Scientific overview of climate change impacts and adaptation priorities in the Central Valley, and links to research

Presentation to California Senate Environmental Quality Committee

September 22, 2015 – Merced, CA

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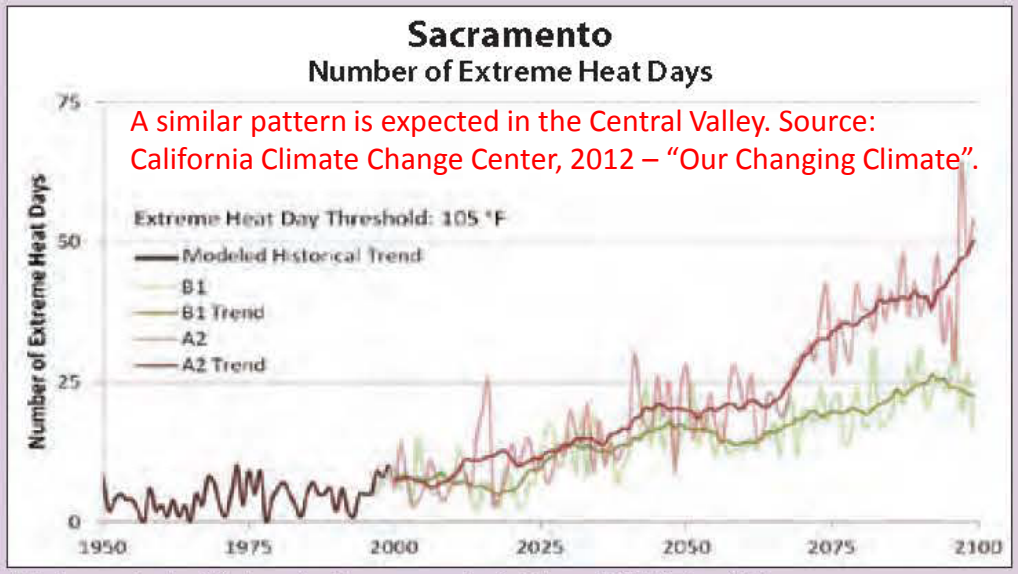
Scientific overview of climate change impacts and adaptation priorities in the Central Valley – overview

As the Earth's temperature increases, corresponding increases in the Central Valley's minimum night-time, maximum daytime and daily average temperature over the annual cycle will affect agricultural crops, air pollution, worker productivity, electricity demand and many other aspects of our lives, ecosystems and economy.

Increases in temperature and shifts in precipitation together will affect water storage, inter-annual availability of water for agriculture and cities, groundwater withdrawals, drought incidence, evaporative demand across the landscape, wildfire incidence and extent, wildlife habitat, and more.

These impacts are outlined in the 2012 California Climate Assessment "Our Changing Climate".



"Extremely hot" days in Sacramento (at least 105°F) will become more common with climate change. By the middle of this century, the number of extremely hot days could increase fivefold (up to 20 days) compared to the historical period (black curve). By the end of this century, under the higher emissions scenario (red curve), they could occur as much as ten times more often than historically. Following a lower emissions scenario (green curve) could make a big difference: Sacramento would see only half that increase.

Scientific overview of climate change impacts and adaptation priorities in the Central Valley – heat

Extreme heat several days in succession will affect outdoor workers, particularly in agriculture. Public health will also be affected by impacts of warming on air quality, food production, the amount and quality of water supplies, energy pricing and availability, and the spread of infectious diseases.

For example, warmer temperatures affect ozone production, as well as smoke form wildfires. Both have known health impacts.

These impacts fall especially hard on poor rural populations characteristic of the Central Valley, owing to the lower level of capacity to cope with and adapt to the impacts of warming.

A strategic area of research and education for UC Merced is inequality, power and social justice. Several faculty and other researchers at UC Merced use the Central Valley as a laboratory for their research, and help build the knowledge base for social solutions.

Scientific overview of climate change impacts and adaptation priorities in the Central Valley – <u>water</u>

Many impacts of climate change on the Central Valley will be felt through changes in the water cycle.

These start in the Sierra Nevada, with snow/rain shifts and earlier snowmelt; and these shifts affect water availability in storage for use during annual and multi-year dry periods. Critical storage includes water in the snowpack, in mountain soils, behind dams and in groundwater).

Further impacts in the region occur through groundwater depletion and quality; and also affect land subsidence.

Several SNRI faculty and researchers at UC Merced focus on hydrology, climate and water resources challenges in the Sierra Nevada and Central Valley.

