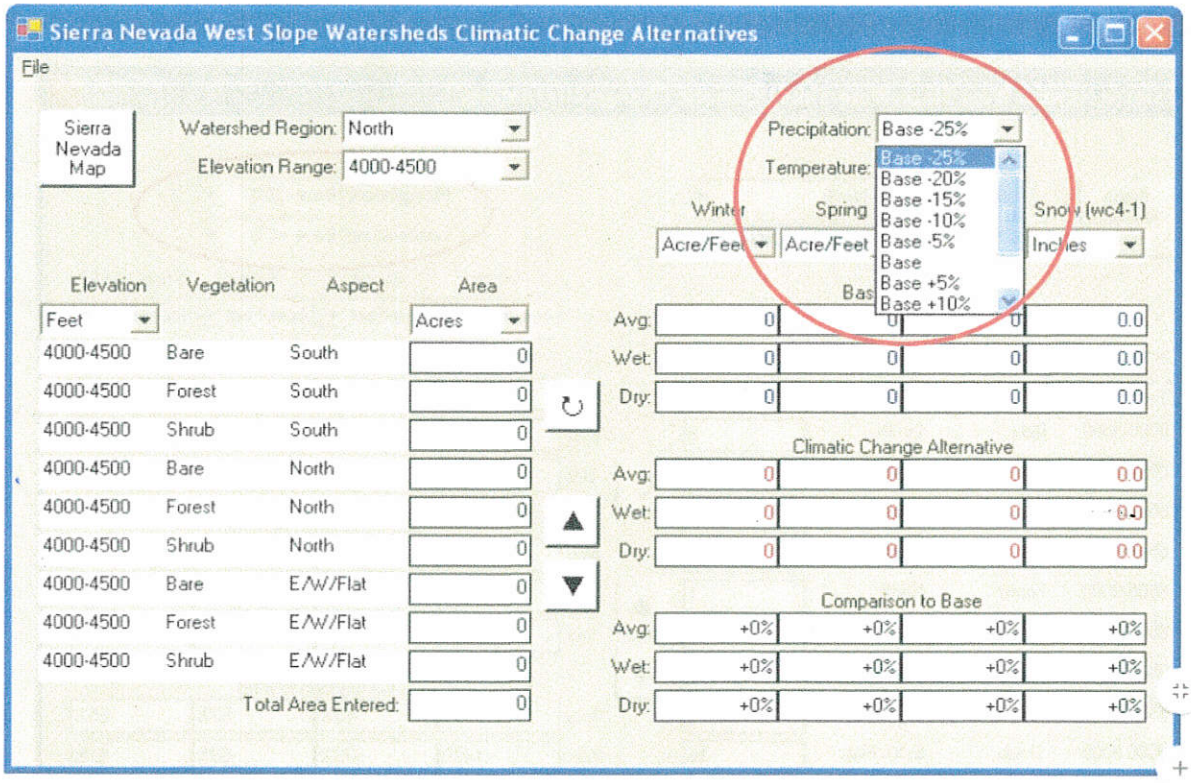
To: California Water Commission
From: Otis Wollan, President, American River Watershed Institute (www.arwi.us)
former 5-term Director, Placer County Water Agency, otiswollan@gmail.com
RE: Comments on Section 2-12 Precipitation Scenario Ensemble predictions

The Climate Change section approach to predicting precipitation is flawed. Averaging the ensemble of scenarios resulted in a 2030 precipitation prediction of an increase of 2.4% and a 2070 precipitation prediction of an increase of 4.6%. Using the average of the ensemble reduces future precipitation to a non-issue.

