

The Impacts of Climate Change on Atmospheric River Storms and California's Water Resource Infrastructure

Lead Principal Investigator

Alan M. Rhoades

Organization

Lawrence Berkeley National Laboratory

Award Amount

\$298,328

Climate Research Topic(s) Addressed:

- » Explore how climate-related events will impact emergency system capacity and potential responses to the loss, damage, or adverse impact of major infrastructure (e.g., major roads, water conveyance structures, Delta levees, electrical and gas transmission, etc.).
- » Quantification of the compounding and cascading effects of climate change and the historically top natural hazards in California such as earthquake, fire, tsunami, and flood. Quantify the compounded hazards on the built environment.

Summary

Atmospheric rivers (ARs) and extratropical cyclones (ETCs) are the predominant sources of precipitation in California. As a result, these weather phenomena are responsible for nearly all flood hazards in the state with impacts that could be amplified in a warmer, low-to-no snow future. This project will analyze the AR-ETC relationship and identify the physical mechanisms and downstream impacts associated with how their co-occurrence amplifies or diminishes flood potential in California, particularly in a warmer world with a focus on headwater regions of major reservoirs and downstream conveyance infrastructure.

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Climate Change Impact on Compound and Cascading Hazards in California

Lead Principal Investigator

Amir AghaKouchak

Organization

The Regents of the University of California, Irvine

Award Amount

\$300,000

Summary

Multiple hazard events (whether extreme or not) can occur concurrently or in a series (cascading) to produce compound hazards with extreme impacts on societal, natural, and built systems that have far greater negative consequences than the independent hazards. The overarching goal of this project is to develop and apply a multivariate framework for the detection and attribution of compound and cascading extremes. The method will be used to identify hotspots and explore which infrastructure and census tract level neighborhoods are most vulnerable.

Climate Research Topic(s) Addressed

- » Quantification of the compounding and cascading effects of climate change and the historically top natural hazards in California such as earthquake, fire, tsunami, and flood. Quantify the compounded hazards on the built environment.

Quantitative Evaluation of Cost-Effectiveness of Coastal Adaptation Strategies in California Through the Development of CoSMoS-ADAPT

Lead Principal Investigator

Borja G. Reguero

Organization

The Regents of the University of California, Santa Cruz

Award Amount

\$320,365

Climate Research Topic(s) Addressed

- » Evaluation of climate change adaptation strategies to understand the equity implications and potential unintended consequences on vulnerable communities, including potential for job loss as well as workforce opportunities in emerging and expanding industries and technologies.
- » Impacts of sea level rise on coastal habitats and communities including estuaries, beaches, dunes, inland waterways, groundwater rise and flooding, sediment transport, wetland migration pathways, vulnerability of coastal infrastructure, public access, and the adaptation strategies in response to these impacts and concerns.
- » Effects and consequences of climate change on nature-based climate solutions, as well as necessary modifications to ensure actions are successful. Examples may include how prescribed fire burn windows will need to be modified to account for drought or heat, how biodiversity conservation can incorporate species migration and population connectivity, how coastal wetland restoration can account for sea level rise projections, and how mountain meadow restoration can incorporate wildfire management.

Summary

California's coast faces significant climate change challenges that threaten the coastal economy, critical infrastructure, communities, and a rich natural system. In response, State agencies and local communities have been scaling up adaptation efforts, increasingly embracing a "pathway" approach, but they have expressed a lack of tools to evaluate local adaptation options and the distribution of benefits at local and regional scales, especially nature-based solutions (NBS). Adaptation planning to date has also raised difficult questions about equity and justice, such as the harm to communities through displacement, or the distribution of costs and benefits of adaptation investments. The proposed research aims to address these gaps by developing (1) local coastal climate hazard information; (2) tools for evaluating adaptation strategies and pathways, and (3) assessments of costs and benefits and their spatial and equitable distribution.

Sierra Nevada Montane Meadows: Keystone Ecosystems for Carbon Stability and Ecosystem Services Under Climate Change

Lead Principal Investigator

Cody Reed

Organization

Point Blue Conservation Science

Award Amount

\$240,407

modifications to ensure actions are successful.

Examples may include how prescribed fire burn windows will need to be modified to account for drought or heat, how biodiversity conservation can incorporate species migration and population connectivity, how coastal wetland restoration can account for sea level rise projections, and how mountain meadow restoration can incorporate wildfire management.

