern foothills of the Gila Mountains. In this region, recharge can exceed 10 mm/yr and runoff exceeds 60 mm/yr. Subsurface infiltration potential is low to moderate across the basin; however, the sand and gravel alluvium of the Colorado River channel and floodplain provide higher infiltration potential than elsewhere in 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 21<sup>st</sup> century to the historical record from 1981-2020 under the IPCC Scenario SSP3-7.0.<sup>10</sup> 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 10-90<sup>th</sup> percentile shaded to show model projection uncertainty.



Climate change projections across the Yuma basin show drier springs (6-21% drier March through May) and a drier December (13%). January-February (15-20%) and June-October (21-59%) are projected to be wetter on average by the end of the century. The increase in precipitation in September-October (2.4-2.9 mm/month) is consistent with a projected increase in extreme events associated with hurricane and tropical cyclone activity. Natural recharge is projected to remain near zero, with slightly negative projections (-0.07 to -0.08 mm/month) in May and June.\* While runoff is projected to remain below 0.7 mm/month, minor increases of 0.17-0.42 mm/month are projected for July-November. Projected increases in temperature range from approximately 2.9 °C in February to 5.1 °C in October. Evapotranspiration (ET) is projected to generally track with precipitation throughout the year, showing increases of 19-42% (0.31-2.2 mm/month) from June through October due to high temperatures and greater water availability.

\*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.

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