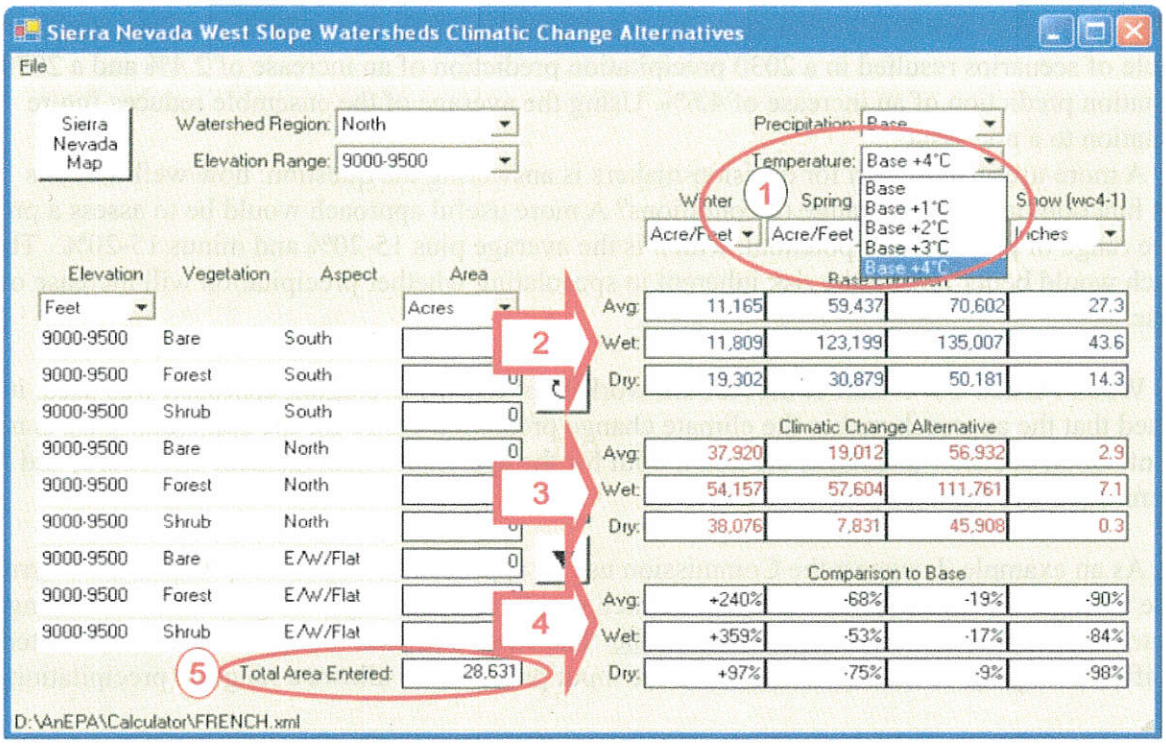
A more useful approach for decision-makers is answering the question: how well will this project function over a likely range of conditions? A more useful approach would be to assess a project over the range of precipitation potential, which is the average plus 15-20% and minus 15-20%. This approach would better inform the risk inherent in speculating whether precipitation will increase or decrease.

When I asked CWC staff at the Auburn workshop why the averaging approach was used, it was explained that the approach makes the climate change prediction easier for the applicant. Ease is not the point. Good decision-making is the point, both for the applicant's management and board, and for the Commissioners here.

