



# CONSTRUCTING CLIMATE RESILIENT COMMUNITIES, LANDSCAPES, AND COASTS IN CALIFORNIA & NEVADA

PERFORMANCE PERIOD  
JUNE 1, 2020 – MAY 31, 2021



 **CNAP**  
California-Nevada Climate Applications Program  
A NOAA RISA team

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CNAP

# WHAT IS CNAP?

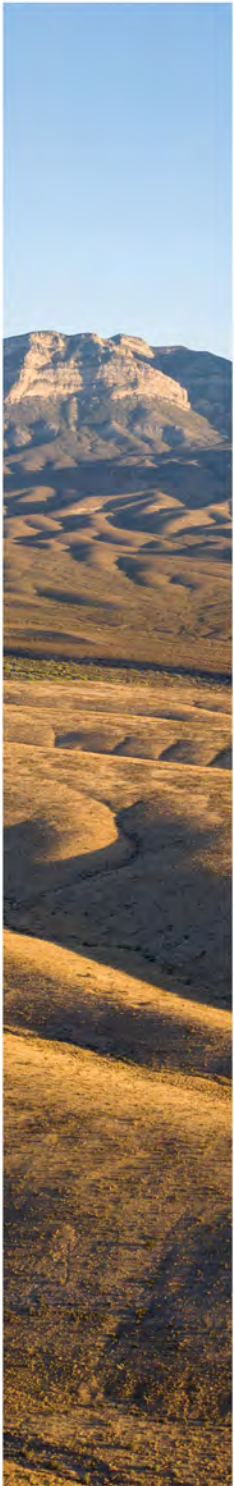
**MISSION:** To improve resilience in California and Nevada by providing decision makers usable climate information through integrating cutting edge physical and social science.

**CNAP, California Nevada Applications Program**, has a long history of providing cutting edge climate science to stakeholders in the region. The program began with an emphasis on California issues in 1999 as the California Applications Program (CAP). In 2011, the team expanded its geographic scope to include Nevada and became CNAP. CNAP's core priority sectors include understanding the effects of climate variation and change on water resources, natural resources and coastal resources (see logic model on page 3), along with other linked systems including societal components.

In 2005, CNAP took a leading role in developing the first California Climate Assessment and has continued in this role since. CNAP researchers have built credibility as non-partisan developers and interpreters of climate science on the regional scale and have experience working with stakeholders to make the information actionable. This year is no exception; several CNAP projects and outcomes are related to climate assessments and capacity building. Most significant, was the first state climate assessment for Nevada as part of the State of Nevada's Climate Initiative. CNAP researchers were essential to the development of the Nevada assessment and helped guide the inclusion and development of potential adaptation measures for Nevada. In addition, CNAP has worked with boundary spanning organization to provide climate information to underserved groups in the Sierras and a Tribal Nation in San Diego. CNAP is working with the Sierra Business Council to provide climate information to rural and underserved communities. Similarly, CNAP worked with the Climate Science Alliance to integrate climate change information in to the Manzanita Band Climate Resilience Project. In 2018, CNAP researchers led the California Fourth Climate Assessment Sierra Nevada and San Diego Regional Reports. During this past year, an independent CNAP researcher evaluated these two regional reports, finding multiple benefits and action items; results were shared with California agencies to improve process and outcomes of the upcoming California Fifth Climate Assessment. Notably, the overall Fourth Assessment, the two regional reports, and their evaluation have relevance to other regional climate assessments.



*CNAP's series of socially relevant scientific research results have important implications for policy and management.*



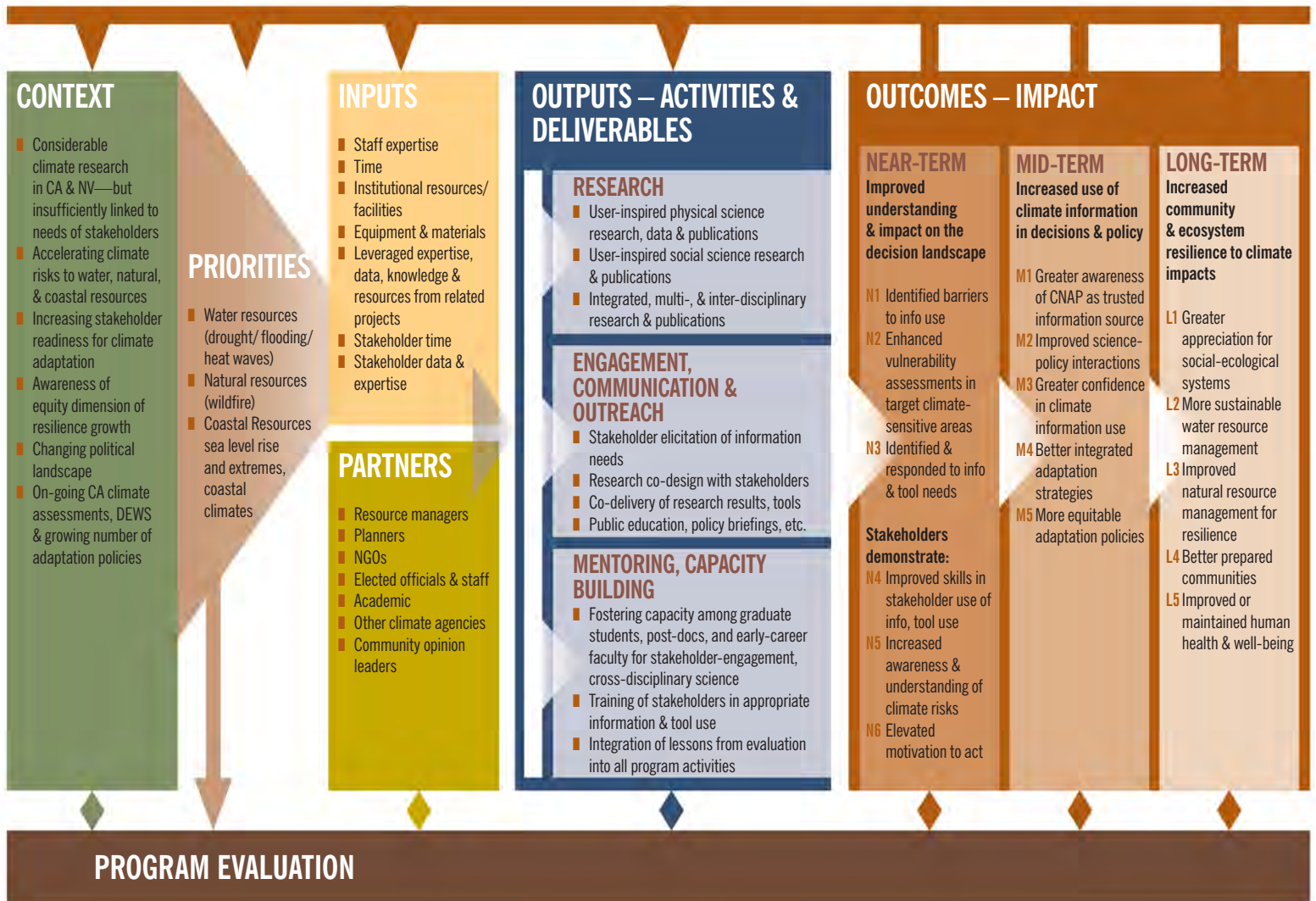
CNAP enhanced our reach and communications related to drought as California and Nevada entered yet another severe drought. As early as December, with NIDIS, CNAP began issuing Drought Status Updates and emphasized the possibility of the return of extreme drought conditions to the region. The drought status updates have continued and CNAP researchers have contributed to new graphical representations of drought conditions in the Drought Status Updates. These have become a resource for agencies and media to summarize the current drought conditions, especially as the effects of the drought become more widespread and impactful. As we enter the dry summer months, attention will turn to communicate the fire risks associated with the ongoing drought.