In particular, SNI research emphasizes the critical importance of measurements and data as the key foundation for systems understanding and thus predictions.

Scientific overview of climate change impacts and adaptation priorities in the Central Valley – water (cont.)

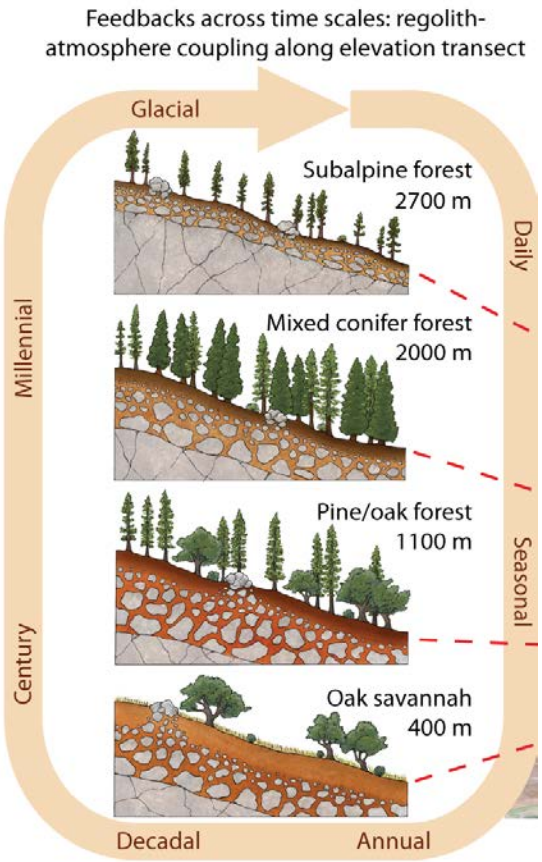
One example of the multi-disciplinary water and ecosystem research is the Southern Sierra Critical Zone Observatory (SSCZO), https://criticalzone.org/sierra.

Four SNRI faculty form the core leadership of this multi-million dollar, internationally recognized program, which engages tens of other researchers, students and collaborators from UC Merced, other UC campuses, and a variety of research organizations around the world.

The SSCZO began in 2007, and is supported by the U.S. National Science Foundation.

SSCZO researchers have established quantitative links between precipitation patterns, temperature, subsurface water storage and ecosystem health in Sierra Nevada forests.

The quantitative predictive capabilities they have developed provide a more-solid foundation for both water and forest management.



Scientific overview of climate change impacts and adaptation priorities in the Central Valley – water (cont.)

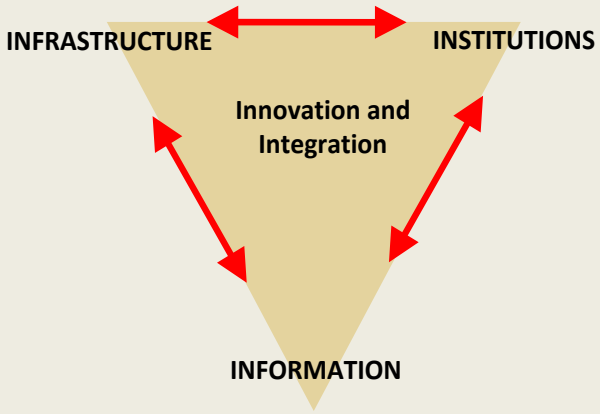
A second example of how UC Merced is addressing the state's critical water challenges is the recently established UC Water Security and Sustainability Research Initiative (UC Water), http://ucwater.org.

Three SNRI faculty plus three faculty from other UC campuses form the leadership core of this multi-million dollar, multi-campus initiative, which has base support through the UC Office of the President.

UC WATER

- is developing innovative, quantitative water accounting and analysis methods, and introducing modern information systems into California's aging infrastructure,
- is improving our understanding of the way water flows through the natural environment, and how it is extracted, conveyed and stored in built and natural infrastructure,
- tightly weaves in legal and policy research, and
- integrates from headwaters through groundwater.