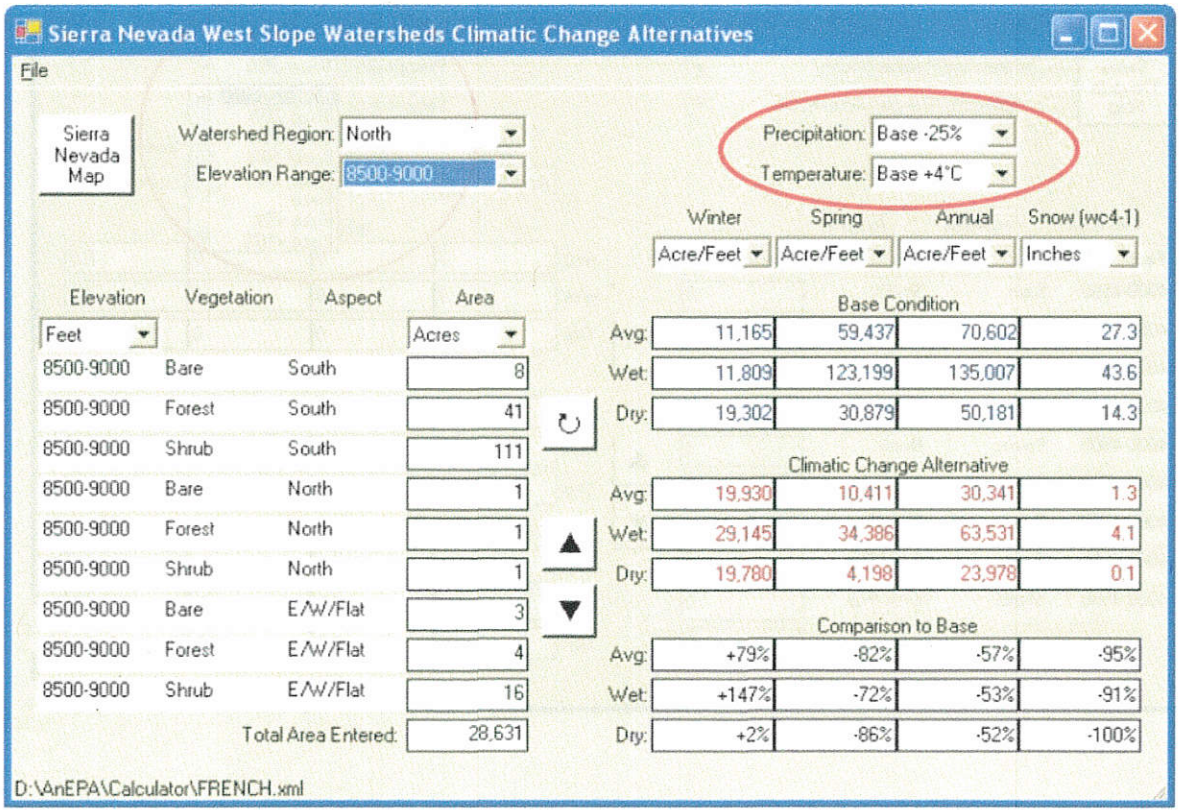
As an example, I suggest the Commission use an approach similar to that used in the Sierra Climate Change Watershed Yield Calculator, which was developed 15 years ago with EPA funding. The calculator is available free from www.arwi.us/calc The calculator uses the HSPF model, calibrated for three different regions of the Sierra. Below is the input page, which allows a range of precipitation.



Precipitation options range from -25% to +25% of base in 5% increments
Temperature range can be 1-4 degrees Centigrade
Example Scenario for French Meadow with +4 degree C and Base precipitation

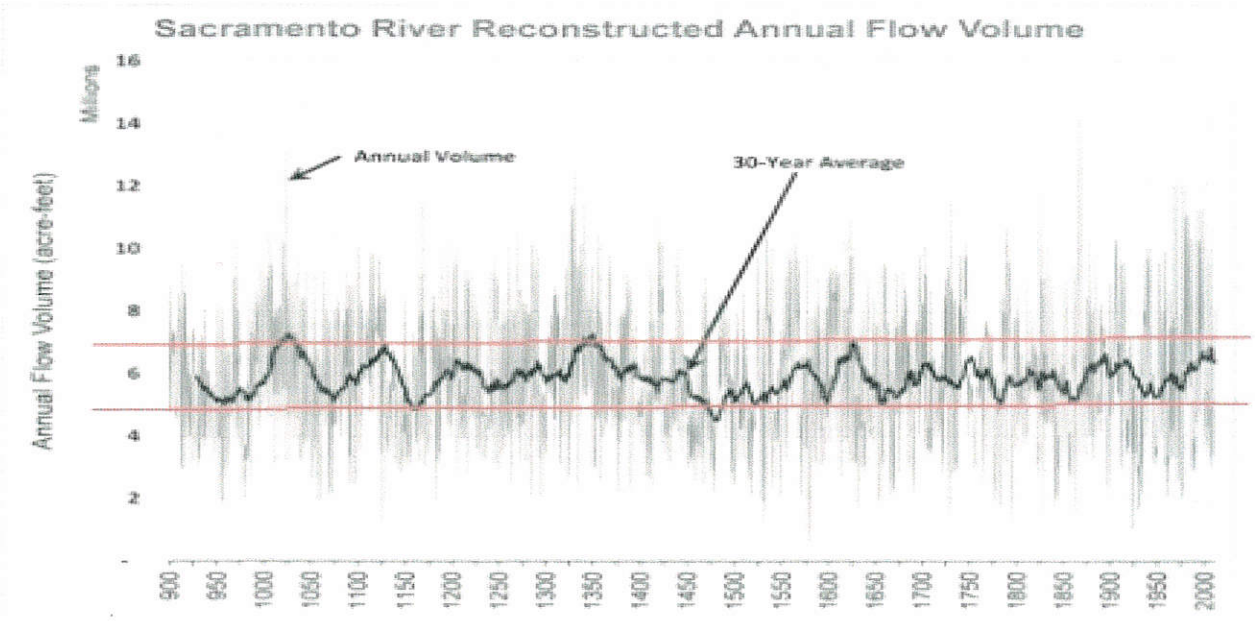


Example Scenario for French Meadows with +4 degree C and -25% precipitation



Tree ring history shows a centennial variation of approximately 30% wet to dry years. The long view of history would suggest a 100-year average, plus or minus 15%.

