

USDA California Climate Hub: Activities and Future Directions

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CA-NV DEWS North Central Coast
Drought and Climate Outlook

11 Oct 2016



United States Department of Agriculture
California Climate Hub

The basic challenge and our solution

Climate research

Producers

Climatic Change
DOI 10.1007/s10584-007-9367-8

Accumulated winter chill is decreasing in the fruit growing regions of California

Dennis Baldocchi · Simon Wong

OPEN ACCESS freely available online



Climatic Changes Lead to Declining Winter Chill for Fruit and Nut Trees in California during 1950–2099

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California perennial crops in a changing climate

David B. Lobell · Christopher B. Field

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Abstract Perennial crops are among the most valuable of California's diverse agricultural products. They are also potentially the most influenced by information on future climate, since individual plants are commonly grown for more than 30 years. This study evaluated the impacts of future climate changes on the 20 most valuable perennial crops in California, using a combination of statistical crop models and downscaled climate model projections. County records on crop harvests and weather from 1980 to 2005 were used to evaluate the influence of weather on yields, with a series of cross-validation and sensitivity tests used to evaluate the robustness of perceived effects. In the end, only four models appear to have a clear weather response based on historical data, with another four presenting significant but less robust relationships. Projecting impacts of climate trends to 2050 using historical relationships reveals that cherries are the only crop unambiguously threatened by warming, with no crops clearly benefiting from warming. A notable robust result is that almond yields will be harmed by winter warming, although this effect may be counteracted by beneficial warming in spring and summer. Overall, the study has advanced understanding of climate impacts on California agriculture and has highlighted the importance of measuring and tracking uncertainties due to the difficulty of uncovering crop-climate relationships.

1 Introduction

Agriculture is an important component of California's economy, landscape, and culture, and is among the human activities most vulnerable to impending climate changes. Two particularly unique and relevant features of agriculture in California are (1) the diversity of crops grown, with California the leading U.S. producer of over 80 crops, and (2) the substantial fraction of agricultural value (roughly one-third

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the production of many tree
chill in California, quantified

It was modeled for two past
periods: 2041–2060 and 2080–2099
using two different climate models
produced, using a stochastic
approach, the 10th percentile of the
winter can safely expect under
late winter chill for many tree

the middle to end of the 21st
century the Chilling Hour Model
it will likely need to develop
to cope with these projected

in California during 1950–2099. Plant

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and plums, including
also leading to reduced crop yields
due to climate change,
to more than those typically reported,
even come close to halving their
yields, complete crop failures may
increase of some will further reduce
if many orchard operations cannot
develop mathematical models that
select tree cultivars with chilling
to available chilling in a specific
understanding of available winter
seasons of the past rather than those
of the future. Since orchard yields remain in
depression of future expected winter
temperature climate change. Without
orchards might receive inadequate
physiological quantities, even though
the conditions were optimal for the
the pair of winter chill decline, the

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Intermediate/translational organizations such as the USDA Climate Hubs



