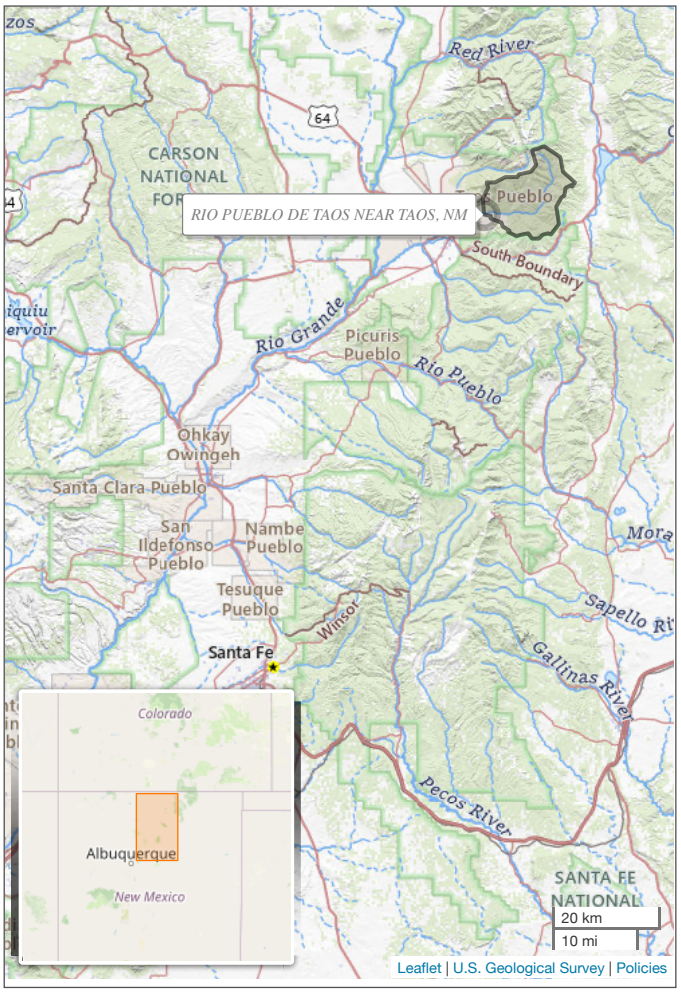
Changes in Streamflow of the Rio Pueblo de Taos near Taos, NM



This fact sheet presents preliminary results from a set of analyses conducted by CLIMAS researchers to better understand basic relationships between climate and streamflow that may be relevant for water resources planning in the Middle Rio Grande. These analyses are for the Rio Pueblo de Taos gage near Taos, New Mexico (USGS gage 08269000). This is one of the longest gage records in the Taos area, although it is not continuous. The record starts in 1940, with a gap from 1951–1962. It is then continuous from 1963 to present.

