

## **Impact of a warmer and drier future on rangeland ecosystems and ecosystem services**

Between 2012 and 2014 California experienced conditions that were warmer and drier than any period over the last 1200 years. Evidence is rapidly mounting indicating that these co-occurring periods of precipitation deficit and warm temperatures are human caused, likely to increase over the next century, and result in levels of drought intensity and duration rivaling those documented in the paleoclimate records. Understanding how these anthropogenic stressors will impact flows of ecosystem services in California is one of the most serious research challenges of our time.

Rangelands are the largest land use type in California, providing vast flows of critical ecosystem services to the state, including forage production for livestock, carbon sequestration and wildlife habitat. However, our ability to forecast how warming and precipitation deficit will impact these key ecosystem services is alarmingly limited. This limitation is one of the single largest barriers to risk management and adaptation planning by stakeholders and significantly weighs on our ability to advance climate science education and civic engagement across the state.

Recently, we were awarded a grant by the National Science Foundation (NSF) that enabled ANR to build key field research infrastructure at the UC Sierra Foothill Research and Extension Center (SFREC) to support rangeland climate change research. This project proposed by our statewide team represents the first generation of work to use this infrastructure. Specific objectives include:

1. Using the new field infrastructure, examine how warming and precipitation deficit impacts forage production and oak regeneration on rangeland.
2. Couple field data with downscaled climate models to create spatially explicit forecasts of future climate impacts on forage production and oak regeneration across the rangeland ecoregion represented by SFREC.
3. Using a network of UC advisor knowledge, develop regionally explicit assessments of how climate change may alter risk profiles for stakeholders and use this research-based assessment to identify and extend regionally relevant adaptation strategies.
4. Create new education programs around climate change including programs that integrate UC 4-H STEM efforts, new project-based learning opportunities for students, and new science content training for educators.

To assess how warming and precipitation deficit impact forage production and oak regeneration we will use large shelters that allow full factorial manipulation of air temperature and precipitation, as well as a distributed wireless mesh sensor network that uses an open source micro-controller, 900 MHz radio, and commercial sensors to continuously measure belowground and aboveground environmental conditions around 30 nodes distributed across the 6,000 acre center. The VisTrails Software for Assisted Habitat Modeling will be used to take experimental results and develop forecasts of how forage production and oak regeneration may change across the ecoregion under future climate change scenarios. Field and modeled results will then be integrated with a pool of advisor knowledge to develop evidence-based risk assessments that inform regionally relevant adaptation strategies. Our climate change education program is built around these linked research and extension efforts, providing authentic research and contextualized approaches to teaching, training and learning for education partners.

Collectively, this project will enable a transformational change in our ability to scale global change to local and regional impacts and, for the first time, provide stakeholders an evidence-based framework to prepare for a warmer and drier future. This project also serves a vital role in stimulating engagement and training of the next generations of scientists and citizens that are faced with conserving our agricultural and natural resources under climate change, as well as advocating for the well-being of some of the most disadvantaged communities across the globe.