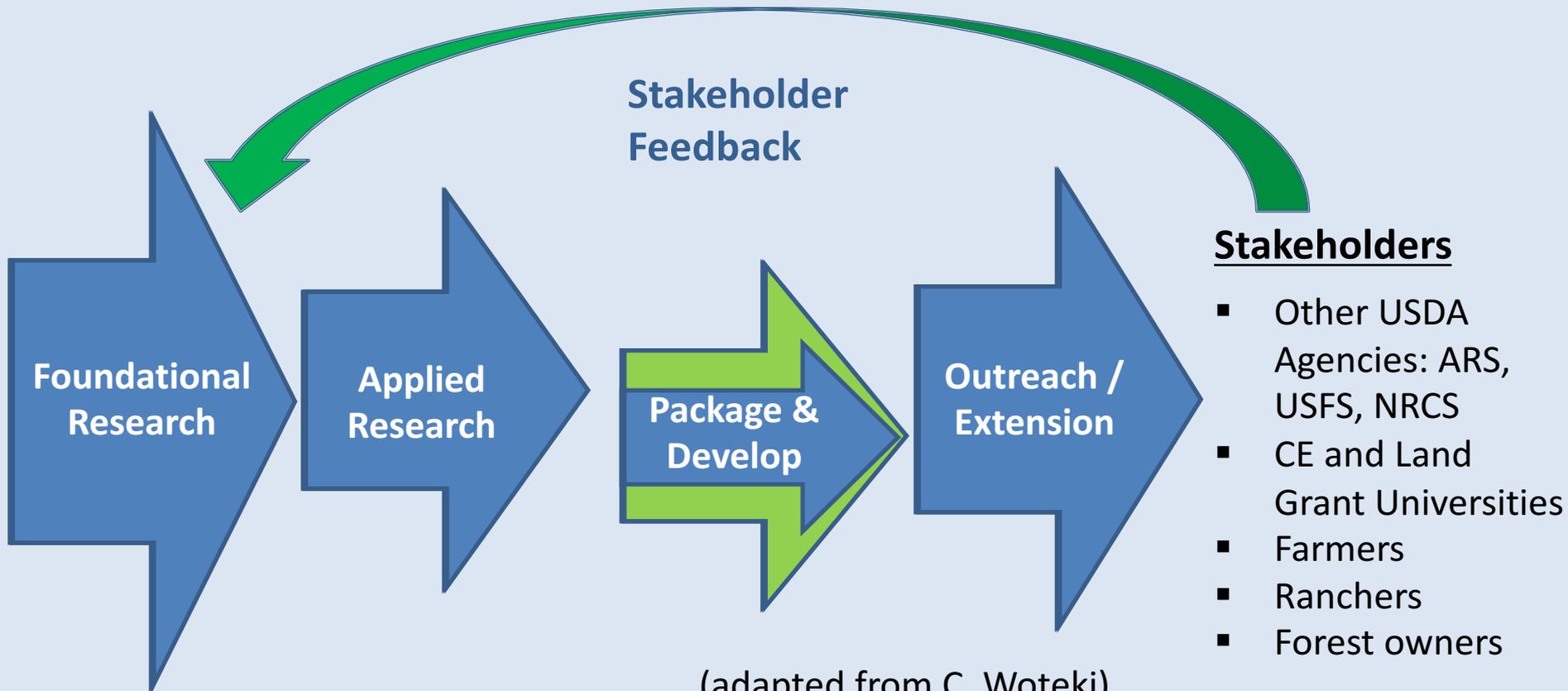
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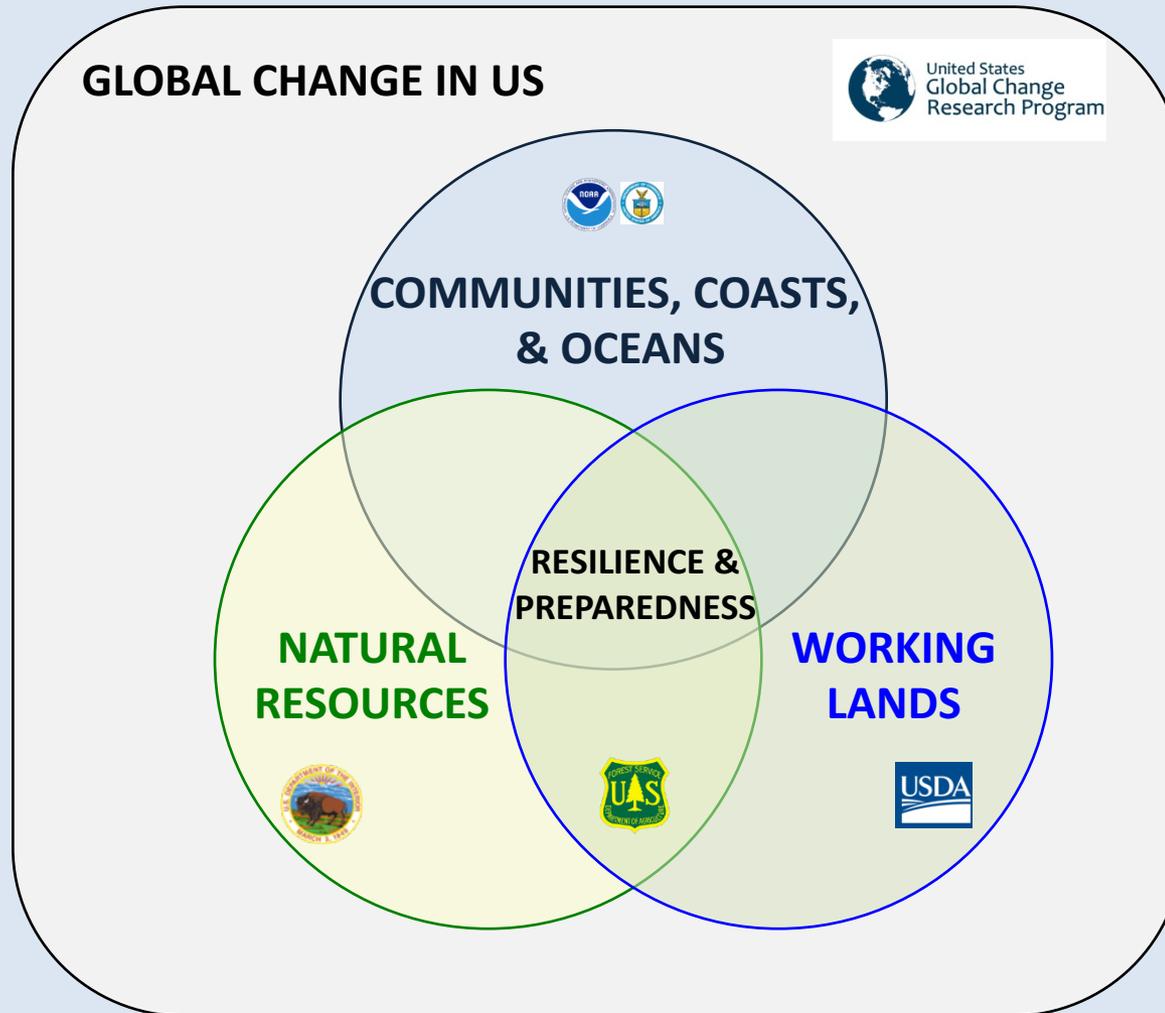
Two-way communication