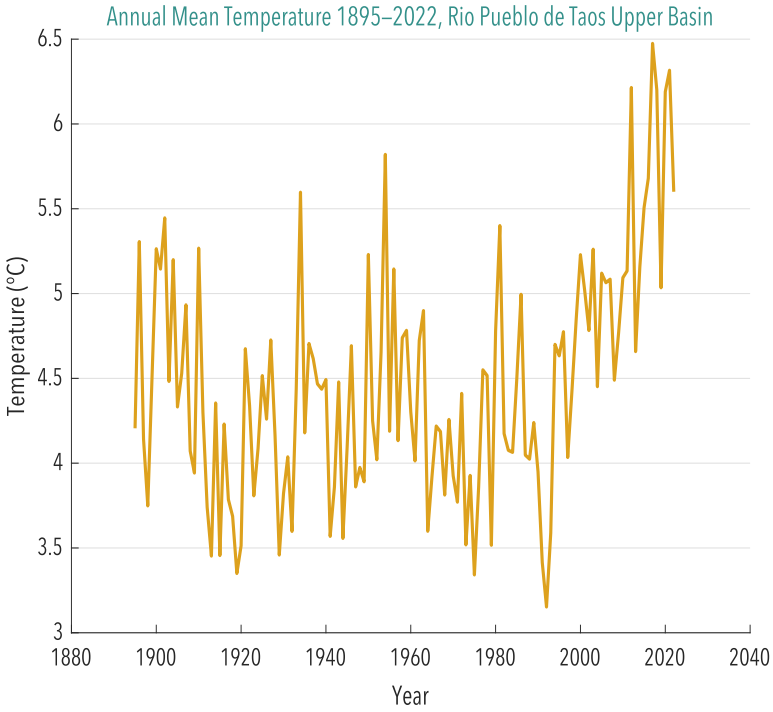
Summary of Key Findings

- Rio Pueblo de Taos streamflow is highly variable and includes periods of high flow and low flow.
- Wet conditions during the 1980s and 1990s are driving a statistically significant* decreasing trend in annual streamflow for the period 1980–2022, but significant trends are not apparent over other time periods.
- Analyses of monthly and daily streamflow suggest changes in peak runoff are taking place:
  - monthly streamflow has shifted, with relatively more flow occurring in April and less in June; and
  - the peak timing of streamflow has shifted nearly two days earlier per decade.
- Runoff efficiency, largely influenced by temperature, has decreased over the period of continuous record.

Temperature

Warming temperatures, particularly in arid and semi-arid regions, can have dramatic impacts on water resources. Soils dry faster under warmer temperatures, and snow melts earlier in the season, leading to changes in the timing of runoff. Warmer temperatures also cause increased evaporation from rivers and lakes, snow sublimation (when snow turns directly into vapor without turning into liquid), and greater rates of evapotranspiration from plants.

The figure at right shows annual mean temperature in the Rio Pueblo de Taos basin above the gage near Taos. ***Although mean temperatures vary from year to year, there is a steep increase beginning around 1990.*** This increase matches records in the upper Colorado River basin and elsewhere.

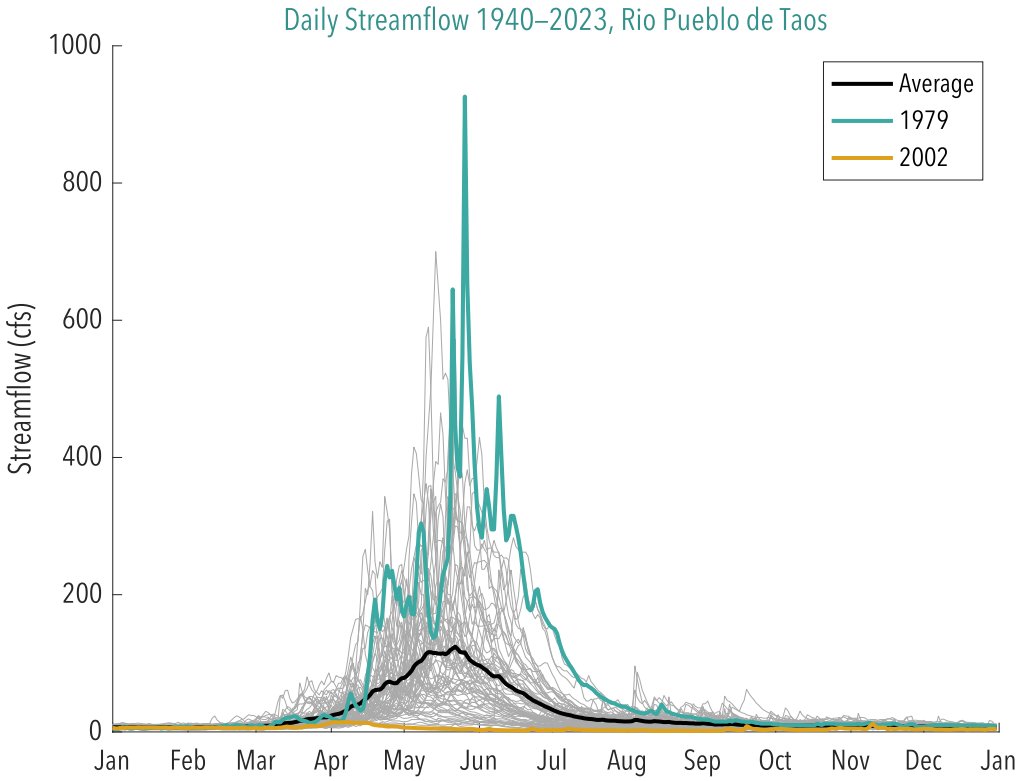


By statistical significance, we mean we are 95% confident the trend is not due to random variability.

Suggested citation:
Meko, Matthew, and Connie Woodhouse. 2024. "Changes in Streamflow of the Rio Pueblo de Taos near Taos, NM." Tucson, AZ: Climate Assessment for the Southwest, University of Arizona.