Figure 3-6 Reconstructed Sacramento River Streamflows



Source: Meko et al. 2014

NCAR data shows precipitation being reduced 5% per decade from 1980-2010

US Southwest May Be Drying Up As Wet Weather Systems Become More Rare

By **Alyssa Navarro**, Tech Times | February 6, 6:16 AM

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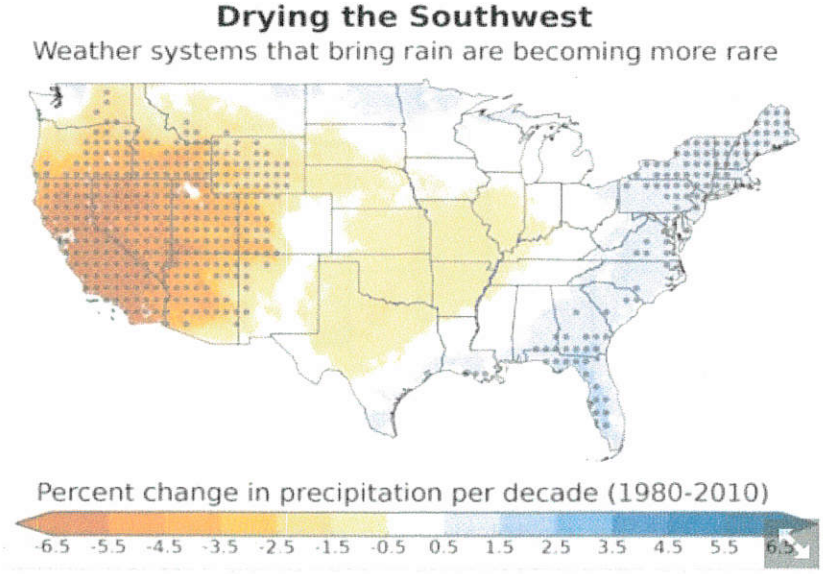

What's considered a normal year of snow and rain in the Southwest is now drier than usual, a new study revealed. Droughts in the region could become more severe in the coming years. (Photo : Andreas Prein/NCAR)

time

Different ensembles seem to convey different trends and messages.
This ensemble of scenarios from NCAR indicate reduced precipitation.

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May 2007

Study predicts permanent drought in Southwest

ASP postdoc Jian Lu contributes to research

Aridity has always been the defining feature of the American Southwest, even as large-scale hydraulic engineering has allowed cities such as Phoenix and Las Vegas to burst from the desert floor.