Hubs improve information flow to AND *from* stakeholders to provide feedback to inform research priorities



(adapted from C. Woteki)

Hubs and other agencies



(adapted from C. Woteki)

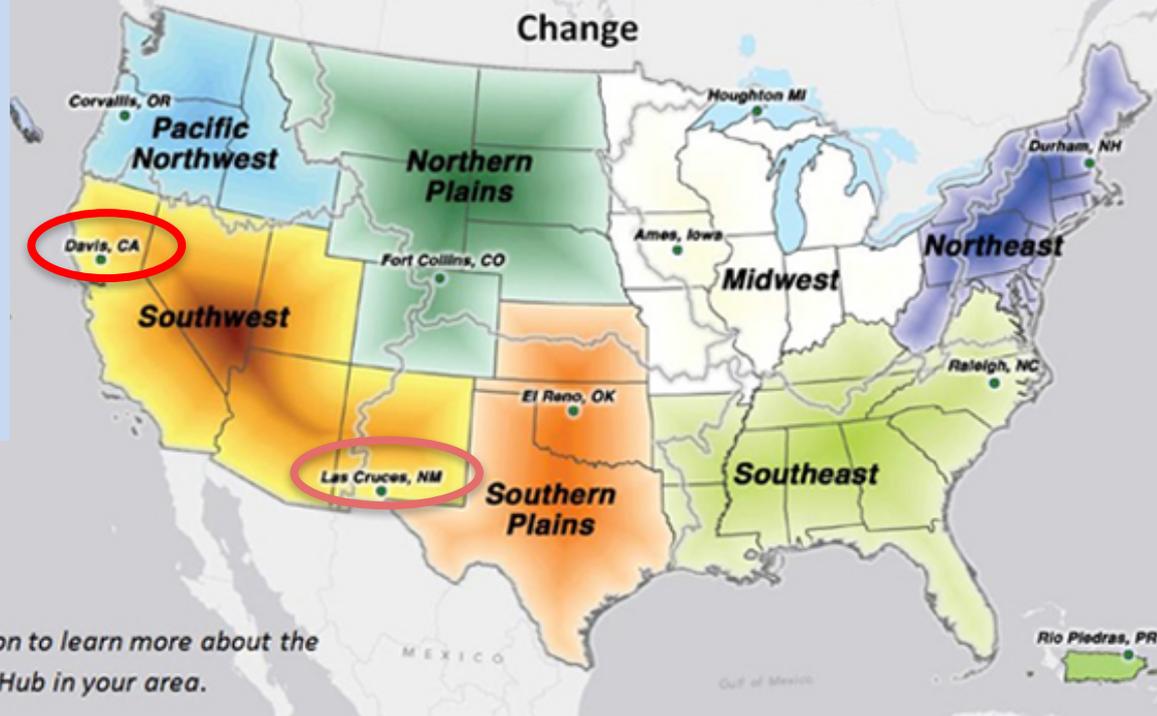
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Formation and location of the USDA Climate Hubs