As an outgrowth of the San Diego Regional Report, CNAP worked with a team of planners for the American Planning Association to develop a report that highlights how planners can use climate information and collaborate to plan for climate resilience, budding the climate capacity of planners. Although the report is focused on the San Diego Region, the approach set forth in the report is applicable throughout California.

CNAP's credibility as a source of climate information is based on a strong scientific foundation. CNAP's series of socially relevant scientific research results have important implications for policy and management. Recent studies provide new understanding of the harmful impacts of wildfire smoke, even relative to other types of pollution, on public health. Another study quantifies the strong role played by evaporative demand (the atmospheric conditions that causing the drying of the landscape) in contributing to drought and hazardous fire conditions and how this process will likely intensify in the future. A recent paper investigates newly available fine grained historical water supply and water use data distributed over several hundred local water collectives to develop a more detailed water balance for California; this information, co-produced with the California Department of Water Resources, is thought to provide a consistent quantitative framework for water resource analysis at a time when water rights and policy are being reevaluated across the West in light of changing climate.

The multi-faceted work CNAP has completed in 2020–2021 fits nicely into the logic model, which is shown on page 3.

# CALIFORNIA NEVADA CLIMATE APPLICATIONS PROGRAM MODEL



CNAP program model highlights the outcomes, or what the type of products it produces including scientific journal articles, reports, stakeholder workshops, and mentoring early career scientists. The program model also describes the short-term, near-term, and long-term goals for the program.

# CNAP TEAM ROLES/RESPONSIBILITIES

## DRI

- Tamara Wall
  - Tim Brown
  - Justin Huntington
  - Nina Oakley\*
  - Kristin VanderMolen\*
  - Dan McEvoy\*
  - Nick Kimutis\*
- 
- Provide leadership to the social science team and guide collaborative interdisciplinary efforts (CA/NV)
  - Primary support for social science research in Nevada and California
  - Focus on Nevada stakeholder climate information needs
  - Provide support and expertise to California-based team members
  - Train postdocs and early-career faculty
  - Support evaluation design and implementation
  - Co-manage media and social media outreach and engagement

## SCRIPPS

- Dan Cayan
  - Julie Kalansky\*
  - David Pierce
  - Alexander Gershunov
  - Haley Mcinnis\*
  - Tom Corringham\*
  - Mike Dettinger
- 
- Provide leadership to the physical science team (CA/NV)
  - Lead role in physical science research
  - Focus on California stakeholder climate information needs
  - Provide support and expertise to Nevada-based team members
  - Train postdocs and early-career faculty
  - Overall program management
  - Co-manage media and social media outreach and engagement

## ADDITIONAL SUPPORT

- Susanne Moser, Moser Research & Consulting
    - Social science research in California
    - Support evaluation design and implementation
  - LeRoy Westerling, UC Merced
    - Research on wildfire and climate impacts in the Sierra Nevada
  - Shradhdhanand Shukla\*  
UC Santa Barbara
    - Drought monitoring and forecasting
  - Dennis Lettenmaier, UCLA
    - Hydroclimatology
  - Duane Waliser, JPL
    - Atmospheric sciences
- \*Early Career CNAP Scientists, postdoctoral fellows, or students.

## ADVISORY COMMITTEE

- Michael Anderson, California State Climatologist, California Department of Water Resources
- Kristen Averyt, Climate Policy Coordinator at State of Nevada
- Susan Kocher, Forestry/Natural Resource Advisor, Central Sierra Cooperative social media outreach and engagement

CNAP Researchers and the CNAP advisory committee. Throughout the year met quarterly with the advisory committee both as a larger group and in smaller groups with each advisory committee member.

PROUDEST ACCOMPLISHMENT THIS PAST YEAR:

## A NEVADA CLIMATE ASSESSMENT



State of Nevada

**CLIMATE  
INITIATIVE**

**CNAP researchers were integral** in developing Nevada's first state led climate assessment as part of the State of Nevada Climate Initiative. The assessment, "Climate Change in Nevada", synthesized climate change information about heat and heatwaves, drought, loss of snow, flood and wildfire risk and the associated impacts to

public health, water resources, the environment, recreation and hospitality, and agriculture. By focusing the climate assessment on sector specific impacts caused by climate change and by including examples of resilience building actions, we were able to provide important adaptation considerations for Nevada. Consideration for adaptation strategies would have not otherwise appeared in the Climate Strategy. Now, with the incorporation of adaptation, future adaptation-assessment efforts will be able to reference the climate assessment to justify that adaptation is part of the Nevada Climate Initiative.

