CLIMATE CHANGE RISKS TO OUR SNOWMELT WATER SUPPLY AND POSSIBLE ADAPTATION RESPONES IN THE SOUTHWEST U.S.

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ABSTRACT

USDA Regional Climate Hubs were established in 2014 to assist stakeholders in maintaining high agricultural productivity under conditions of climate change. The Southwest Regional Climate Hub is characterized by extreme climate variability and physical diversity. In the Southwest, as climate changes, water scarcity will become the most important issue. (KEYWORDS: climate change, regional climate hub, adaptation, variability)

INTRODUCTION

In February of 2014, the USDA announced that seven Regional Climate Hubs had been established across the United States (Figure 1). There are great differences between the regions as well as significant differences within many of the regions. In the USDA Southwest Regional Climate Hub for Risk Adaptation and Mitigation to Climate Change six states are included in addition to the U.S. Affiliated Pacific Islands. The states are New Mexico, Arizona, Utah, Nevada, California and Hawaii. The Affiliated Islands include the Territories of American Samoa and Guam, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau. The Southwest Climate Hub is located in Las Cruces, NM. Because of high agricultural production, a Subsidiary Hub has been located in Davis, CA to address climate change effects on high value crops.

Some of the states like New Mexico, have significant desert areas that annually receive an average of only 23 cm of precipitation or less. The highest annual average precipitation in the Southwest Region is in Hawaii with 1168 cm, which is also the largest annual average precipitation in the U.S. High temperatures are also variable with the highest maximum temperature recorded in Death Valley, CA and the U.S. at 57^0 C. The lowest temperature posted in the region was -56^0 C at Peter's Sink, UT.

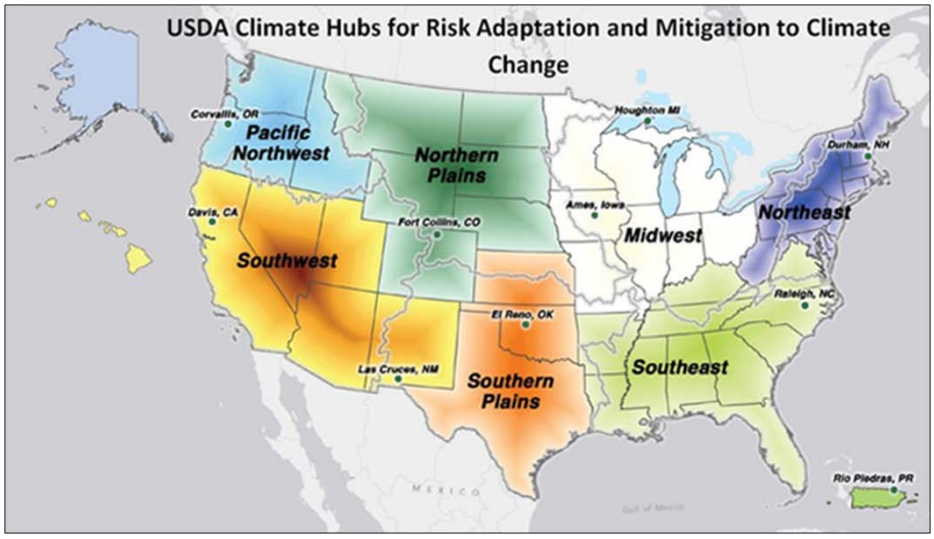

Figure 1. USDA Regional Climate Hubs for Risk Adaption and Mitigation to Climate Change. Subsidiary Hub locations are Davis, CA; Houghton, MI; and Rio Piedras, PR.

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The objectives of the hubs will differ because of regional differences in agricultural production and differences in climate as well as water availability, which becomes especially critical in regions dependent on irrigated agriculture. In the Southwest Hub, the specific objectives are listed below:

- Survey and address the vulnerability of Southwest agriculture to climate changes. Based on identified vulnerabilities, start to assemble hazard and adaptation plans to combat the agriculture vulnerabilities.
- Provide technical support for land managers to respond to drought, heat stress, floods, pests, and changes in growing seasons. To do this we have set up cooperative agreements with Agricultural Experiment Stations and Cooperative Extension Services at the Land Grant Universities to hold workshops for stakeholders in five states and with a combination of federal, state and local agencies in Hawaii and the western Pacific Islands. These partnerships will result in each state holding workshops to promote climate-smart decision-making.
- An agreement has been established with environmental educators to develop a weather and climate change module designed for the 7th grade level to foster education of future generations of land managers. The module is under development and will be tested in the first year on a set of middle school teachers. After modifications have been made, the module likely will be expanded into a Future Farmers of America (FFA) program.
- There are numerous reports and other information in states of the Southwest Region that provide adaptation strategies to cope with shortages of water and reduction of agricultural productivity due to climate change (e.g., Garfin et al., 2013). We will coordinate with states in the Southwest region to compile research related to climate change, water resources, and agricultural practices, and the result will be organized into a spatial format and provided on the Southwest Hub website or published in peer reviewed journals.
- Develop a strong web presence for the Southwest Regional Hub that can be used to publicize ongoing efforts for adaptation to climate change as well as providing links to other agencies addressing climate change such as the USGS Climate Science Centers, U.S. Fish and Wildlife Service Conservation Cooperatives, and NOAA Regional Integrated Science and Assessment centers.