USDA Climate Hubs for Risk Adaptation and Mitigation to Climate Change



In early 2014, USDA created 10 Climate Hubs

CA Hub is at **University of California, Davis**

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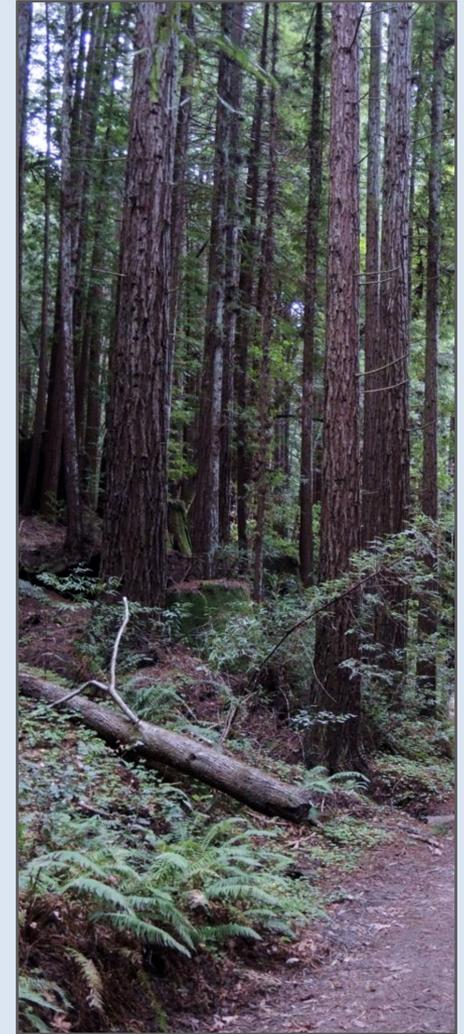
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Focus areas of the California Hub



Specialty crops

Forests



Rangeland



We depend on our partners

Partners are essential to our work. We define three types of partners:

- 1. Key partners** (organizations with whom we coordinate closely and from whom we draw core members);
- 2. Subject experts** (usually individuals, e.g. from universities, national labs, etc);
- 3. Information-sharing partners** (with whom we cross-post announcements and events).

- California Department of Food and Agriculture (CDFA)
- California Landscape Conservation Cooperative (CA LCC)
- California Natural Resources Agency
- California Nevada Climate Applications Program (CNAP)
- Southwest Climate Science Center (SWCSC)
- USDA Agricultural Research Service (ARS)
- USDA Forest Service (Pacific SW Region and Pacific SW Research Station)
- USDA Natural Resources Conservation Service (NRCS)
- University of California Agriculture and Natural Resources (UCANR)
- UC Davis College of Agriculture and Environmental Sciences
- UC Davis John Muir Institute of the Environment (JMIE)
- Western Regional Climate Center (WRCC)



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Extension: our key link to producers

- Rather than work with individual land users, we create and disseminate climate-relevant information in **partnership with extension agencies**.
 - UC Cooperative Extension
 - USDA Natural Resources Conservation Service
 - Resource Conservation Districts?
- Extension is our **key link back from producers**, to help us craft relevant, practical outputs.