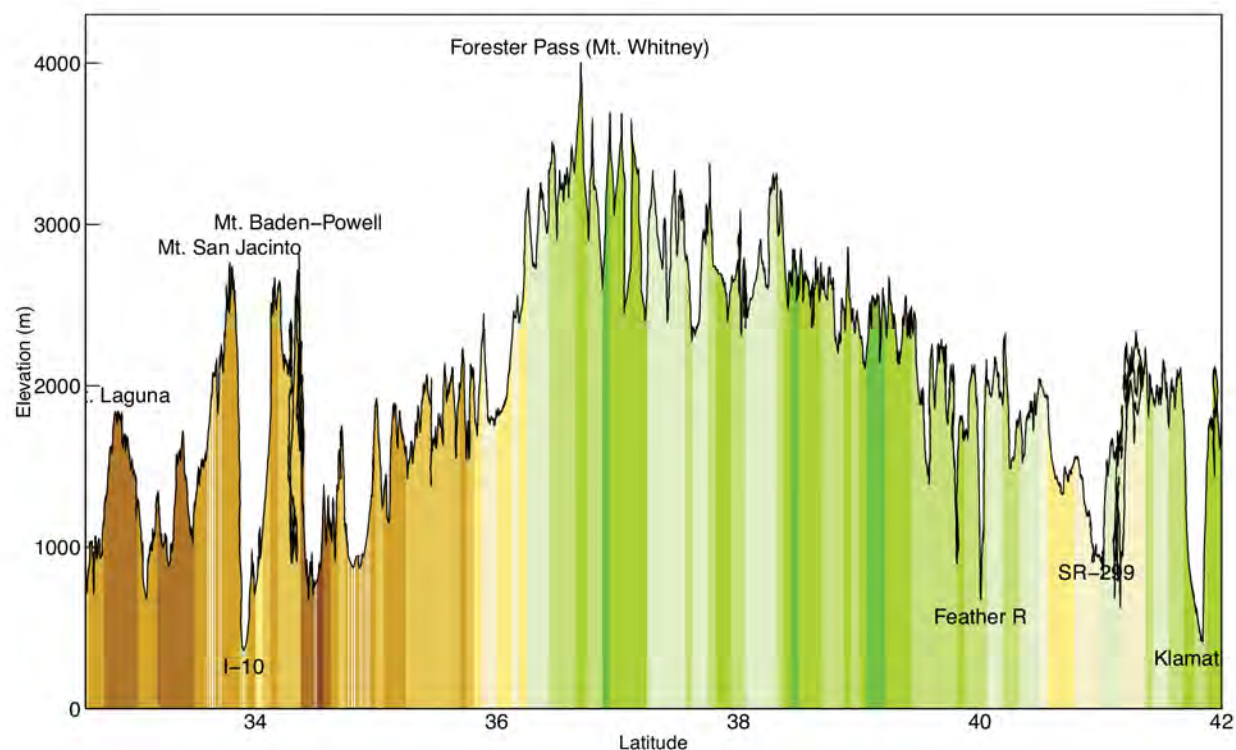
In addition, CNAP researcher Susi Moser contributed to the Nevada State Climate Governance Section which outlines how a climate strategy might be implemented. As noted in the Governance Section, a major tenet of the Climate Initiative is sustained science based climate assessments. With this in mind, CNAP continues to interact with Nevada science and policy actors to push forward a more complete assessment activity in the future. The research needs to build climate resilience identified in "Climate Change in Nevada" provide preliminary ideas for a more comprehensive climate assessment for Nevada. As part of this effort, we are working to identify others in Nevada to contribute to this effort highlighting the climate expertise in Nevada, increasing the state's capacity to address climate change.

Based on the Climate Assessment, Nevada Cooperative Extension with input from the CNAP authors developed a summary of the "Climate Change in Nevada" climate assessment. The shorten version, "Climate Impacts in Nevada" is more approachable and digestible for a broader audience supporting a wider understanding of climate change impacts in Nevada. This summary of the full assessment will be available in Spanish by the end of the summer.

After the completion of the summary report, Kristen Averyt, who led the Nevada Climate Strategy, reported to Nevada's climate list serve that "The NV Climate Initiative Climate Working Group and University of Nevada Extension collaborated to develop a short primer on climate change and how it affects our state. Drawn from the comprehensive information presented in the State Climate Strategy, this is an excellent resource that distills the best available science on climate change here in Nevada."

# NEW PARTNERSHIPS & FOCUS AREAS

**Pacific Crest Trail (Cayan, Gershunov, Kalansky):** Cayan, Gershunov and Kalansky along with Erica Fleishman, representing Oregon Climate Change Research Institute (OCCRI) are developing a partnership with the non-profit Pacific Crest Trail Association (PCTA; pcta.org) a group of volunteers and staff who manage the Pacific Crest Trail (PCT). The PCT is a national scenic trail that crosses three states and numerous local, state and federal jurisdictions, running approximately 2650 miles from Southern California to northern Washington. The PCT is used each year by 100's of thousands of wilderness visitors. Climate, from short to long time scales, affects the PCT, its surroundings and its visitors in myriad ways.



**The figure above shows the latitude of the California PCT along the bottom and the elevation of along the PCT along the vertical axis. The color shading shows the percent change of precipitation in 2035–2065 using RCP 4.5.**

This connection was forged by interest and concern by the PCTA as climate continues to change. CNAP views this collaboration as an exemplar of how to integrate physical, natural, and social science in support of communities, decision makers, and resource managers that seek to increase adaptation and resilience to climate variability and change. Climate change is affecting the ecosystems along the PCT and the experiences and safety of trail users and trail-maintenance volunteers. These effects cascade to local populations that rely on seasonal visitation of the PCT. At present we have had two discussions with a member of the PCTA Board of Directors and selected PCTS staff, along with presenting a climate/climate change webinar in mid-June 2021. There is interest to partner on developing a better understanding and awareness of climate variability and



climate change influences on the PCT. The partnership we have discussed encompasses assembling ground and remotely sensed observations available over past decades to construct a meaningful climatology (averages, extremes, and variability) of weather and climate, hydrology, and climate-related disturbances such as droughts, wildfires and floods, as they apply to PCT concerns. Projections of future climate will also be investigated to explore how different scenarios of greenhouse gas emissions may stress or benefit ecosystems, species, and people. Importantly, the group of us are committed to supporting the priorities of sovereign Tribes and with traditionally underserved urban and rural populations who are affected by management of the PCT and its users.