We define water security as the reliable availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks. Sustaining water security in the face of interrelated changes in population, climate and land cover requires investments in three tightly-linked areas:

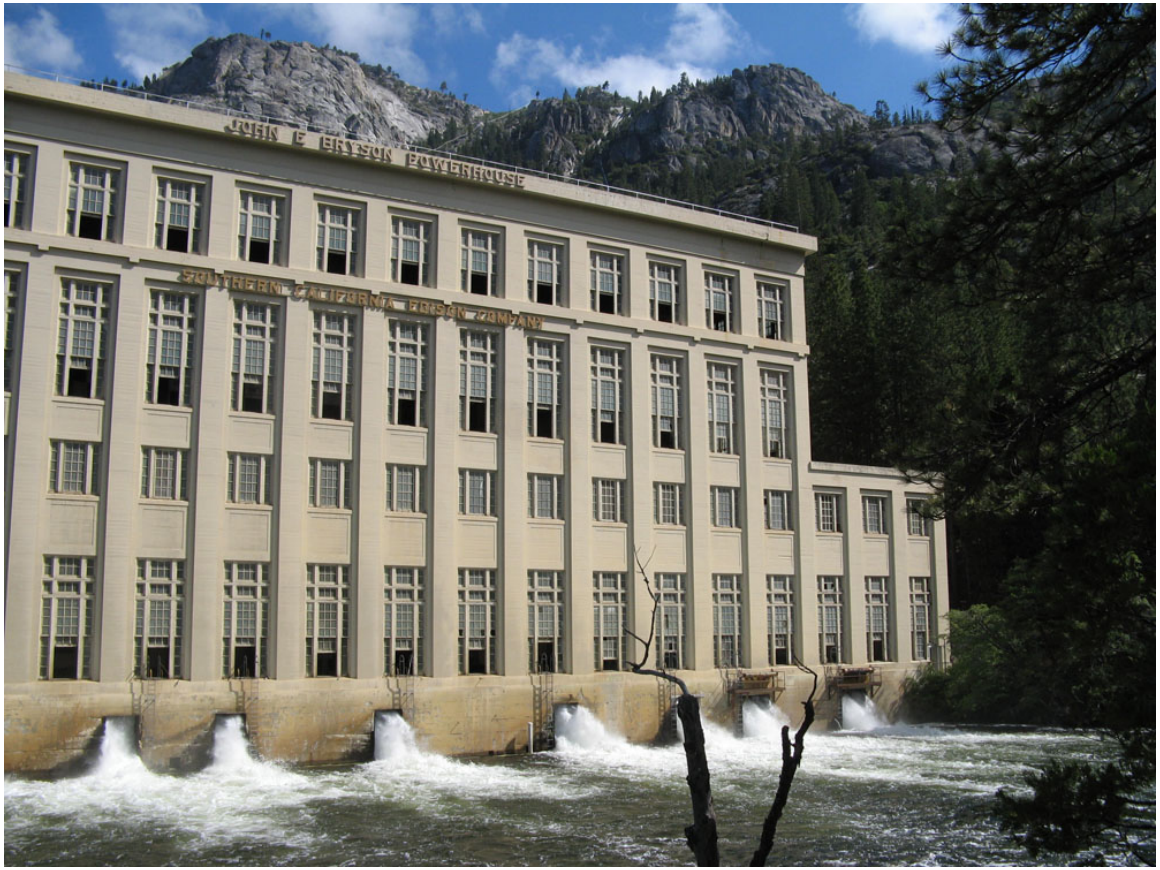


Scientific overview of climate change impacts and adaptation priorities in the Central Valley – <u>energy supply</u>

Electricity demand is affected by temperature, particularly the demand for summer cooling.

Drought conditions result in less hydropower production, and thus more production of electricity by fossil fuels.

SNRI researchers are working with hydropower utilities to improve forecasting and thus operation of mountain plants thought improved hydrologic information.



Scientific overview of climate change impacts and adaptation priorities in the Central Valley – energy supply (cont.)

The Central has tremendous potential for production of renewable energy.

UC Merced is committed to become carbon neutral on its campus by 2025, which is aligned with UC President Napolitano's goal of carbon neutrality for UC as a whole.

UC Merced is the lead campus in UC Solar, a multi-million dollar strategic research program, with base support through the UC Office of the President.

UC efforts are aimed at developing technology and approaches for the Central Valley and California as a whole to become carbon neutral.

SNRI researchers also have a vigorous research program around biomass energy, including production of biogas from waste feedstocks.

The Central Valley has the potential to help the state displace natural gas with more-renewable fuels.


UC Merced, 1 MW PV array

Scientific overview of climate change impacts and adaptation priorities in the Central Valley – <u>ecosystems</u>

Ecosystem health and the ability of forests, grasslands, riparian areas to yield ecosystem services is affected by climate change, and resource managers need new levels of both knowledge and resources to meet current and future challenges.