CLIMAS
Climate Assessment for the Southwest
A NOAA CAP TEAM

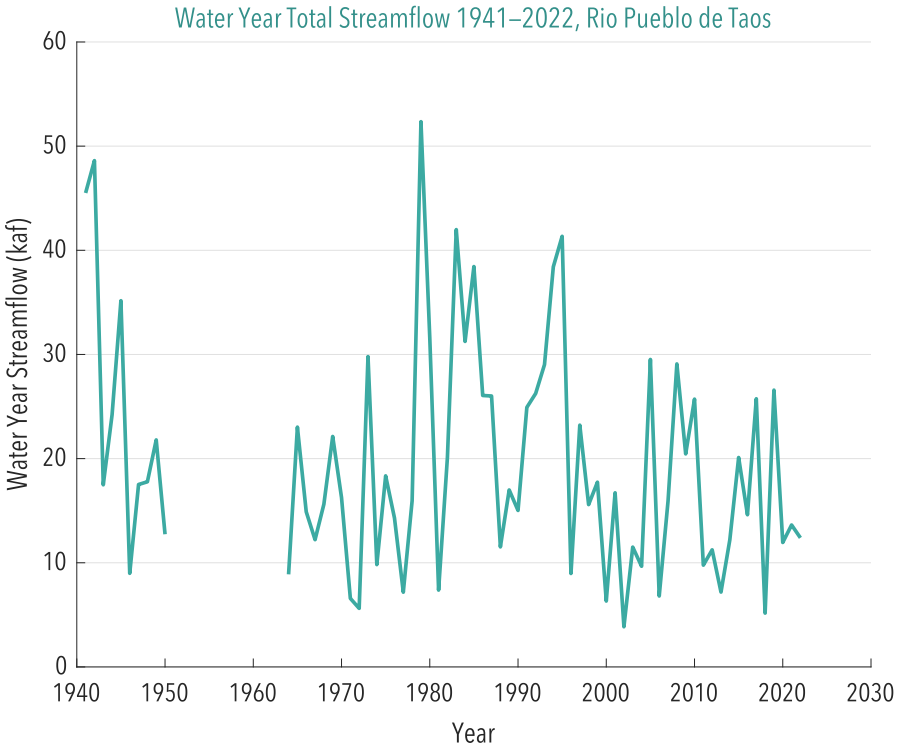
Streamflow Variability



Rio Pueblo de Taos streamflow, as illustrated in this annual hydrograph, is highly variable. The figure above shows daily streamflow at the Rio Pueblo de Taos near Taos for 72 years (1940–1950, 1963–2023). Each gray line represents one year. The average is indicated by the black line and the two most extreme years (highest and lowest annual flow) are in teal (1979) and yellow (2002).

The figure to the right, of water year (October–September) total flow for the Rio Pueblo de Taos, displays a different sort of variability than the daily flow patterns.

Besides the year-to-year variability, this time series also shows periods of high flows and low flows. Higher flows were recorded for many years in the 1980s and 1990s. Low flows are evident in the 2000s.