**Nevada Department of Water Resources (NDWR) (Wall):**

NDWR reached out to Dr. Wall in the spring of 2021 seeking support to engage and survey water users in Nevada on their priorities and concerns around water availability, quality, and quantity in advance of preparing to revise the Nevada State Water Plan. The survey will be launched in the summer of 2021. Given the heightened awareness and concern in Nevada due to the ongoing drought and likely water deliver shortages from the Colorado River, this survey is exceptionally timely and relevant for all of Nevada’s residents and economic and ecological health.

**Fire Environment Management System (FEMS) (Brown):**

Remote Automated Weather Stations (RAWS) provide operational hourly fire weather in fire prone areas. There are around 1,800 active stations across the country including Alaska and the Pacific Islands. The network began modestly in the mid-1980s and has expanded since. The Western Regional Climate Center (WRCC) is the national archive for these data. RAWS data are used for a variety of purposes including operational fire weather observations and fire danger indicators and inputs for fire danger operating plans among others. We have begun a major project to perform quality control on the national dataset and to gap fill missing data. This new dataset will be ingested into a new platform named the Fire Environment Management System (FEMS). This project began in California, expanded to Arizona and New Mexico, and will in the coming months expand nationally. USFS and BLM are the primary partners. This effort is part of a new focus to work with fire agencies in preparing and providing in situ and gridded data for decision support.



# RESEARCH HIGHLIGHTS

**Projected Changes in Reference Evapotranspiration in CA and NV (McEvoy, Pierce, Kalansky, Cayan and Abatzoglou):** Evapotranspiration is an important component of the water budget and accounts for a large portion of the fate of precipitation—particularly in semi-arid regions in California and Nevada, in controlling agricultural irrigation demands, and in interannual variability in water resources. This research by CNAP adds wildfire to the long list of environmental processes influenced by evapotranspiration, and suggest a thirstier atmosphere in the coming decades. CNAP researchers, McEvoy and team used observations and downscaled climate projections over California and Nevada to show that atmospheric thirst has increased over the past four decades and is projected to increase substantially over the 21st century under a high-warming scenario. Increased atmospheric thirst taxes water resources and exacerbates drought. Not surprisingly, these same factors load the dice for fire activity in portions of California and Nevada. The team showed that two-week excursions of atmospheric thirst, defined using a standardized drought index called EDDI (evaporative demand drought index), co-occurred with a disproportionate amount of daily burned area across California in the summer and autumn. This logically follows with the notion that high periods of atmospheric thirst dessicate fuels enhancing their ability to ignite and carry fire, and as hot, dry, and windy conditions tend to promote fire propagation. The team found that 2-week periods of extreme atmospheric thirst, similar to those experienced in previous notorious fire seasons, are projected to increase by up to 6-10 times in summer and 4-6 times in autumn by the end of the century.

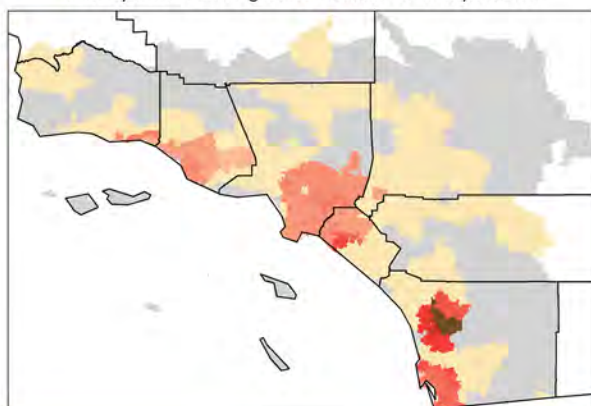
The media identified the relevance of the findings resulting in several media stories ranging from local to national.

- Regional audience: Nevada Independent interview
- National audience: NPR Morning Edition interview
- AGU featured an article about the paper in EOS

McEvoy, D. J., Pierce, D. W., Kalansky, J. F., Cayan, D. R., & Abatzoglou, J. T. (2020). *Projected Changes in Reference Evapotranspiration in California and Nevada: Implications for Drought and Wildland Fire Danger.* *Earth's Future*, 8(11), e2020EF001736.

## b) Mean Wildfire PM<sub>2.5</sub> ( $\mu\text{g m}^{-3}$ ) - 1999-2012

Fire Upwind + Strong SAW - Seasonal Interpolation



## Santa Ana Winds, Wildfire and Health (Gershunov, Corringham):

Over the past year, two research papers have shown the impacts of wildfire smoke on health. California felt the devastating health effects of wildfire during the summer of 2020 when air quality was poor throughout the region as a result of smoke from multiple fires being blown eastward from the coast into Nevada. Two new papers provide the first epidemiological evidence that wildfire smoke impacts the health of adults

The figure to the left shows the wildfire specific concentration of PM<sub>2.5</sub> using a seasonal interpolation method. Figure from Aguilera et al., 2021.

and children much more than similar levels of pollution from other sources. One of the research papers was covered by 93 news outlets, including the New York Times and the Guardian, and has been accessed over 10,000 times in the last six months. This national and international media coverage reaches a large audience including members of the public and policy makers highlighting the public health threat of wildfires beyond the immediate hazard of the fire. The results point to the need for improved air quality standards targeted specifically at wildfire smoke.

*Aguilera, R., Corringham, T., Gershunov, A., Leibel, S. and Benmarhnia, T. (2021). Fine Particles in Wildfire Smoke and Pediatric Respiratory Health in California. Pediatrics 147. <https://doi.org/10.1542/peds.2020-027128>.*

*Aguilera, R., Corringham, T., Gershunov, A. and Benmarhnia, T. (2021). Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. Nature Communications 12, 1493. <https://doi.org/10.1038/s41467-021-21708-0>.*

Additional research into Santa Ana winds, which fan the most catastrophic wildfires in Southern California, show that the Santa Ana winds are often responsible for out of season heatwaves. These out of season heat waves can increase hospitalizations for dehydration, renal failure and stroke. The public health risks associated with out of season heat waves, and the trends of the Santa Ana Wind events that drive them, point to the need for warning and policies to mitigate these heatwaves. Research into the meteorology and climatology of Santa Ana winds and their flavors (hot and cold) revealed an interesting connection to the Great Basin snowcover. This research was co-produced with forecasters at the National Weather Service facilitating the results into improve Santa Ana Wind forecasts and nuance heat and wildfire risk warnings.