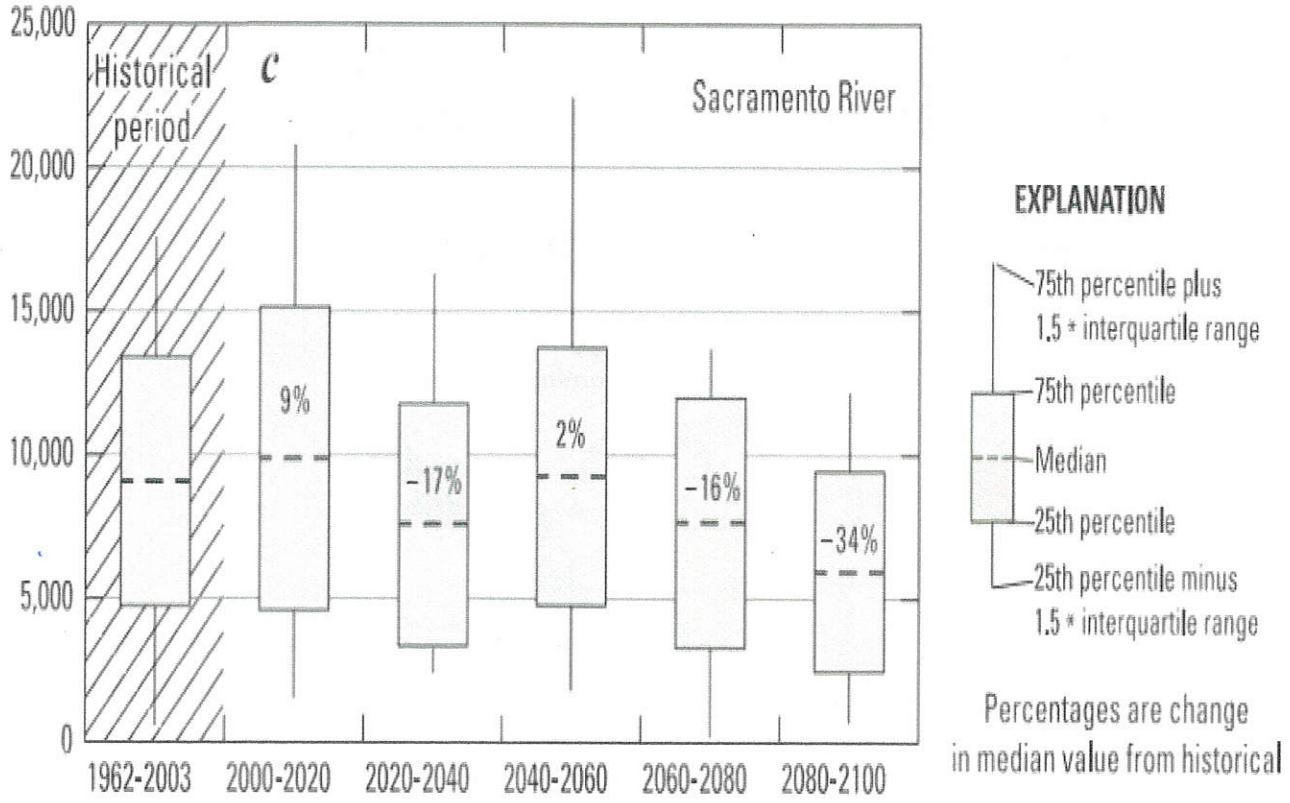
But according to a sobering new study, the Southwest's aridity is about to get worse. Published in the April 9 issue of Science, "Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America" predicts that climate change will permanently alter the landscape of the Southwest so severely that conditions reminiscent of the Dust Bowl days of the 1930s could become the norm within a few decades.

"Our study suggests a perpetual arid condition over the American Southwest," says Jian Lu, a postdoctoral researcher in ASP/CGD who is an author of the study.

Of the 19 different computer models that the research team used for the study, all but one showed a drying trend in the swath of North America between Kansas, California, and northern Mexico. The models predicted an average 15% decline in runoff for the Southwest between 2021 and 2040, compared to the average surface moisture between 1950 and 2000.

The Southwest's future droughts are expected to be of a different nature than those that have afflicted the region in the past. Scientists attribute past droughts to variations in sea surface temperatures caused by El Niño and La Niña events in the Pacific Ocean. La Niña is especially influential as it tends to shift precipitation belts north, leaving the Southwest thirsty.