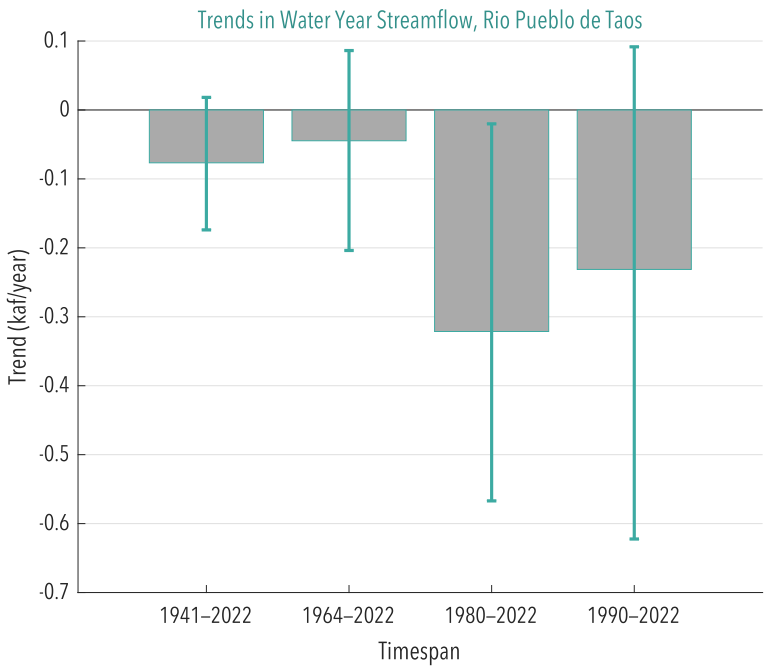


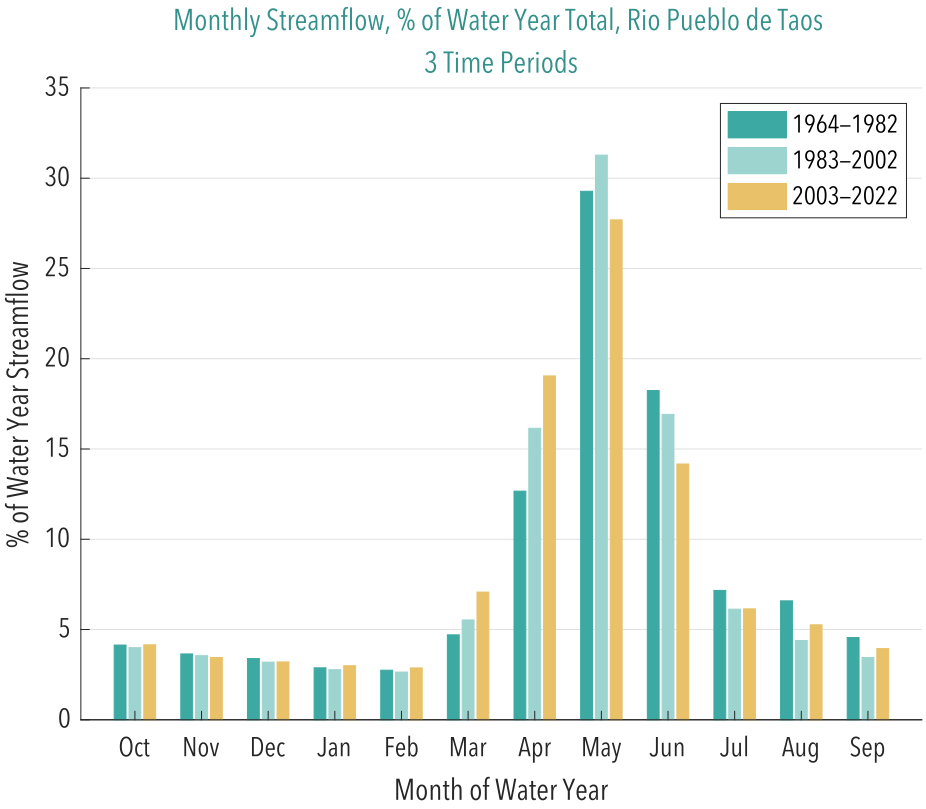
Streamflow Trends

Wet conditions in the 1980s and 1990s drive an apparent decreasing trend in annual streamflow over the past four decades. However, there is no significant decrease in streamflow if the trend analysis includes the early part of the record.

There is a statistically significant decreasing trend in streamflow over the years 1980–2022. However, when the streamflow record is analyzed over two longer periods (1941–2022 and 1964–2022), or a more recent period (1990–2022), there is no significant trend, except for 1980–2022.

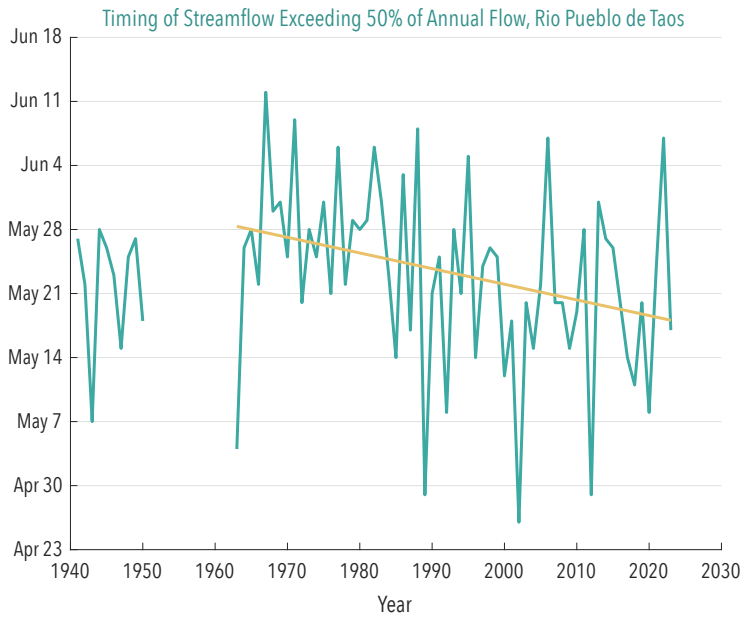
The thin vertical lines for each period indicate statistical uncertainty in the trend. The range of uncertainty increases with shorter intervals of time. The line for the 1980–2022 period stays below zero, while it ranges from positive to negative values for all other periods.