*Schwarz L., B.J. Malig, J. Guzman Morales, K. Guirguis, A. Gershunov, R. Basu and T. Benmarhnia, (2020) The health burden of fall, winter and spring heat waves in Southern California and contribution of Santa Ana Winds. Environmental Research Letters. 15, 054017*

*Gershunov, A., J. Guzman Morales, B. Hatchett, R. Aguilera, T. Shulgina, K. Guirguis, J. Abatzoglou, D. Cayan, D. Pierce, P. Williams, I. Small, R. Clemesha, L. Schwarz, T. Benmarhnia, and A. Tardy, (2021) Hot and cold flavors of southern California's Santa Ana winds: Their causes, trends, and links with wildfire. Climate Dynamics. DOI: 10.1007/s00382-021-05802-z.*





**Water Use and Agricultural Productivity in CA (Cayan and Corringham):** Recent patterns of water use and supply in California are identified in a paper using a new dataset compiled from the California Department of Water Resources water balance data for 2002–2016. The water use and supply includes surface and ground water, although ground water reporting has been incomplete. These data are used to support the Water Plan released every 3–5 years and are the most comprehensive and finest spatial and temporal scale dataset for California water resources. Using the Bay-Delta watershed as a case example, the research shows that recent fluctuating patterns in water use are highly correlated with variations in precipitation. Developed water supplies and use show these fluctuations but they are modified by reservoir inflows and releases, ground water supplies, and Delta outflows. Second, although the annually precipitated water supply in the Bay-Delta varies by about 30%, the developed water supply damps this considerably. The water management system maintained nearly constant agricultural water use even in periods of intense drought, with year to year variation of about 7%. Variability in urban water use is higher (20%), largely due to conservation during periods of drought. This information can help improve water resource management because it connects regional scale data to meaningful policy decision-making at county and sub-county levels. In classifying twenty crop types in the Bay-Delta watershed into subjective categories of high, medium and low applied water use, a few crops are determined to require the greatest water use is attributed to a moderately small assortment of crops: almonds and pistachios, alfalfa, other deciduous, rice, grapes, along with other truck, corn and cotton. At a time when water rights and policy are being reevaluated across the West in light of changing climate, decision-making informed by science and data is urgently needed. The statewide water balance data provides the means to establish a consistent quantitative framework for water resource analysis throughout the State.

The recent research described above is relevant for the groundwater estimates in the Central Valley of California. Statewide, urban water use over the 15 year dataset was about 20% of total water use compared to agriculture which was about 80%. The ongoing water use dominance of agriculture in eight of California's ten hydrologic regions, the South Coast and San Francisco Bay being the exceptions where urban use dominates. Agricultural use in four regions, Tulare Lake, the Sacramento River, the San Joaquin River, and the Colorado River account for more than 70% of the entire Statewide total developed water use. Recently, agricultural water use has been empirically determined to be the cause of ground subsidence due to groundwater extraction in association with particular crop types as has been commonly believed for decades.

*Helly, J. Cayan, D., Corringham, T., Stricklin, J. and T. Hillaire, 2021: Patterns of Water Use, San Francisco Estuary and Watershed Science, in press.*

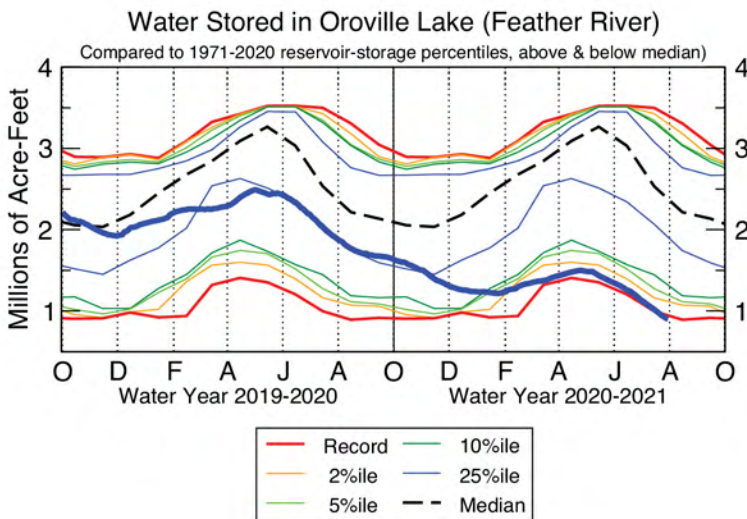
# OUTREACH & ENGAGEMENT ACTIVITIES

## **NIDIS Drought Status Updates and Webinars (Dettinger, Kalansky, McEvoy, Abatzoglou):**

California and Nevada are currently in one of the worst two year droughts in the observational record. Although last year was dry in the region, but due to the water management infrastructure it is not until the second dry year that the drought begins to have significant impacts. With NIDIS, CNAP has been releasing Drought Status Updates to provide the region up to date information on the status of the ongoing drought. CNAP has provided novel graphical representation of the drought including the precipitation tracking and water storage tracking observations that are on the CNAP website. Many of these were shared on Twitter by Mike Dettinger, who had 1,000 impressions a day on average. Drought Status Updates were released about every two weeks during the winter months and monthly since March. The pageviews range from nearly 400 to over 1,200 with people spending on average 10 mins or longer on the Drought Status Update. The California State Water Resource Control Board in a major media release referred to the Drought Status Update for current drought conditions. Other water managers have shared their appreciation for proving all the information about drought conditions in one consolidated location.

CNAP also contributed to the California Nevada Drought Early Warning System (DEWS) webinars. These webinars have a diverse audience and have between 100–200 attendees. Please see below for a list of CNAP’s contribution to the webinars.