Climate Vulnerability Assessments

- All Regional Climate Hubs were required to complete a Vulnerability Assessment in 2014-15
 - review existing knowledge
 - identify regional priorities
- **Vulnerability assessment for the Southwest** completed Dec 2014
 - forestry, specialty crops, field crops, rangeland
- Tailored for **three different audiences**:
 - A **50-page report** for the Climate Hubs national office
 - **Peer-reviewed articles** for the academic community
 - **Fact sheets** on each topic for stakeholders

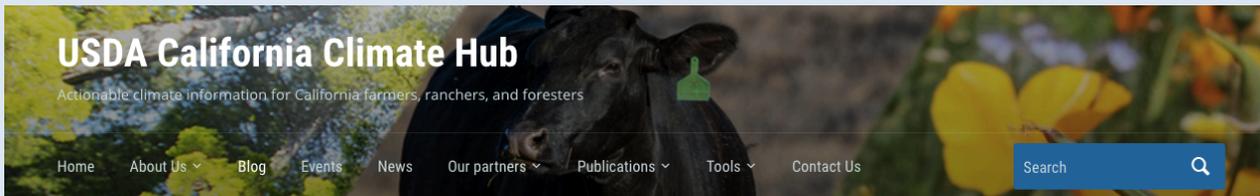
CA rangelands vulnerability assessment

- CA rangelands are economically, ecologically, and culturally important, and distinct from rangelands of the arid SW.
- Climate Vulnerability Assessment in partnership with SW Hub and CA Rangelands Conservation Coalition
- Process includes review by academics, government agencies, extension, NGOs, and ranchers
- Estimated completion date: October 2016



CA Hub Website

caclimatehub.ucdavis.edu



Home » Blog » Climate Hubs convene to discuss adaptation across North America –

Blog

Climate Hubs convene to discuss adaptation across North America –September 3, 2016

A cornucopia of categories for crops –July 21, 2016

Testing efficient irrigation at UC Davis' Russell Ranch –July 15, 2016

California's farmers save on

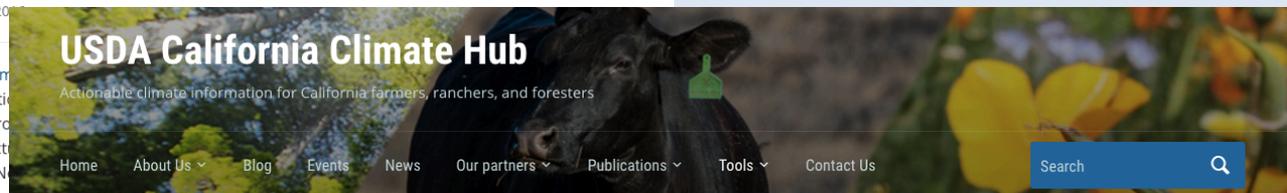
Climate Hubs convene to discuss adaptation across North America –

By Amber Kerr in Blog on September 3, 2016

On August 17-18, 2016, the North American Climate Hub Adaptation brought together practitioners from a variety of systems from rural neighborhoods to coastal infrastructure represented, with members of the National Climate Hub network.

Publications

Drought Fact Sheets



Home » Tools

Blog

Climate Hubs convene to discuss adaptation across North America –September 3, 2016

A cornucopia of categories for crops –July 21, 2016

Testing efficient irrigation at UC Davis' Russell Ranch –July 15, 2016

tools.taccimo.info/tbi_tools_list.php

Tools

The USDA Climate Sub Hub for California and its parent Southwest Regional Climate Hub have compiled a list of tools to help farmers, ranchers, foresters, and other stakeholders adapt to climate change. We hope they are of assistance to you!

A full list of climate tools compiled by the national Climate Hub network can be found [here](#), and a list of drought tools can be found [here](#). Additionally, our parent Southwest Regional Climate Hub has compiled a list of tools, apps, databases, and websites from our partners [here](#).

