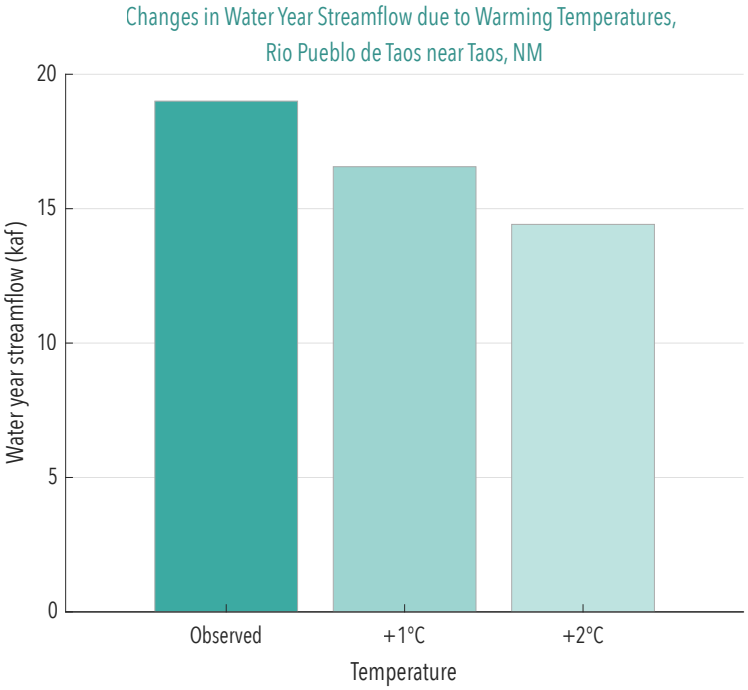
Streamflow Response to Warming Temperatures, Rio Pueblo de Taos near Taos, NM

As temperatures warm, even if precipitation doesn't decrease, decreases in streamflow should be expected due to higher rates of evaporation. But how much of a decrease should be expected?

13% less streamflow per 1°C of warming.

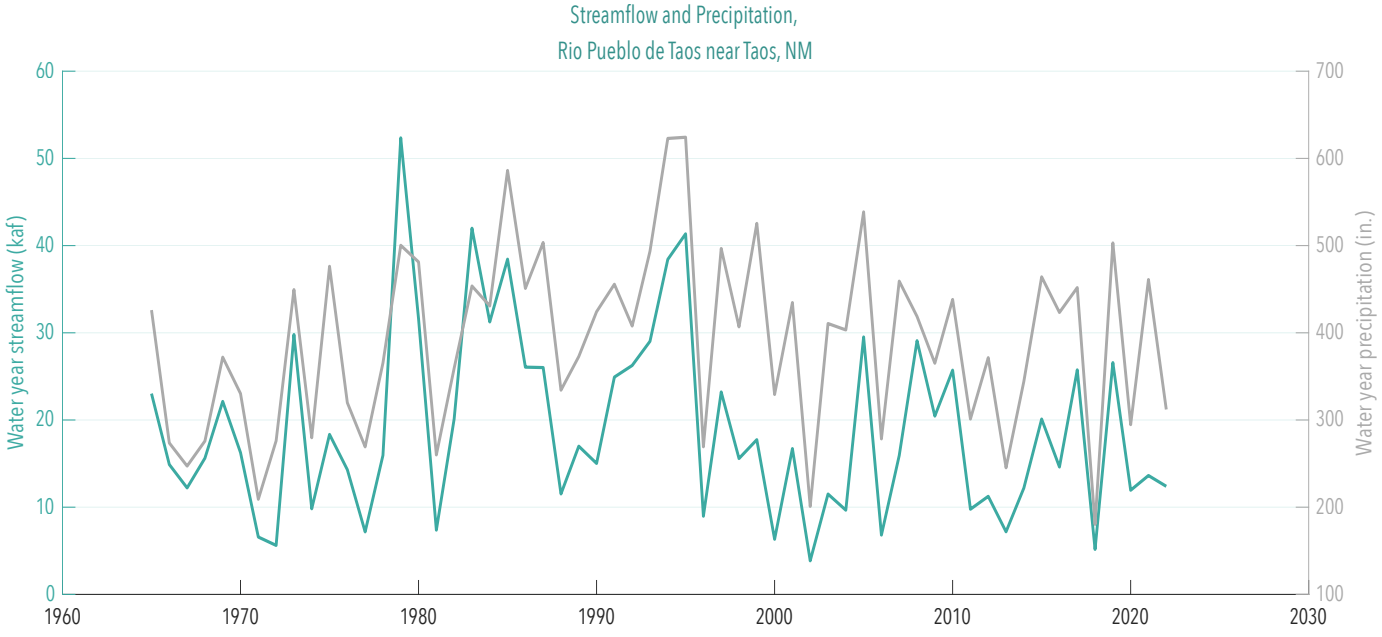
Based on an analysis of past streamflow variability in relation to precipitation and temperature, we found that warmer temperatures tend to correspond to flows that are decreased relative to what would otherwise be expected for a given amount of precipitation.