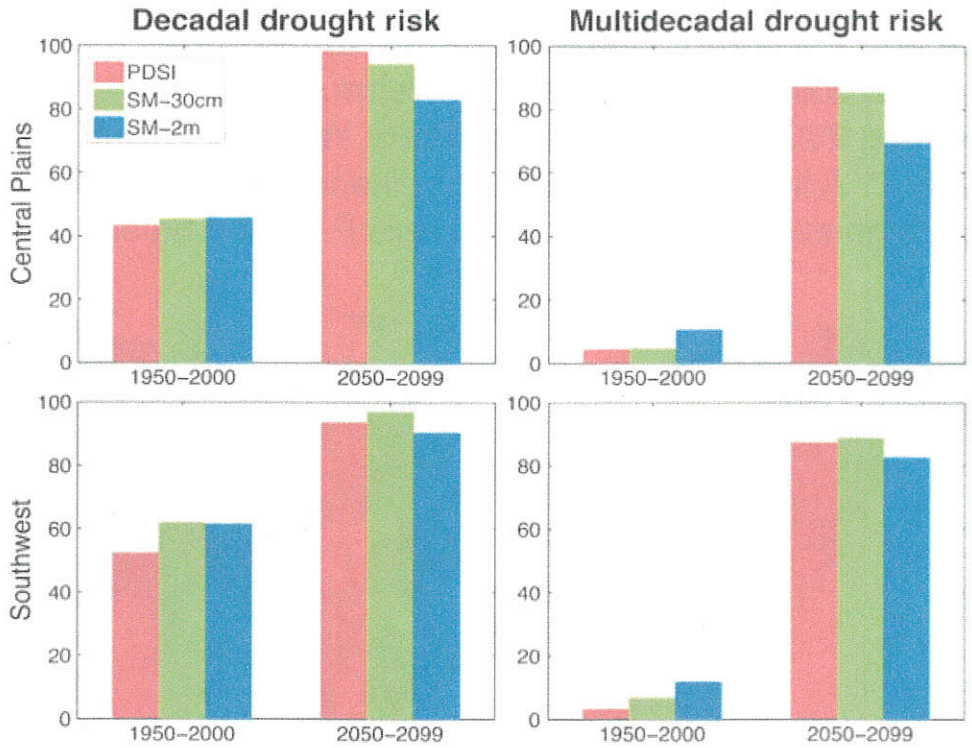
The ensemble of scenarios used by USGS indicates significant precipitation reduction



Hanson, R.T., Flint, L.E., Flint, A.L., Dettinger, M.D., Faunt, C.C., Cayan, D., and Schmid, W., 2012, A method for physically based model analysis of conjunctive use in response to potential climate changes, Water Resources Research, vol. 48, W00L08, doi:10.1029/2011WR010774

This NOAA & NASA ensemble predicts high risk of decadal and multidecadal droughts

Fig. 5 Risk (percent chance of occurrence) of decadal (11-year) andmultidecadal (35-year) drought, calculated from the multimodel ensemble for PDSI, SM-30cm, and SM-2m.



Benjamin I. Cook et al. Sci Adv 2015;1:e1400082

Published by AAAS

Science Advances

From NOAA and NASA:

Unprecedented 21st century drought risk in American Southwest

Benjamin I. Cook1,2,*, Toby R. Ault3 and Jason E. Smerdon2

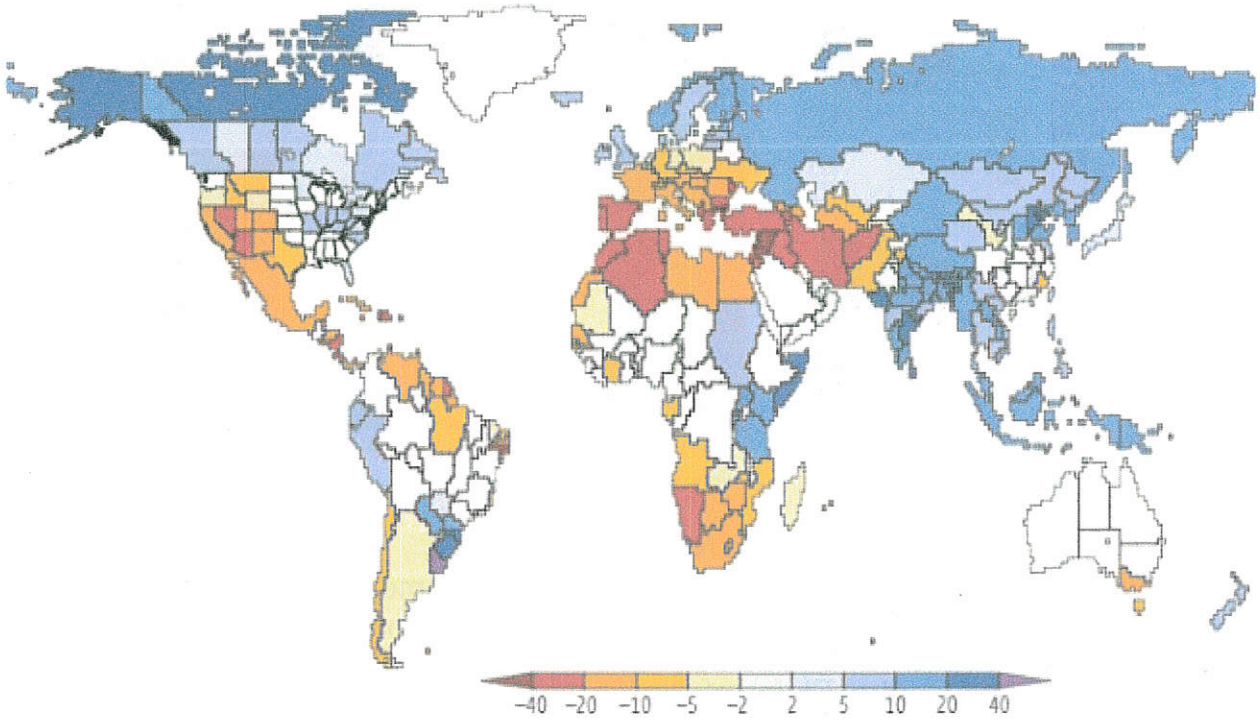
Abstract

In the Southwest and Central Plains of Western North America, climate change is expected to increase drought severity in the coming decades. These regions nevertheless experienced extended Medieval-era droughts that were more persistent than any historical event, providing crucial targets in the paleoclimate record for benchmarking the severity of future drought risks. We use an empirical drought reconstruction and three soil moisture metrics from 17 state-of-the-art general circulation models to show that these models project significantly drier conditions in the later half of the 21st century compared to the 20th century and earlier paleoclimatic intervals. This desiccation is consistent across most of the models and moisture balance variables, indicating a coherent and robust drying response to warming despite the diversity of models and metrics analyzed. Notably, future drought risk will likely exceed even the driest centuries of the Medieval Climate Anomaly (1100–1300 CE) in both moderate (RCP 4.5) and high (RCP 8.5) future emissions scenarios, leading to unprecedented drought conditions during the last millennium.

Another ensemble shows precipitation patterns moving toward poles, with a 20% reduction in precipitation in our region.

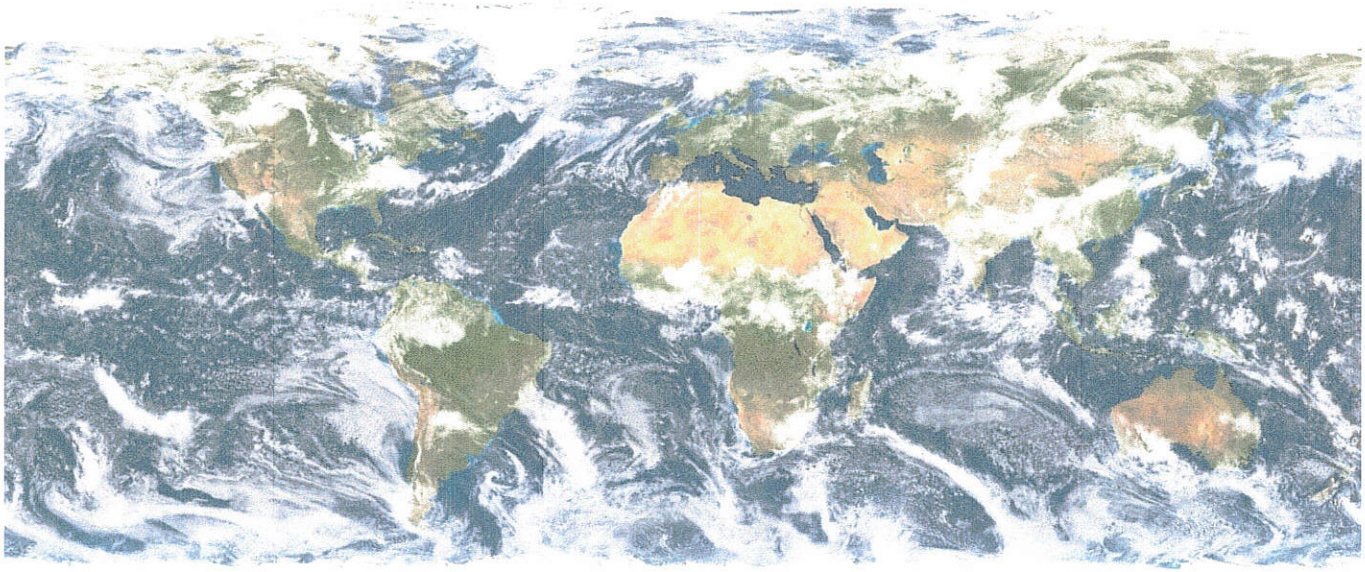
Science and Planning: Climate change undermines basic assumptions of historical water management systems.