Climate Hubs Tool Shed

Drought Tools

National List of Climate Tools

Southwest Region List of Climate Tools

Publications

Drought Fact Sheets

Causes

Forests

Crops

Water policy

Rangelands

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United States Department of Agriculture
California Climate Hub

UC ANR Forest Stewardship Series update

- Collaboration with UC-Berkeley
- Two new 12-page briefs for for the UC ANR Forest Stewardship serie, for owners of CA forestland, on [climate adaptation](#) and [mitigation](#)
- Evaluating the existing 24 briefs in the series for updates related to climate change



PUBLICATION 8233

FOREST STEWARDSHIP SERIES 3
Forest Ecology

LAURIE LITMAN, InfoWright, Stockton, CA; GARY NAKAMURA, I



PUBLICATION 8237

FOREST STEWARDSHIP SERIES 7
Forest Regeneration

CLARA LYNN NIINAMAKER, California Registered Professional Forester, Scotland, UK

Climate Hubs Tool Shed

Database of existing tools to adapt to and mitigate climate change
tools.tacclmo.info/tbl_tools_list.php

The screenshot shows the 'Climate Hubs Tool Shed' website. At the top, there are three buttons: 'About', 'Feedback', and 'Smart Search'. Below these is a search input field with the placeholder text 'search'. The main content area is divided into two sections: 'Sector' and 'Region'. Under 'Sector', there are six checkboxes: 'Agriculture' (checked), 'Climate', 'Ecosystem Services', 'Forestry', 'Grazing Land', and 'Livestock'. Under 'Region', there are eight checkboxes: 'Caribbean', 'Midwest', 'Northeast', 'Northern Plains', 'Pacific Northwest', 'Southeast', 'Southern Plains', and 'Southwest' (checked). Below the region filters is a 'Search' button. The results section shows 'Tools found: 165'. At the bottom, there is a row of six icons representing the sectors: Agriculture (carrot), Climate (thermometer), Ecosystem Services (leaf), Forestry (tree), Grazing Land (cow), and Livestock (chicken). Below this row is a link 'About My Woods' with a small icon.

Other upcoming Hub projects

- **Physiological impacts of climate change on California specialty crops (with LBL)**
- **Climate-based decision making by California almond farmers (with UCB, UCM)**
- **Parameterizing COMET-Farm greenhouse gas accounting model for CA specialty crops (with CDFA, CU Boulder)**
- **2016 Natural Areas Conference 17-20 October in Davis**
- **Building Blocks of Climate Smart Agriculture workshop in Sacramento, Feb 2016**



Our focus on drought in 2015-2016

- **Current drought** has profoundly affected of our sectors
- **Six drought fact sheets** for the general public published at caclimatehub.ucdavis.edu
- **Your ideas** on other drought-related projects welcome

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CALIFORNIA SUB HUB OF THE SOUTHWEST REGIONAL CLIMATE HUB
California Drought Fact Sheet Series 1
Informing the general public about the 2012-16 drought

Causes and Consequences of the Drought

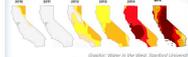
Background
The term "drought" is generally used to refer to deficits in water supply, but it can also refer to meteorological (precipitation), hydrological (streamflow), or agricultural (crop yield) deficits compared to a long term average. The US Drought Monitor uses a number of measurements including precipitation, snowpack, streamflow and more, which it uses to sort droughts into 5 categories of intensity. Almost half of California is currently under Exceptional Drought conditions, which are expected only once per 50 or more years¹.

How bad is the current drought?
How this drought compares to past droughts depends on the timeframe, location, and metric of concern. In terms of snowpack, this drought is the worst in California's instrumental record. Snowpack in April 2015 was at a mere 5% of the average—the lowest level ever recorded².

Widespread scientific consensus has not yet been reached about whether the current drought is attributable to climate change. However, it is understood that future droughts will likely become more frequent and more severe as temperatures rise in California. This is due to numerous factors, including the effects of increasing temperatures on the Sierra snowpack, a critical water resource for all sectors. As a result of reduced snowfall and accelerated melting, the amount of water stored in the April snowpack is expected to fall 25-40% from its historic average by the year 2050³.