CLIMATE DATA COLLECTION AND APPLICATIONS

The climate and hydrologic data networks in New Mexico have been upgraded to make them more comparable to other southwestern states. Twelve existing basic NRCS SNOTEL sites have been upgraded to enhanced SNOTEL sites, and five new enhanced SNOTEL sites have been installed to fill gaps in the existing snow monitoring network. Additionally, four new NRCS SCAN sites have been installed South-to-North along the Rio Grande to better assess changes in soil moisture and record climate data close to irrigated agricultural areas.

New climate stations have been installed in the remote areas of New Mexico with the capability of rapidly relaying the climate data to central data centers. Four new climate stations have also been installed in the Navajo Nation to increase network capabilities. Nine new year-round RAWS climate stations have been installed in northern New Mexico for providing information in forests not only for water availability analyses but also assessing forest fire potential. These upgrades in climate data collection were funded by the National Science Foundation in order to make New Mexico competitive with networks of other states in competing for research funding.

AS CLIMATE CHANGES IN THE SOUTHWEST WATER AVAILABILITY BECOMES A PRIMARY LIMITING FACTOR

Although water in the Southwest is scarce, the most dependable source of water in major rivers, such as the Rio Grande, comes from snowmelt. Because temperatures both globally and regionally are increasing (Gutzler, et al., 2006), major changes in snowpack accumulation, runoff, and water supply are occurring as well. First, warmer temperatures are causing less snowfall in winter, therefore, at the beginning of the snowmelt period around 1 April, the snowpack is reduced, the snowmelt begins sooner, and the total snowmelt contributed to runoff is less. As a result the snowmelt runoff peak moves forward in time as shown in Figure 2. The peak can occur 3-6 weeks earlier

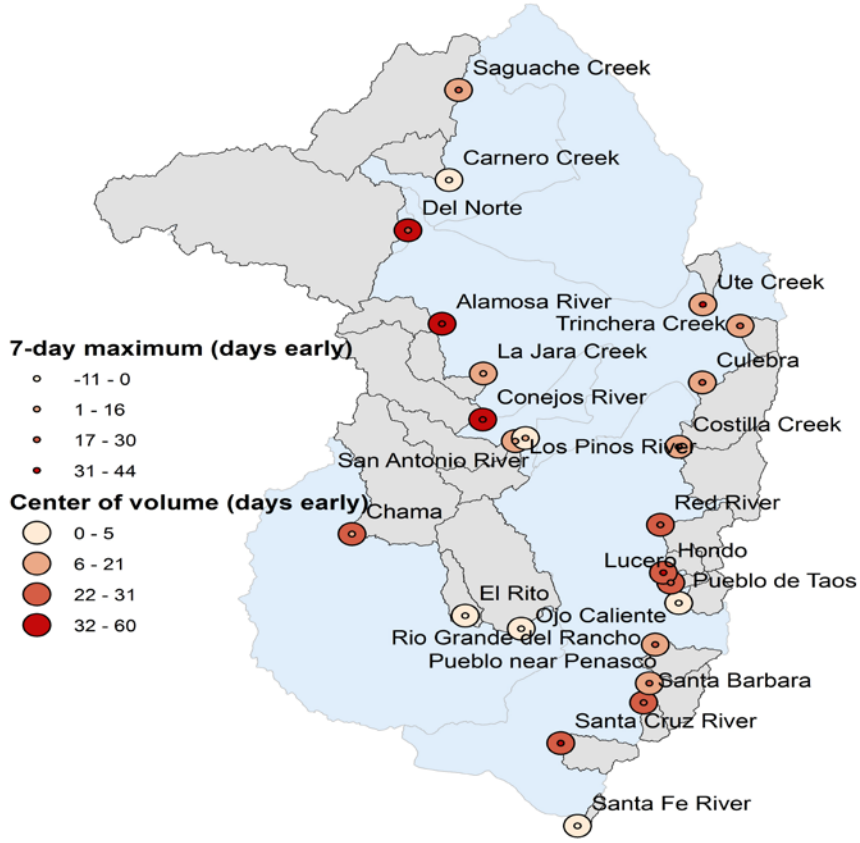

Figure 2. SRM (Martinec, et al., 2008) simulated changes in streamflow timing comparing the 1999 measured hydrograph to the 2099 simulated hydrograph.

in the Rio Grande sub basins by 2099. In most cases the peak value itself is somewhat less after the climate change although we have noted higher peaks in several basins.