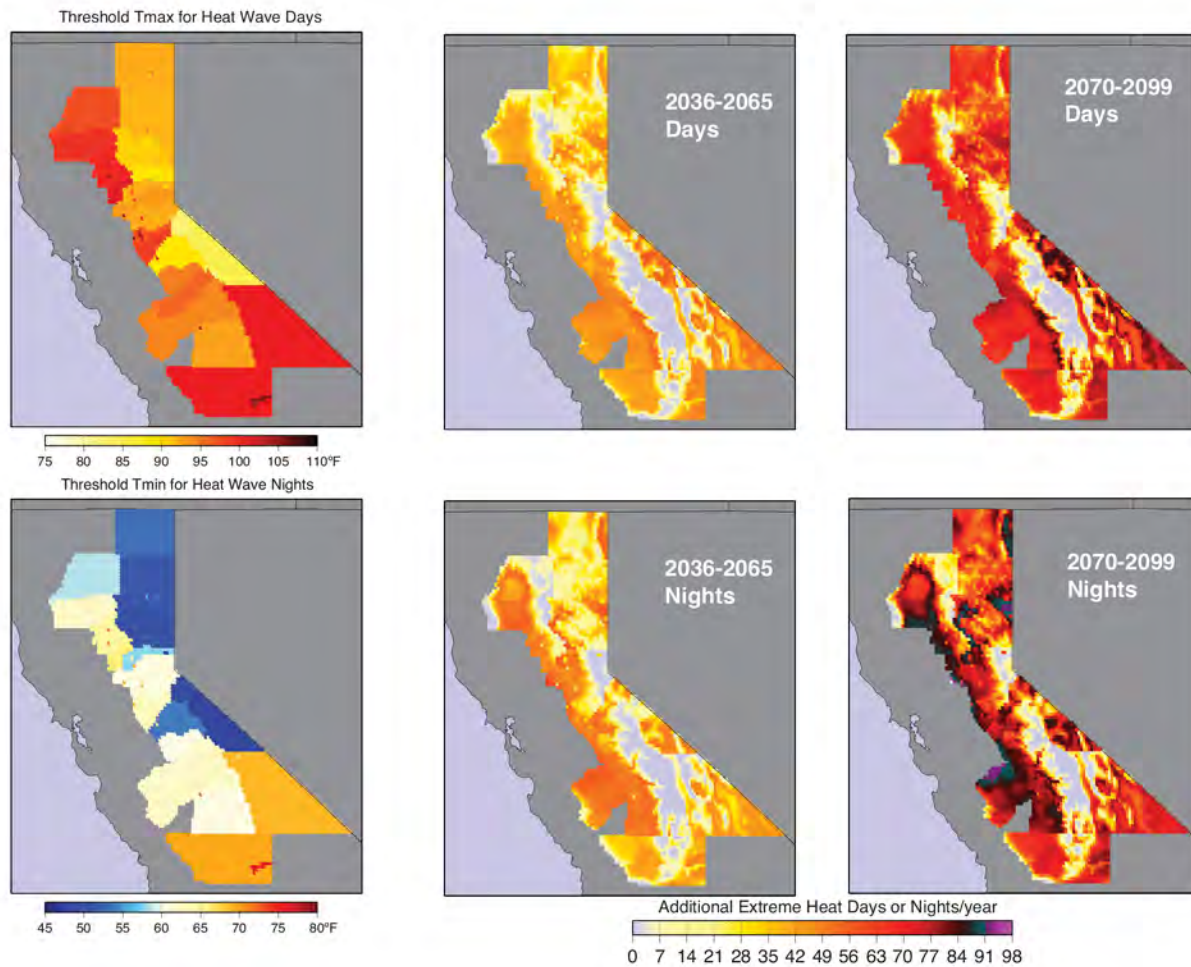
- July 2020: J. Kalansky – Drought Climate Update and Outlook
- September 2020: S. Shukla – Drought Climate Update and Outlook
- November 2020: J. Kalansky – Tools and Resources for your Winter Toolbox
- January 2021: J. Kalansky – Drought Climate Update and Outlook
- March 2021: D. McEvoy – Drought Climate Update



The ongoing severe drought in California is being tracked by CNAP. A new drought metric, shown here and in ongoing form on the and included in the Drought Status Update provided on the CNAP web page, has been developed by CNAP researcher Mike Dettinger.

Oroville reservoir storage from the start of the 2020 Water Year (October 1, 2019) through October 2021, compared to 1971–2020 reservoir storage percentiles. Source: CNAP 2020–2021 Drought Years Reservoir tracker (visit to see similar graphics and more for major 10 northern California reservoirs).

**Sierra Business Council (Dettinger):** As an outgrowth of the California Fourth Climate Assessment Sierra Nevada Region Report, CNAP researcher, Dettinger, is working with the Sierra Business Council in a vulnerability assessment. A major objective of this effort is to provide climate-risk information into the hands of disadvantaged and underserved communities in the Sierra region that wasn't possible during the creation of the Fourth Assessment. The close interaction with underserved communities is a big part of the Sierra Business Council's mission and expertise which facilitates the interactions between CNAP and underserved communities to get them the climate information they need.



**Illustration of Jurisdiction-based vulnerability changes. Heatwaves is one of a dozen different climate-stress indicators that are summarized with in two dozen jurisdictions in the region.**

**Climate and Public Health (Gershunov):** Gershunov and colleagues have presented to the El Cajon Collaborative ([www.elcajoncollaborative.org](http://www.elcajoncollaborative.org)) and the Community Health Improvement Partners ([www.sdchip.org](http://www.sdchip.org)), both organizations focused on underserved communities. The focus of presenting to these groups is to provide an understanding the health risks associated with climate extremes. This work on environmental health impacts is increasingly focused on underserved communities (Mehta et al. 2021, McElroy et al. 2020, Ilango et al. 2020).

# INITIATIVES TO ADVANCE

## **Supporting Coastal Adaptation to Uncertain Sea-Level Rise**

**(Moser):** CNAP researcher, Moser, is leading a project to provide guidance on how to support conversation about managed retreat from coastal areas. Much of the engagement with the larger coastal community will occur within the next year. Moser will be presenting and discussing her research within academia and media. She will be presenting her paper on coastal retreat communication, “Waves of Grief and Anger: Communicating Through the “End of the World” as We Knew It”, at the Managed Retreat '21 conference in June. During the same conference, Moser is hosting an interactive workshop session that was co-developed with Sarah Watson and is based on her book chapter. In addition, Moser will be part of a briefing of journalists by Andy Revkin on his ongoing podcast, “Sustain What?”. The session will focus on retreat journalism, and is a unique opportunity to influence how reporters talk about this issue. There is the possibility to work with a colleague to integrate the findings into a training for regional decision makers with the Tijuana River National Estuarine Research Reserve.