What is causing the current drought?
Some models suggest that climate change may have increased the likelihood of the drought due to a possible but uncertain relationship with the so-called "Ridiculously Resilient Ridge"⁴. This ridge is a large region of high atmospheric pressure that persisted northwest of California from 2012 to 2014. This pressure formation brought on the drought by diverting winter storms and blocking the typical northwesterly winds that would otherwise cool the state.

How long is the drought likely to continue?
We do not have a way of confidently predicting when the drought will end. Short-range climate forecasting (over one to several years) is still a highly uncertain science, and the effects of phenomena like El Niño are difficult to predict with confidence⁵.



The US Drought monitor maps of July 2010-2015 show the drought's increasing severity.



Effects of the Ridiculously Resilient Ridge on the trajectory of storm events off of the Western US.

USDA United States Department of Agriculture
CALIFORNIA SUB HUB OF THE SOUTHWEST REGIONAL CLIMATE HUB
California Drought Fact Sheet Series 5
Informing the general public about the 2012-16 drought

Drought and rangeland sustainability

California rangelands: definition and importance
Rangeland is defined in a number of ways along a variety of factors, including ecosystem type, dominant vegetation, and utility for livestock grazing. The Sustainable Rangelands Roundtable, for instance, defines rangelands as "areas dominated by self-regulating vegetation comprised predominantly of grasses, grass-like forbs, shrubs, and dispersed trees"¹, while the Forest and Rangeland Resources Assessment and Policy Act of 1977 defines them as land that is, among other things, "suitable for grazing or browsing of domestic livestock for at least a portion of the year"². While not all definitions include explicit mention of grazing, rangelands commonly provide millions of acres of critical forage—wilder grasses, forbs, and shrubs—to support California's cattle, sheep, and goat industries.

How does drought affect rangelands?
Forage production in California rangelands is strongly dependent on the magnitude and timing of precipitation. Summer forage in northern California is highly dependent on temperate, rainy weather in the fall and winter, while grazing in central California is more dependent on this weather during the spring³.

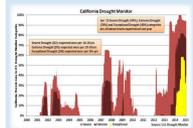
The intensity of the current drought threatens significant impacts to rangelands and the multi-billion dollar livestock industries of California that depend on it⁴. Rangelands in the Sierra foothills, for instance, have received only 23% of the average rainfall expected from January to March of 2015⁵. As a result, forage production per acre has fallen from an average of 700 pounds per acre to merely 475 pounds per acre in March 2015⁶.

Climate stressors also impact the livestock industries that utilize rangelands. Livestock tend to graze near sources of water, and as excess heat stresses the animals and the drought makes stock ponds dry up and disappear, the animals will concentrate their grazing around the few water sources left. If ranches do not reduce stocking rates, this can cause overgrazing in these locations—a problem typically followed by ecosystem damage like soil erosion, reduced root length in vegetation, and susceptibility to non-native species invasion⁷. In addition, the concentration of salts in drying forage makes livestock hesitant upon eating it, and can even be toxic at high nitrate levels⁸. All the while, stock ponds are drying up and getting saltier themselves. Rising water temperatures in ponds or troughs can themselves dramatically increase livestock water needs and contribute significantly to the unhealthiness of salts and the growth of toxic blue-green algae in water sources⁹.

Altogether, livestock water demand will be increasingly unmet by California's drying, warming rangelands, as both the quantity and quality of forage and water are decreasing with the drought.



Cattle grazing in California's Wildcat Canyon Regional Park.



California Drought Monitor

USDA United States Department of Agriculture
CALIFORNIA SUB HUB OF THE SOUTHWEST REGIONAL CLIMATE HUB
California Drought Fact Sheet Series 2
Informing the general public about the 2012-16 drought

Drought and Forests in California

Background
About one-third of California is covered in forests. From the redwoods of the northern coast to the oak woodlands of the foothills, California's diverse climate, soils, and geography support a wide range of forest ecosystems¹. Most of these forests are adapted to periodic drought as a feature of the state's Mediterranean climate. However, warming trends, dense tree cover from fire suppression tactics, and the ongoing intense drought are threatening their stability, with especially pronounced impacts observed on the west side of the Sierra Nevada Range and in low to mid-elevation forests².