The figure at right shows the observed 1965-2022 mean water year streamflow for the Rio Pueblo de Taos at the gage near Taos Pueblo—about 19 thousand acre-feet. ***Our analysis suggests that each 1°C temperature increase would result in a 13% decrease in average annual streamflow. That would mean the average annual streamflow would decrease to about 16.5 thousand acre-feet for one-degree warmer temperatures, and to about 14.5 thousand acre-feet with two degrees of warming.*** For reference, 1°C of warming translates to1.8°F of warming; a 2°C rise is the equivalent of a 3.6°F rise.



Precipitation and Streamflow

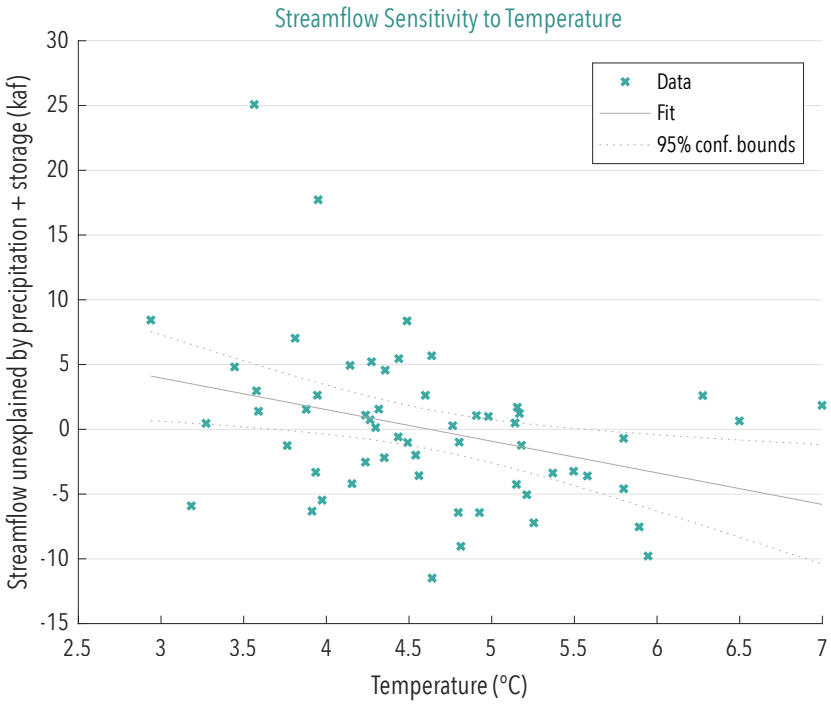
Streamflow and streamflow variability are primarily controlled by precipitation. The figure below shows water-year streamflow and water-year basin precipitation totals, 1965-2022, for the Rio Pueblo de Taos. ***Streamflow varies year-to-year, generally in step with year-to-year precipitation variability, but other factors act to mediate the conversion of precipitation to streamflow. Temperature is one of those mediating factors.***



Estimating Streamflow Sensitivity to Temperature

A given year's streamflow volume can be mostly accounted for by that year's precipitation total and the amount of soil moisture storage in the basin left over from the previous year, but precipitation and soil moisture don't account for all of the streamflow variability.