## **Drought Amelioration Outlooks (DAO) (Shukla, Lettenmaier, VanderMolden):**

During this year, we initiated engagement with NIDIS’s CA-NV DEWS stakeholders to understand their subseasonal forecasts related needs and challenges, as well as to identify relevant end-users for drought amelioration outlooks. This year we also formed a technical advisory group for our project. The technical advisory group is made of academic researchers and government scientists who are leading subseasonal forecasting and/or dissemination related products. This engagement allows for independent review of our project, as well as coordinating and leverage from other projects that are supported by NOAA.

On the technical side, we produced hindcasts of high resolution subseasonal climate forecasts. These high resolution climate forecasts are to be used to run hydrologic models to provide forecasts of critical drought indicators such as soil moisture and runoff. Additionally, Shukla and Lettenmaier collaborated on research to examine the skill of forecasting flood at subseasonal scale. The analysis was led by a then graduate student at UCLA, whom both helped advise during this research that was published in Journal of Hydrometeorology (Cao et al., 2021).





During this next year we plan to engage with CA-NV DEWS stakeholders to seek their feedback on DAO products. We also plan a webinar or online training to provide further details on how DAO products are generated, how skillful they are, and how they can be used to support decisions.

**Capacity Building Workshops (Wall):** In the last half of 2021 we plan to launch a set of climate information capacity building workshops (virtual or in person, depending on current COVID-19 restrictions and concerns, as well as the opportunity for engagement) that focus on rural areas in NV to support these areas engagement with the Nevada Climate Strategy. We hope to enhance the future usability of any Nevada climate assessment activities that maybe occurring in the next several years. Virtual workshops will be designed in a 2–3 part series of 2–3 hour meetings and in person workshops will be designed as a short full day (i.e., 10 am–3 pm to allow for drive time). A key group targeted to work with will be emergency and county managers across the Nevada.

**Climate Hazard Impacts on Disadvantaged Communities (Gershunov and Corringham):** CNAP is working on extending our research on air quality (see Research Accomplishments) to include demographic and socioeconomic status interactions with a view to understanding how poor air quality differentially impacts disadvantaged communities. We are also in the planning stages of projects that aim to quantify flood vulnerability in disadvantaged coastal communities in California, and in communities of color across the United States. This type of research identifies the areas and regions where climate justice is of utmost importance when implementing climate adaptation strategies.



# SOCIETAL IMPACTS

**Red Flag Project (Wall and Brown):** The Red Flag Project works with multiple NOAA partners and stakeholders on reviewing and revising Red Flag Warnings. Overall, there is a concern amongst NWS and fire agency personnel that the Red Flag Warning is not an effective messaging medium. As a result of these issues and questions, the California Nevada Applications Program (CNAP), NWS Fire Weather, the National Integrated Drought Information System (NIDIS) and the National Wildfire Coordinating Group, Fire Environment Committee, began a collaborative project in 2018 to begin an assessment of this forecast product with the aim of developing an improved product that meet the NWS, the fire management community, and public warning needs. The involvement of the technical advisory committee in the Red Flag Project (comprised of representatives from Predictive Services and NWS) has been exceptionally strong. Throughout the last year, as the Red Flag Warning Project Technical Advisory Committee and the research team has met, we engaged in often lengthy conversations about the technical challenges of developing new criteria for issuance that seemed to go in every direction. These meetings were sometimes frustrating, but a combination of facilitation, confidence that each perspective was valued, and a willingness to keep talking meant that as we tried and discarded methodological approaches, by the time we found what we think worked well, everyone was on board and supportive. This internal support from the NWS TAC Technical Advisory Committee participants—which includes the people who will be presenting the project final recommendations to their supervisors is vital to the success of the project. If the recommendations developed by this project are used to revise the Red Flag Warning and Fire Weather Watches product, this will impact the lives and safety of millions of people across the United States.

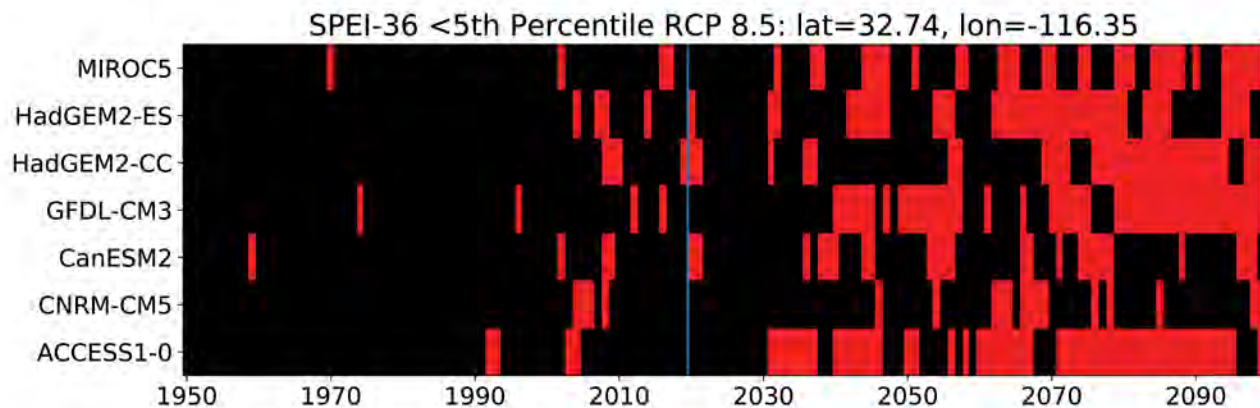


# CAST STUDY EXAMPLES OF CAPACITY BUILDING & SOCIETAL IMPACTS

**Climate Resilience Report for the Manzanita Band (Kalansky):** Partnering with the Climate Science Alliance, CNAP contributed to the Manzanita Band of Kumeyaay Nation Tribal Resilience Project by providing an assessment of historical climate trends and climate change projections. The Manzanita Climate Resilience Project was created to explore the integration of climate change scenarios with natural resources, specifically 'snyaaw (Coast Live Oak), as a central focus. This effort is focused on informing decision-making that sustains cultural and traditional resources and practices and increases flexibility in how services and programs are managed.