Science Mag 2008, **Stationarity is Dead: Whither Water Management,** P. C. D. Milly,1* Julio Betancourt,2MalinFalkenmark,3Robert M. Hirsch,4Zbigniew W.Kundzewicz,5Dennis P. Lettenmaier,6Ronald J. Stouffer7

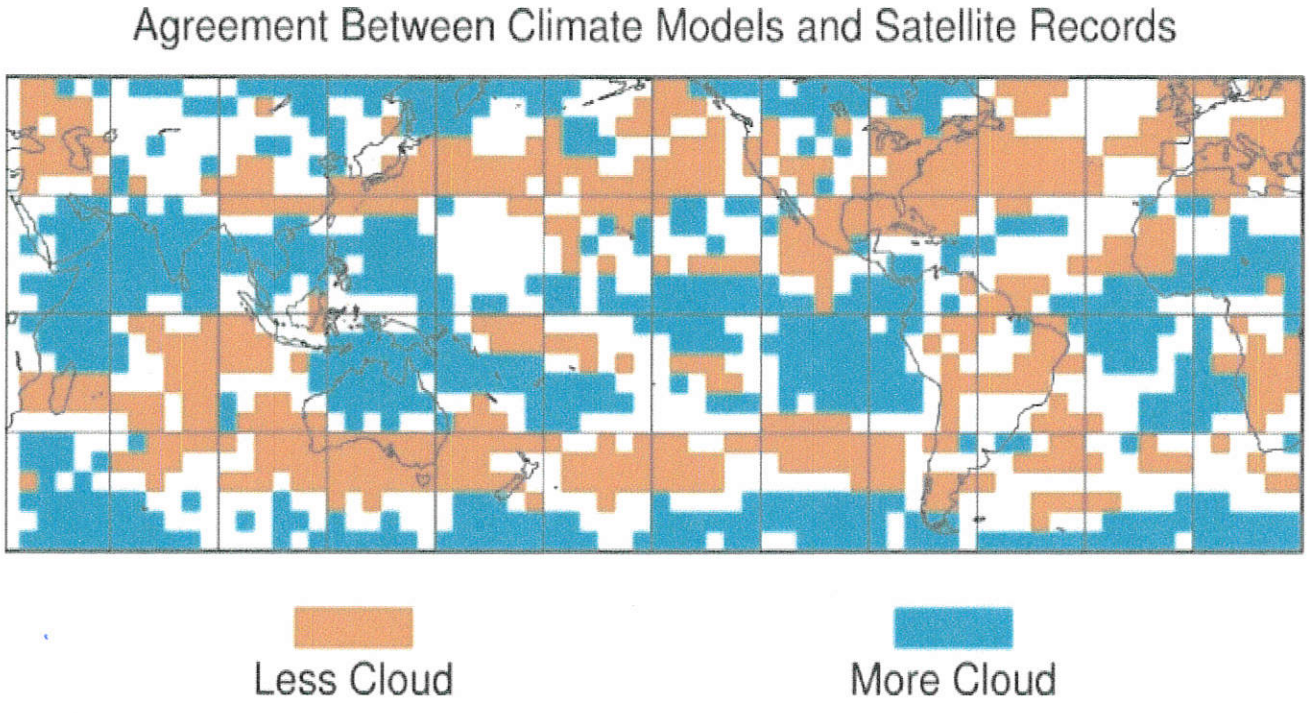


Human influences. Dramatic changes in runoff volume from ice-free land are projected in many parts of the world by the middle of the 21st century (relative to historical conditions from the 1900 to 1970 period). Color denotes percentage change (median value from 12 climate models). Where a country or smaller political unit is colored, 8 or more of 12 models agreed on the direction (increase versus decrease) of runoff change under the Intergovernmental Panel on Climate Change's "SRES A1B" emissions scenario.

The world's clouds are in different places than they were 30 years ago



From Washington Post, July 11, reporting on Nature Journal paper
The moisture bearing clouds are shifting toward the poles, widening semi-tropic dry regions around equator.



"Places from California to Southern Africa could experience more dry conditions going forward as cloud belts shift."
From Washington Post, July 11, 2016 reporting on Nature Journal paper