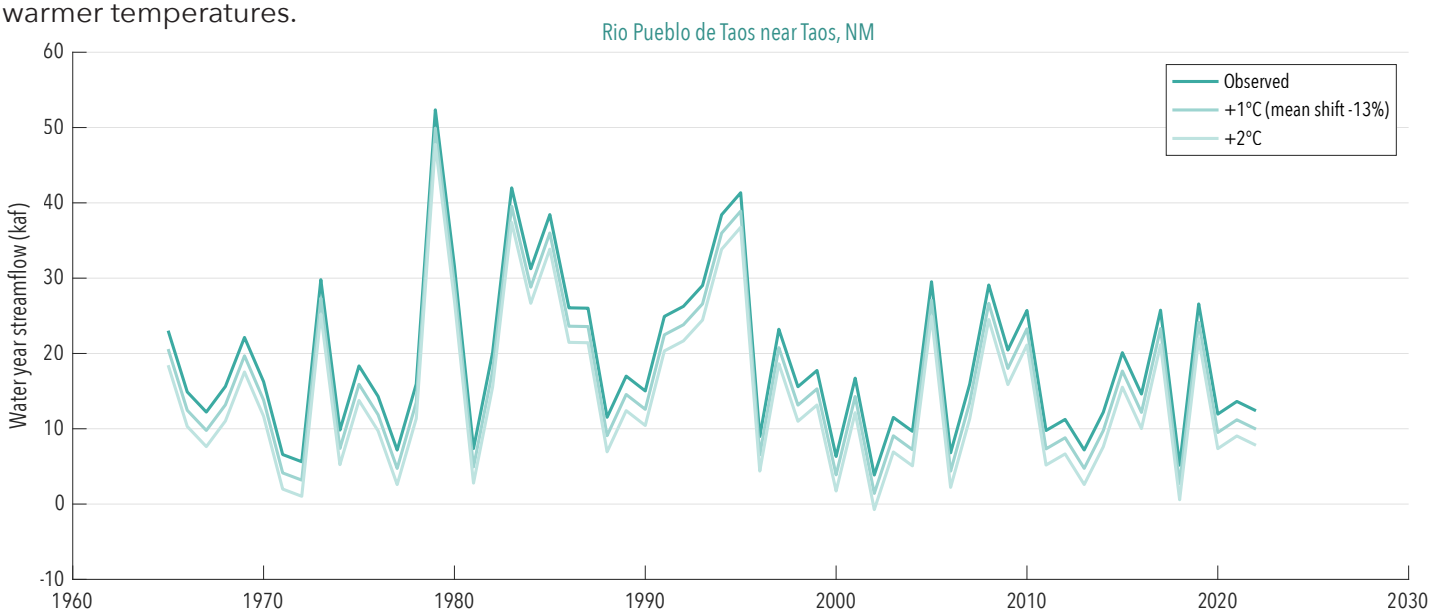
The figure at right shows that unaccounted-for Rio Pueblo de Taos streamflow in relation to basin temperature. ***Warmer years generally correspond to flows that are less-than-expected for a given amount of precipitation.*** The line-of-best-fit in the plot is where we get our estimate of -13%/1°C sensitivity. The 95% confidence bounds indicate the uncertainty of our estimate; we can say with very high confidence the sensitivity is between -3%/°C and -23%/C.



How might decreased "mean streamflow" look year-to-year?

The mean or average tells us what is reasonable to expect, in the absence of any other predictive information. Adding the effects of warming to the existing streamflow record provides a scenario for future flows.

The figure below shows observed water-year streamflow for the Rio Pueblo de Taos, along with streamflow series which have been shifted to reflect a decrease of mean associated with the effect of 1°C and 2°C warmer temperatures.



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)

CLIMAS
Climate Assessment for the Southwest
A NOAA CAP TEAM