Department of the Interior

U.S. Geological Survey

Southwest Climate Science Center

2017 Science Workplan

USGS
science for a changing world

Introduction

The mission of the Southwest Climate Science Center (SW CSC) is to provide the region's resource managers with essential scientific knowledge and tools to anticipate and adapt to climate change. The SW CSC is committed to providing the best science available, and to working in partnership with stakeholders in the Department of the Interior and other agencies and organizations to identify critical knowledge needs and to share information. Although the SW CSC is primarily focused on the southwestern United States, it collaborates with other CSCs across the country to develop capacity at the national level and address regional challenges.

The general science objectives, staffing needs, and operating principles for the SW CSC over a five-year span starting in 2013 are described in the Science Agenda. This Annual Science Workplan details the specific research priorities and planned actions for the SW CSC during federal fiscal year 2017 (FY 17).

Stakeholder Engagement

The SW CSC maintains regular contact with the Landscape Conservation Cooperatives (LCCs) and has participated, when possible, in LCC Steering Committee meetings. It is also in close contact with the USDA Southwest Climate Hub, and with the two NOAA RISAs in the region (CLIMAS and CNAP). These entities, as well as the SW CSC Stakeholder Advisory Committee (SAC) have been kept informed of major SW CSC activities. The SAC met most recently in Tucson in April 2016, and part of the agenda was directed toward more effective communication and engagement among SAC members and the SW CSC. The SW CSC has also been in contact with other stakeholders in the region as necessity and opportunity arise. For example, the SW CSC recently co-organized a joint meeting of LCCs and stakeholders to identify shared objectives related to conservation and climate change in California. A primary outcome included the identification of several high priority, collaborative projects that are ready for implementation within the next 1-3 years (for details, see http://www.californialcc.org/joint-lcc-csc-meeting). Additional stakeholder contacts have been made through university and USGS Principal Investigators (PIs) sponsored by the SW CSC.

The climate-science information needs expressed in the Science Agenda and the research themes intended to meet those needs (see below) reflect guidance provided in 2011 and 2012 by the SAC, the LCCs, and other resource-management agencies. Subsequent meetings with the SAC, and discussions with diverse stakeholders, have clarified stakeholder needs and priorities, and identified gaps and emerging needs for scientific knowledge. Our plans for stakeholder engagement, as well as our research priorities, have been and will continue to be adjusted and adapted based on discussions with the stakeholder communities.

Research Priorities

The SW CSC Science Agenda describes 5 research themes, based on climate-science information needs that have been communicated by the resource-management agencies with which the SAC members and LCCs are affiliated. The SW CSC research themes are:

- *Climate science and forecasting*
- *Hydroclimate and water availability*
- *Ecological responses and vulnerabilities*
- *Designing monitoring strategies*
- *Establishing best information exchange practices*

Given limited resources and needs for particular information in a given fiscal year, the SW CSC prioritizes research objectives annually. All themes may not be addressed in a given year. Theme 5 (*Establishing best practices*) is particularly critical to success of the SW CSC. Accordingly, starting in FY 13, the SW CSC has been sponsoring integrative projects aimed at understanding, testing, and assessing approaches to scientist-stakeholder engagement that produce effective management and scientific outcomes. The ultimate objective is to identify the sets of best practices for collaboration and knowledge exchange between researchers and stakeholders. This initiative reflects the high priority the SW CSC places on effective stakeholder collaboration, as indicated in the SW CSC Goals outlined in the Science Agenda.

Funding Commitments for FY15 and FY16

Projects funded in FY15, targeting six science priorities identified in the 2015 Science Workplan and listed in the FY15 RFP, include:

- *Fighting drought with fire: can managers increase forest resistance to drought using prescribed fire?* (2 yrs, U.S. Geological Survey and University of Arizona)
- *Feedback index for assessing the impact of restoration on ecohydrological processes in response to variable climate.* (2 yrs, U.S. Geological Survey and University of Arizona)
- *Hydrological response of atmospheric river events in the Salt and Verde River basins: climatology and possible future changes.* (2 yrs, University of Arizona)
- *Development, delivery, and application of data on climate extremes for the southwestern United States* (3 yrs, University of California-Davis, University of Arizona, Desert Research Institute, Scripps Institute of Oceanography, and U.S. Geological Survey)

The last of these projects addresses 2013, 2014, and 2015 Science Workplan priorities, and was directly invited by the SW CSC. It aims to develop an integrated climate-knowledge network and data exchange for the region that will allow scientists and stakeholders to both obtain and

contribute information, focusing particularly on climate extremes with demonstrable impacts on management planning and decision-making.