Climate Research Topic(s) Addressed

- » Effects headwater management practices have on downstream water supply and quality, hydrology, habitat quality, and biodiversity. Examples may include, but are not limited to, identifying practices that maximize snowpack retention, measure watershed yield based on management induced changes in forest form (e.g., density/basal area), and identifying what conditions resulting from potential forest management techniques will maintain, support, or degrade habitats and ecosystem services.
- » Roles of wetlands and their associated ecosystem functions in maintaining carbon storage, water supply, water quality, flood control, biodiversity, and habitat connectivity. This may consider various habitat restoration techniques, including animal and other process-based restoration such as beavers.
- » Identification of climate refugia or habitat conditions that can provide increased climate resilience and support species adaption to climate change. This includes, but is not limited to, identification of critical population connectivity, migration pathways and corridors, and habitat restoration and conservation opportunities.
- » Effects and consequences of climate change on nature-based climate solutions, as well as necessary

Summary

Montane meadows in the Sierra Nevada region are inland mineral soil wetlands that provide important habitat for over half of the region's vertebrate species, are critical components of California's water infrastructure, and contain high densities of soil carbon. Despite the importance of these keystone ecosystems, they remain understudied, particularly compared with the surrounding forest. This project will address this need by conducting a review of existing literature and developing a synthesis of the state of meadow science. It will also identify gaps in knowledge and opportunities to address these gaps. In addition to identifying key knowledge gaps, this project will leverage two other state-funded research efforts to address an important unknown for climate change adaptation - the long-term persistence of soil C in meadows.

Climate Change-Related Occupational Hazards

Lead Principal Investigator

Elizabeth Noth

Organization

The Regents of the University of California,
Berkeley

Award Amount

\$662,139

Summary

Climate change-related rising ambient air temperatures and episodic air pollution events from wildland fires in the Western United States expose Californians to excess heat and reduced air quality which may have substantial, preventable adverse impacts on health and job performance. These direct and indirect impacts on vulnerable populations in California have been largely understudied and unaccounted for in policy planning. This project focuses on a set of vulnerable populations that share key characteristics that put them at excess risk of heat illness and wildfire-related adverse respiratory outcomes now and in the near future. It will conduct a risk assessment to characterize heat and wildfire smoke exposure risks to the following populations - warehouse and storage workers; people who are incarcerated or working in State or federal facilities; active-duty US military personnel in CA; workers at post-harvest food processing locations and other animal production; and free and incarcerated workers at wildfire firefighter camps.

Climate Research Topic(s) Addressed

- » Evaluation of climate change adaptation strategies to understand the equity implications and potential unintended consequences on vulnerable communities, including potential for job loss as well as workforce opportunities in emerging and expanding industries and technologies.
- » Increased understanding of climate change-related occupational hazards, including which workers are most vulnerable to the impacts of climate change and best practices to mitigate these impacts.

Influence of Future Sea-Level Rise on Tsunami Hazards in California

Lead Principal Investigator

Jason R. Patton

Organization

California Department of Conservation

Award Amount

\$353,762

- » Effect of building codes on improving resilience to climate change-induced events and extremes, such as extreme heat, wildfire, or flooding.

Summary

The influence of future Sea-Level Rise (SLR) on tsunami hazards is likely to have substantial health and safety, economic, and societal impacts, especially as more people move to coastal California. Some research has been conducted to evaluate the potential impact of SLR on tsunami hazards in California, yet this work was focused on one location and one phenomenon. We propose to further this important work by expanding analyses of SLR impacts to four sea-level hazard levels from new probabilistic tsunami hazard analysis data at eight key index study sites statewide. We also propose to expand the scope of this study and to evaluate additional processes that impact coastal communities and ports and harbors. We propose to conduct tsunami risk and vulnerability analyses, tsunami loads engineering analyses, coastal erosion analyses, and sediment transport analyses at these study sites.