Analyses at the monthly time scale show that while streamflow peaks in May, a greater proportion of flow is now occurring in April, and less in June, suggesting a shift to earlier runoff. The graph to the left shows average monthly streamflow over three time periods, 1964–1982, 1983–2002, and 2003–2022. While flows over the cool season months are similar for these time periods, there are marked differences for spring and early summer months. Specifically, in 2003–2022, there is a greater proportion of flow in March and April and a corresponding lower proportion in May and June compared to the two earlier periods.

Streamflow Timing

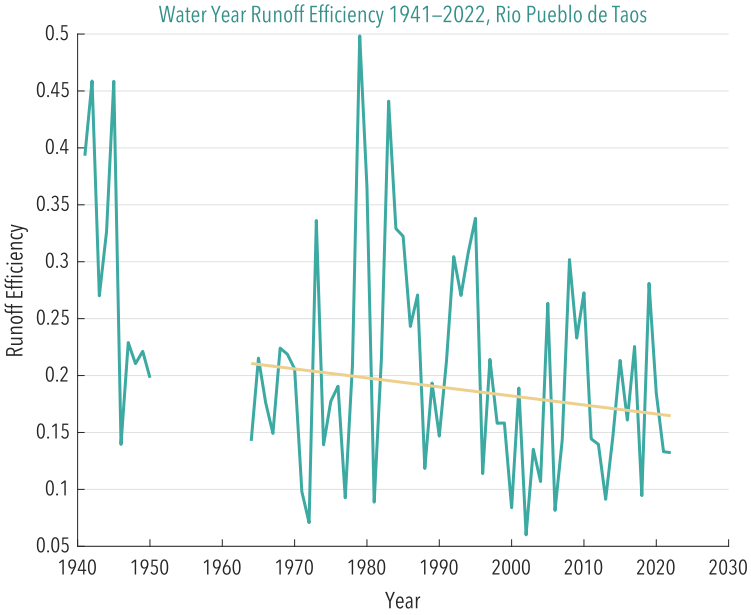


Peak streamflow, defined here as the date when 50% of the calendar year streamflow has passed the gage, is occurring earlier, by nearly two days per decade.

Shifts in the timing of runoff can be more precisely quantified using daily data. The time series to the left shows the date for each year when 50% of the annual streamflow has passed the gage—a measure of streamflow peak timing. The gold line indicates a trend towards an earlier streamflow peak over time (here, just the continuous part of the record is used). This trend towards earlier peak flow, by nearly two days a decade, is statistically significant.

Runoff Efficiency

Runoff efficiency is the proportion of total precipitation (rain and snow) that falls in a watershed that ends up in the river—the ratio of volume of water year streamflow to the volume of water year total precipitation. Although many factors influence this percentage, temperature plays a key role. While quite variable, the runoff efficiency for the Rio Pueblo de Taos averages about 20% over the continuous part of the record (1964–2022). ***However, over this period, runoff efficiency has decreased, indicating a smaller proportion of precipitation is now making its way into the river.***



About this fact sheet

The analyses presented here were developed by members of the Climate Assesment for the Southwest (CLIMAS) program as part of a project to understand relationships between climate and water availability in the Middle Rio Grande basin to support water resources planning. For more information about these analyses or this project, contact: Connie Woodhouse (conniew1@arizona.edu) or Matt Meko (meko@arizona.edu)

The CLIMAS program is a partnership between the National Oceanic and Atmospheric Administration, the University of Arizona, New Mexico State University, and the Inter Tribal Council of Arizona. The CLIMAS team and our partners work to improve the ability of the region's social and ecological systems to respond to and thrive in a variable and changing climate. The program promotes collaborative research involving scientists, decision makers, resource managers and users, educators, and others who need more and better information about climate and its impacts. For more information about CLIMAS, visit www.climas.arizona.edu or contact CLIMAS Director, Dan Ferguson (dferg@arizona.edu).