Significance of Snowpack
Snowpack in the Sierras has long served as a natural form of water storage, and the slow melting provided a stable water source for forests, keeping them hydrated into the summer months. Earlier snowmelt periods mean that the forests experience a longer dry season, leaving trees water-stressed and more vulnerable in the long-term. In 2015, April snowpack was at a mere 5% of average levels³, and it quickly fell to zero by May 2015⁴. This is the lowest measurement since instrumental recording began in 1950.

Coupled with higher air temperatures, which melt snowpack and increase evapotranspirative water demand, the drought is proving severely damaging for California's trees. Indeed, the combination can even be fatal for them.

Increased Tree Vulnerability
It is hard to attribute tree mortality to a single cause; it is often a combination of conditions and agents. Extreme drought can eventually kill trees directly through cavitation or carbon starvation, but what happens more often is that drought weakens trees and makes them more susceptible to wood-boring pests. For example, the number of trees killed by beetles in California tends to jump after several years of inadequate precipitation⁵.

Drought and Fire
Drought stress, exacerbated by warmer temperatures, is causing tree mortality and lowering the moisture content of forest fuels, increasing vulnerability to fire. Several studies have linked the recent increase in fire severity and length of the fire season to spring/summer temperatures and the percentage of the year that snowpack is present⁶. The Palmer Drought Severity Index (PDSI) and similar drought indicators have been utilized



The US Drought monitor maps of July 2010-2015 illustrate the severity of drought, based on a wide variety of metrics including snowpack.

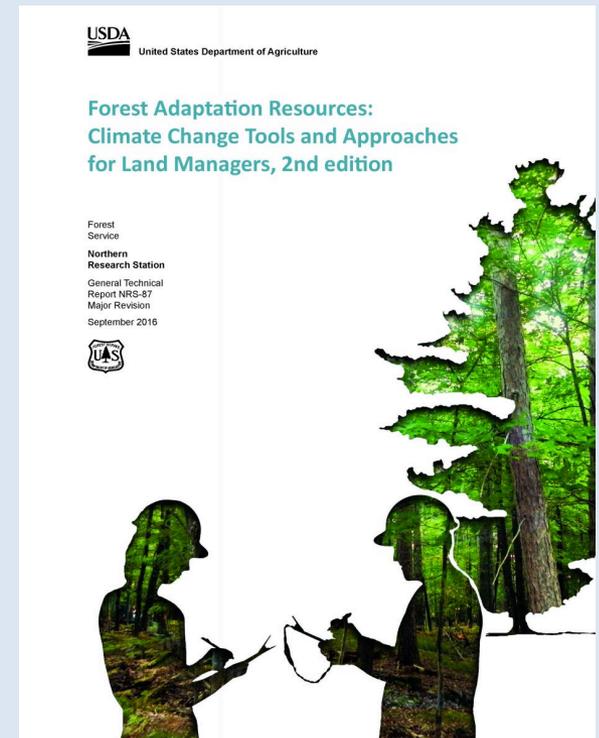


High levels of ponderosa pine mortality observed in the Southern Sierra during 2005 SPSA aerial survey.



Forest Adaptation Workbook

- With Northern Forests Hub
- www.adaptationworkbook.org and USFS NRS-GTR-87-2
- Voluntary adaptive management framework
- Encourages organized decision-making rather than overwhelm or avoidance



Next steps: Improving our process

- Developing our workplan for 2017 and beyond
- Continuing to facilitate communication among USDA personnel and partners via our stakeholders committee



Acknowledgements and photo credits

Thank you to all of our partners and collaborators.

Contacts

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- Amber Kerr, coordinator, ackerr@ucdavis.edu

All photos by Amber Kerr except as specified:

- Slide 2 (Tom Cooper, Michigan cherry farmer): USDA NRCS
(http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=nrcs143_023447)
- Slide 3 (Climate Hub regions):
http://www.usda.gov/oce/climate_change/regional_hubs.htm
- Slide 10 (tools database screenshot):
http://tools.taccimo.info/tbl_tools_list.php
- Slide 11 (cornucopia): Louise Jackson, UC Davis
- Slide 12 (lettuce, Salinas Valley): Kerri Steenwerth, USDA/ARS