Drought stress, tree mortality and high-intensity wildfire in the Sierra Nevada, and associated effects on water and other ecosystem services are of particular concern.

Many SNRI researchers are engaged in research that builds he knowledge base for better ecosystem management, particularly in the Sierra Nevada and foothills.

SNRI research includes climate-wildfire links and predictions, ecosystem health, shifts in ecosystem species as the climate warms, and verification of the water implications of forest management.

Scientific overview of climate change impacts and adaptation priorities in the Central Valley – climate communications

In the Central Valley and across the American public there is a sizable political divide on the issue of global warming; and flows of political messages and news concerning global warming have contributed to substantial growth of this divide over the past decade.

There is, however, evidence that climate-change acceptance and thus support for adaption and mitigation is increased by mechanism-explaining interventions (wisdom deficit). Framing and use of a trusted message source are essential.

UC Merced's Center for Climate Communications, conducts and promotes research on communicating climate issues, including climate variability and adaptation.

The Center

- examines the meaning and presentation of climate reports from varied sources, and studies how the presentation of climate information influences the public;
- works with stakeholders to develop better ways to talk about and think about climate issues; and
- hosts and carries out outreach activities.

Climate change is a "wicked problem", and engaging the public in a discussion of complex scientific issues is especially difficult because of the basic neurological wiring of the human brain. A wicked problem has no solution that is positive across all values.

Wicked problems
Some problems are so complex that you have to be highly intelligent and well informed just to be undecided about them.

Laurence J. Peter
(of Peter Principle)

Challenges and successes in coordinating adaptation efforts among academic, federal, and state partners, and how the state might be helpful in supporting and improving these efforts

The current multi-year drought and rise in high-intensity wildfire activity highlight that the Sierra Nevada is at a tipping point with respect to water temperature effects on both ecosystems and water supply.

The region needs a sustained effort for restoring our Sierra Nevada forests to a sustainable conditions, including the provision of traditional ecosystem services such as habitat, biodiversity, recreation, timber, grazing and water security; and also further opportunities for renewable energy and carbon sequestration.

UC Merced and SNRI work closely with resource managers such as the U.S. Forest Service and California Resources Agency to develop the knowledge base and tools for better, adaptive resource management. The UC and our resource-management partners need opportunities and incentives to sustain this support for doing strategic research and translating it to management actions through bond funding for water and conservation, and other leveraging.


Thinning small trees, Stanislaus-Tuolumne Experimental Forest

Challenges and successes in coordinating adaptation efforts among academic, federal, and state partners, and how the state might be helpful in supporting and improving these efforts

The region (and whole state) would benefit from an accurate, transparent, timely water-resources accounting system to support decision making. This system needs to extend from the Sierra Nevada headwaters (including snow and soil-moisture storage, rain, snowmelt, evapotranspiration and runoff flows) through Central Valley agriculture (including diversions and evapotranspiration) and groundwater (storage, recharge and withdrawals). While these quantities are estimated by models, they are measured in very few places if at all.

UC and private-sector technology provides the opportunity to transform water decision making.

Modest investments now will have very large immediate and long-term benefits.

Low-cost measurement node, part of a distributed water-resources information system

Challenges and successes in coordinating adaptation efforts among academic, federal, and state partners, and how the state might be helpful in supporting and improving these efforts

The region can move to a healthier, lower-carbon economy through investments and incentives to move our cities, towns, farms and daily lives to renewable energy. State agencies and elected officials from coastal areas must work with Central Valley elected officials, businesses and the UC and Cal State to achieve this.

Transportation poses particular problems, both inter-regional and intra-regional.

A sustained effort in climate communications will benefit the region's economy and can garner greater regional support for actions aimed at achieving a sustainable energy and water future for the state, a healthier living environment, healthy ecosystems and a stronger economy.

SNRI and UC Merced as a whole are committed to both the education and strategic research in social science, engineering and natural science that address the region's climate challenges.

As a research university, our products are both our graduates, and new knowledge.

Challenges and successes in coordinating adaptation efforts among academic, federal, and state partners, and how the state might be helpful in supporting and improving these efforts

A sustained effort to develop climate solutions through research and development, and public-private partnerships would speed the region's transitions to a renewable energy future.

UC Merced is part of the broader UC effort to develop climate solutions. The legislature has a critical role to play in facilitating this cooperation through support for development of knowledge and technology, incentives for cooperation and adoption, and climate literacy.