Using one-time funds received by the SWCSC to address the ecological drought underway in California, we funded two additional projects in FY15. Both are linked closely with ongoing or imminent management planning and decisions:

- *Can management increase forest resistance to drought?* (1 yr, University of California, Davis and U.S. Geological Survey)
- *Impact of drought on waterbird wetland habitats, bioenergetics, and movements in the Central Valley of California* (1 yr, U.S. Geological Survey and Point Blue Conservation Science)

We also continued co-funding of a project with the Northwest Climate Science Center that leverages funding from the Joint Fire Sciences Program our funding supports efforts at linking the research with management decisions:

- *Relations among cheatgrass-driven fire, climate, and sensitive-status birds across the Great Basin.* (2 yrs, University of California, Davis)

In FY16, we did not distribute an RFP, and all funded projects represented direct-funded projects, solicited directly by the SWCSC to meet specific needs. Those projects included:

- *Vulnerability to hotter drought from leaf to landscape: Understanding inter-annual patterns in tree physiology, chemistry, and mortality* (1 yr, National Park Service and U.S. Geological Survey)
- *Water-resources relevant hydroclimatic reconstructions for western North America* (2 yrs, University of Arizona and US Geological Survey; co-funded with NCCWSC and Alaska CSC)
- *Pyramid Lake Paiute tribe traditional knowledge and climate adaptation* (1 yr, University of Arizona)

Finally, the SWCSC has direct-funded two projects aimed at addressing the research theme of *establishing best practices.* The first commenced in FY13 and continued through FY16; the second project started in FY15:

- *Evaluating the impact of climate science produced in the Southwest Climate Science Center on resource management agency decisions* (4 yrs, University of Arizona and Desert Research Institute)
- *Evaluating the impact of stakeholder engagement on the use of climate science in drought-related management decisions in California* (1 yr, University of Arizona)

Reflecting the SWCSC's commitment to this research theme, and to the recognition that better tools and capacities are needed for effective climate adaptation, the SWCSC funded two projects in FY15, each bridging between research and science facilitation, and each leveraging programs and capacities at the new Center for Climate Adaptation Science and Solutions (CCASS):

- *Partnership to increase capacity for tribal climate adaptation* (2 yrs, University of Arizona)
- *Support for enhanced scenario planning outcomes* (2 yrs, University of Arizona)

Emphasis on Theme 5 (*Establishing best practices*) will continue in FY17, as an overarching theme in the FY17 Request for Proposals (RFP) on more specific topics related to other themes.

Funding Plans for FY17

For FY 2017, the SW CSC identifies six research priorities, as outlined below. These research priorities are based on the core themes outlined in the 2013 SWCSC Strategic Science Plan and build on the priorities identified in the RFPs of 2013-2015. The FY17 priorities are based on our experience of the past several years, including developing needs in the management sector and emerging capacities in the research sector. They are integrative; each priority includes some element of the five research themes from the 2013 SWCSC Strategic Science Plan. These priorities will be applied in the FY17 RFP. RFP projects to be funded will comprise targeted, short-term efforts that apply directly to specific management challenges, either locally or broadly across the landscape. Each project will address one or more issues faced by stakeholders, generate knowledge to address that challenge, and communicate the results to stakeholders in actionable ways. In addition, we will continue to develop direct-funded projects in selected areas, particularly for Theme 5 (*Establishing best practices*), and to advance climate adaptation capacity for tribes in the Southwest. We may also provide funding for engagement and application of results from selected projects funded in previous funding cycles (FY13 to FY16).

The six major priorities to be identified in the FY17 RFP include:

1. **Consequences of changing precipitation patterns and extremes.** The Southwest is characterized by highly variable precipitation regimes, and precipitation variability influences key ecological and hydrological processes and outcomes. In coming years, the region is likely to experience changes in the frequency, intensity, and seasonality of precipitation. An important priority is to better understand the ecological, hydrological, and societal consequences of precipitation extremes, both in the near-term and under projected future scenarios. What threats and opportunities for resource managers are posed by increased precipitation variability? How can managers most effectively plan for variability and altered extremes? How might precipitation extremes or anomalies be leveraged to advance management goals?

2. **Interactions of temperature extremes and precipitation variability.** Elevated temperatures have non-linear effects on evaporation and transpiration, and hence can amplify ecological and hydrological effects of precipitation deficits. Higher average and extreme temperatures are forecast for much of the Southwest in coming decades, but precipitation forecasts have much greater uncertainty. Regardless, the region is likely to experience interannual, decadal, and multidecadal precipitation variability, with periods of unusually high and unusually low precipitation. Consequences of 'hotter droughts' deserve attention, as do those of 'hotter normals' and 'hotter pluvials'. Given the precipitation variability of the region, how are temperature extremes likely to interact with precipitation variability to influence water resources, vegetation composition and structure, wildlife and fish populations and habitats, and other issues of concern to managers? What is the full range of plausible scenarios that managers may be faced with in coming years and decades?