In order to make seasonal moisture projections, upper atmosphere circulation patterns and storm system tracks can be monitored. The circulation patterns and storm tracks are directly responsible for the amounts of moisture received in various parts of the western United States. Zonal flows across the western U.S. set up to favor snow accumulation in the Southwestern States in an El Nino year. In such a situation, the northern Rockies experience dry conditions. Ridges and valleys in the upper air flow (La Nina) result in dry conditions in the Southwest and favorable snow accumulation for the northern Rockies.

The sooner that long-term and comprehensive climate data sets are assembled, the more likely we will have an improved understanding of actual changes that have already occurred as well as better input to climate models for long-range projections. When downscaling of the climate model run data takes place, the more confidence we will have in the model outputs that are typically used at the locations where measurements are already made.

The most efficient water producing sub basin in the Rio Grande is the Rio Grande near Del Norte, CO. Figure 3 is produced by SRM and shows the measured hydrograph in 1999 compared to 2099a (with only a temperature increase) and 2099b with temperature and precipitation changes. Peaks for both temperature increases and temperature plus precipitation changes show the earlier occurrence of the peak flow. The major things to note are the earlier peaks in early May, and the large difference in hydrograph between June, July and August when water demand is the greatest.

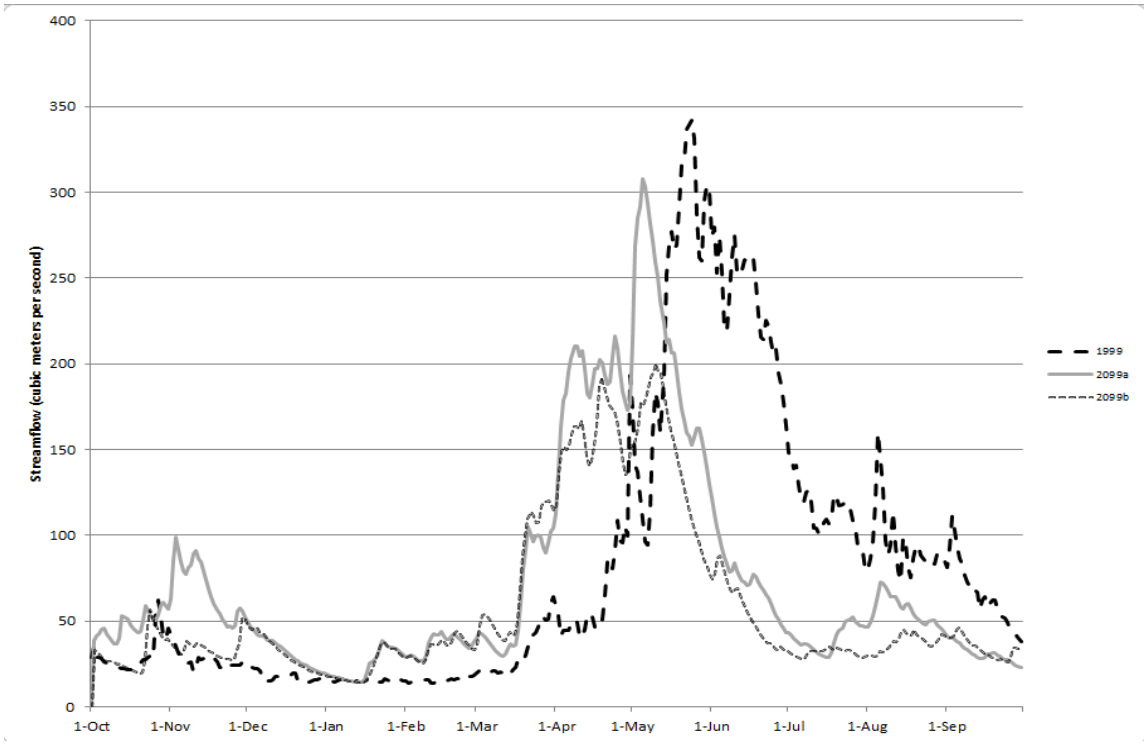

Figure 3. Measured 1999 hydrograph for the Rio Grande snowmelt basins compared to hydrograph simulation for 2099a with temperature increases only and the 2099b with temperatures and precipitation changes resulting from the climate change.

CONCLUSION

The recently established USDA Regional Climate Hubs have already generated much discussion on climate change and possible effects. In order to provide relevant adaptation information to farmers, ranchers and forest landowners, the Southwest Hub is developing a set of informational sheets on climate change to be discussed in workshops. The Southwest Hub is transmitting the information through the expert capabilities of Agricultural Experiment Stations and Cooperative Extension Services in each state to stakeholders.

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