*“This collective effort to understand climate change impacts in our community and advance strategies and solutions is part of our commitment to taking care of all of our relations. In this report our voices are united, and our commitment strong to our people now and our future generations.”*

—CHAIRWOMAN ELLIOT-SANTOS



**Historical and future RCP 8.5 timeseries of extreme (<5th percentile relative to 1950–2019 base period) 36-month SPEI from 7 global climate models. SPEI is a drought indicator that includes atmospheric conditions. Individual years below the extreme threshold are represented by single red bars. The increase in drought years affects the preservation approaches to preserve Coast Live Oak Data and figure provided by D. McEvoy and were based on McEvoy et al., 2020, (research highlights).**

The Manzanita Band received a grant to develop the resilience report. CNAP was able to provide a climate analysis which allowed Manzanita to use their grant funding to focus on exploring adaptation options. With completion of phase one, Manzanita Band was able to leverage the report to get a phase two award. With the Manzanita Resilience report Manzanita and the Climate Science Alliance worked together to lay the foundation for focusing on Manzanita's oaks in phase two and recognizing the role and need for prescribed and cultural burning which has helped Manzanita get the next round of funding. The Manzanita Resilience Report definitely has allowed Manzanita to bring more capacity, resources, funding, information, build their planning off of, and new projects to the community.



**California Fourth Climate Change Assessment  
Sierra Nevada and San Diego Regional  
Reports (Dettinger, Kalansky, Cayan, Pierce,  
Gershunov):**

The California Fourth Climate Change Assessment incorporated regional reports to examine climate vulnerabilities and adaptation that are occurring on a more local scale. CNAP researchers took a leading role in developing the Sierra Nevada and San Diego reports which were published in 2018. The reports required working intricately with other regional scientists and a diverse group of stakeholders to ensure the reports captured information about climate impacts and adaptation for multiple sectors including but not limited to water, energy, transportation, land-use, agriculture, ecosystems and health. The evaluation of the reports (see below) has revealed how the reports have improved adaptive capacity. Users emphasized the value in having a single, “easy-

to-read,” “definitive” document that summarizes the “best available science” on climate change and impacts to help inform their work. Stakeholders additionally noted the importance of local academic authorship in fostering confidence in decisionmakers that the science communicated is “nonpartisan” and “trustworthy.” Inasmuch as the regional reports are perceived to reflect those characteristics, they have been helpful to stakeholders in gaining decisionmaker support for and motivating progress toward adaptation planning and implementation.

*“It’s also really helpful when we’re talking to stakeholders to have something that’s San Diego specific because people will pretty quickly say, ‘Oh, that’s not for San Diego, that’s for the entire coastline, does that apply here as well?’ So it’s really nice for the city to have a scientific research paper that can back up everything that we’re saying and can back up the policies that we’re drafting as we move forward with the adaptation plan.”*

—USER OF THE SAN DIEGO REGIONAL REPORT

There have been several efforts that have built upon the Sierra Nevada Regional Report. The previous mentioned work with the Sierra Business Council (see Engagement and Outreach) is one such example. Another is a new effort with the California Tahoe Conservancy as part of their ongoing Tahoe Climate Adaptation Action Planning program to develop and provide high-resolution ensemble hydrologic projections of climate-change impacts using the CNAP-downscaled California Fifth Climate Assessment projections.

# EVALUATION

**Over its tenure**, CNAP has conducted both programmatic evaluations and project base evaluations. Last year CNAP completed the programmatic evaluation of mentoring within CNAP. In response to that, there have been regularly scheduled mentoring calls.

This year the focus was on the evaluation of the California Fourth Climate Change Regional Reports. The purpose was to evaluate the effectiveness to support local adaptation planning and implementation. The evaluation is based on semi-structured interviews conducted with 12 regional report stakeholders (seven in San Diego and five in the Sierra Nevada) and written responses collected from an additional stakeholder of the Sierra Nevada Region Report, all between July and October 2020. Summaries from the interviews were then analyzed to identify patterned themes (Bernard 2017). Those themes include: (1) credibility and trust, (2) participation, (3) audience, (4) actionability and use, and (5) additional information needs. All 13 stakeholders who participated in the evaluation expressed satisfaction with the reports and provided several concrete examples of use in adaptation planning and implementation. The use types were primarily conceptual but also included justification. They also offered recommendations corresponding to those topics for consideration in the development of future regional reports. Many of those recommendations may fall outside the purview and decision making of individual authors (and/or CNAP), and to consider them adequately may require examination of larger questions about the scope, accessibility, and ultimately the purpose of regionally focused climate change assessments. The feedback and recommendations that stakeholders have offered lend insight into their perspectives, preferences, and priorities with respect to the production of regional climate change and impacts information intended for their use. This evaluation report has been shared with state agencies planning the California Fifth Assessment to improve the regional reports in the future. In addition, the evaluation is also relevant to other regions and localities as they are planning climate assessments.

**The full report can be found on the CNAP website: [cnap.ucsd.edu/2021/06/28/2021-evaluation](https://cnap.ucsd.edu/2021/06/28/2021-evaluation)**

# IMPACTS OF COVID-19

**One general outcome noticed** within the team was that COVID-19 highlighted the intersectionality of all things—so including health, climate, economic, race and equity issues. We also learned how to host an interactive virtual meeting using Mural during our annual meeting. There were certain aspects of this that we would like to carry forward, in particular the use of Mural Board to gather all ideas, not just the ones from the most vocal participants. Active discussion and brainstorming sessions were conducted with our small but very engaged Advisory Committee, both as a group and individually.

**Business Disruption Survey (VanderMolen and Wall):** The business disruption project has shifted in focus and in partnership. Previously the project was focused on identifying the impacts of wildfire (including active fire, threat of fire, smoke, and PSPS) to small and medium sized businesses (SMBs) in Butte County (CA) in partnership with the Center for Economic Development at Chico State University. However, due to the onset of the COVID-19 pandemic and low interest from Butte County businesses in participating in the project, we have shifted focus to identifying the impacts of wildfire and COVID-19 to SMBs in the Sierra Nevada in partnership with the Sierra Business Council (Truckee, CA).

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