3. **Managing in the aftermath of landscape-scale disturbances.** Much scientific work is currently focused on the direct, real-time impacts of large wildfires, insect-pest outbreaks, and mass mortality of trees and shrubs. Those events reset successional time to zero, remove incumbents, release resources for new generations of plants, and provide opportunities for colonization by native or exotic species. However, the course of succession may depend on environmental conditions and ecological processes in the first years and decades after the disturbance. Climatic, hydrological, and ecological processes in the aftermath of severe disturbances may set long-term successional pathways, determining habitat and landscape configurations that can persist for decades or more. Observational, experimental, and modeling studies can identify alternative scenarios of landscape revegetation and guide decisions and actions following severe disturbances. Exploration of the consequences of alternative climate scenarios, including climate extremes, for ecological trajectories is needed. Recent and ongoing disturbances provide opportunities for *in situ* experiments to facilitate understanding of change and consequences of management decisions. Application of tools designed to help managers and planners think through the consequences of alternative successional trajectories, including emergence of novel ecosystems, are also needed. Can management strategies be developed that will leverage different disturbances, different post-disturbance trajectories, and different restoration approaches to yield landscape mosaics that maintain vital ecosystem services and biodiversity? What management strategies – new, existing, or both – are likely to be robust to different future scenarios? How can new monitoring and evaluation frameworks be developed to better understand and respond to ecosystem changes following disturbance?

4. **Management of upper watersheds and downstream water resources.** In the Colorado and San Joaquin/Sacramento River systems, as well as most of the minor river systems of the Southwest, water captured as winter snowpack is delivered to rivers and reservoirs for agricultural and domestic use. Management decisions in upper basins (e.g., forest thinning, post-mortality revegetation) influence delivery via groundwater and surface streams to the lower basins, and conversely management practices in lower basins can feed back (e.g., via dust deposition) to affect water storage and delivery from upper basins. Management decisions in the lower basins can also affect efficiency and efficacy of water allocations. Better understanding of the linkages between headwaters and downstream flows, and between management decisions and water delivery, will improve drought resilience and water management.

5. **Learning from recent and ongoing climate events.** The American Southwest has experienced, and continues to experience, climatic events from which lessons can be drawn for the future. A prominent example is the ongoing regional drought, which has persisted in much of the region since 1999, and has been accompanied by unusually high temperatures. This and other recent and ongoing climate anomalies can be leveraged to better understand the consequences of climate variability and change in the coming years and decades, and can be used as a testing ground for understanding future vulnerabilities as well as for developing effective adaptation strategies. Ecological and hydrological responses to recent climate anomalies can be used to gauge responses to future events or trends. The effectiveness of ecological and hydrological models in explaining observed responses can determine robustness of those models in a changing environment, and identify knowledge gaps. Ongoing climate events and extremes can help assess the efficacy of current management and restoration practices.

6. **Utilizing emergent scientific capacities and decision tools.** Scientific capacities are improving rapidly in some key areas of climate science, notably in ability to analyze climate-model results to make probabilistic projections of daily weather patterns and extremes across the seasons. Products of these kinds of analyses, developed in collaborations involving hydrologists, ecologists, and resource managers, can inform planning and management under climate change. These emerging climatological capacities can also inform mechanistic understanding of ecological and hydrological consequences of climate change. To date, ecological forecasts have depended largely on correlational models, and many ecological changes observed to date are not consistent with predictions of those models. Ecological responses to climate change are often under more subtle control, involving daily and seasonal extremes. Integrating emerging climatological capacities with emerging ecological and hydrological capacities, in context of specific management needs, can advance the science of climate adaptation while simultaneously helping address management challenges. At the same time, decision

toolkits are expanding and diversifying, and creative application of robust and appropriate tools for decisions, applied in concert with state-of-the art science, can advance the entire field.

Workforce Planning

The SW CSC now has two full-time USGS on staff. In FY17, we will add a third staff member, which will bring us up to full capacity under the current budget and scope of the Center. A Science and Applications Coordinator will be hired during FY 17. This person will bring much-needed assistance to the SW CSC Director and Deputy Director in implementing the Strategic Science Agenda (SSA), planning for development of the next SSA, and distributing the workload of coordinating and overseeing the various activities of the Center.