Climate Research Topic(s) Addressed

- » Evaluation of climate change adaptation strategies to understand the equity implications and potential unintended consequences on vulnerable communities, including potential for job loss as well as workforce opportunities in emerging and expanding industries and technologies.
- » Explore how climate-related events will impact emergency system capacity and potential responses to the loss, damage, or adverse impact of major infrastructure (e.g., major roads, water conveyance structures, Delta levees, electrical and gas transmission, etc.).
- » Impacts of sea level rise on coastal habitats and communities including estuaries, beaches, dunes, inland waterways, groundwater rise and flooding, sediment transport, wetland migration pathways, vulnerability of coastal infrastructure, public access, and the adaptation strategies in response to these impacts and concerns.
- » Quantification of the compounding and cascading effects of climate change and the historically top natural hazards in California such as earthquake, fire, tsunami, and flood. Quantify the compounded hazards on the built environment.

A Multi-Sector Assessment of Climate Change Adaptations in California Agriculture and Communities

Lead Principal Investigator

Josue Medellin-Azuara

Organization

The Regents of the University of California,
Merced

Award Amount

\$353,515

Climate Research Topic(s) Addressed

- » Impacts and cascading effects of future extreme heat and drought on agricultural productivity including, but not limited to, the effect on crop patterns, pollinator health, food security (cost and nutritional availability), and economic viability. Evaluate how competing uses for water during periods of drought have impacted agricultural production, and the effect of future climate changes, regulations, and water systems.
- » Impacts of drought and climate change-induced aridity on surface and groundwater supply, changes to surface-groundwater connections, and recharge potential, including the economic and equity impacts of these changes.
- » Evaluation of climate change adaptation strategies to understand the equity implications and potential unintended consequences on vulnerable communities, including potential for job loss as well as workforce opportunities in emerging and expanding industries and technologies.

Summary

Climate change continues to challenge California's agricultural systems, resulting in economic losses that cascade into rural communities and the regional economies. This research aims to provide action-based science to enhance climate resilience in California by integrating, for the first time, the coordinated adaptations of crop and animal agriculture in the state to project the interplay in allocating water resources and land use strategies. This research will respond to three major research questions. What are the impacts of climate extremes on water availability for agriculture? What is the range of potential impacts of climate extremes on productivity in California agriculture, including crops and livestock?, and, What are the economic and equity implications of agricultural adaptation to climate for rural communities and local regional economies that rely on agriculture?

A Widescale Assessment of Heat Tolerance in the California Flora: Identifying Predictors and Vulnerabilities for Plant Conservation in a Warming World

Lead Principal Investigator

Justin Valliere

Organization

The Regents of the University of California, Davis

Award Amount

\$516,819

Climate Research Topic(s) Addressed

- » Impacts of climate change (including extreme events) on biodiversity and native species, including what factors affect vulnerability and resilience, ways to identify the greatest threats to biodiversity caused by climate change (including but not limited to invasive species and pests), understanding how species or populations will respond to climate change, and identifying techniques and metrics for tracking and monitoring the effects of climate change on biodiversity.
- » Effects and consequences of climate change on nature-based climate solutions, as well as necessary modifications to ensure actions are successful. Examples may include how prescribed fire burn windows will need to be modified to account for drought or heat, how biodiversity conservation can incorporate species migration and population connectivity, how coastal wetland restoration can account for sea level rise projections, and how mountain meadow restoration can incorporate wildfire management.
- » Effects of climate change on California Native American tribes' traditional food sources, food systems, and culturally important species.

Summary

Despite the well-recognized threat of climate warming, impacts on native plant species are understudied. With over 6,000 plant taxa, predicting the consequences of climate change on the California flora is a significant challenge. There is a strong need for empirical data on plant heat tolerance across the state's diverse ecosystems to develop and implement strategies for preserving biodiversity and ecosystem services in a warmer world. This project will fill this research gap by addressing four key questions: 1. What are the limits of heat tolerance in California's plant species? 2. Which species and ecosystems are the most at-risk under rising temperatures? 3. Do populations of widespread plant species exhibit varying degrees of heat tolerance? 4. Can we identify key predictors of heat tolerance in the California flora?

Pollination in a Changing World: The Effects of Habitat and Temperature on the Health of California's Wild Pollinators

Lead Principal Investigator

Marilia Palumbo Gaiarsa

Organization

The Regents of the University of California,
Merced

Award Amount

\$363,430

Summary

Pollinator-dependent crops in California are valued at more than \$11 billion, making California the largest producer of fruits and vegetables in the United States. However, California's reliance on managed honeybees for pollination is problematic. The high cost and carbon emissions associated with hive transport, along with the persistently high rates of colony loss reported by beekeepers, render this system unsustainable. To address this issue, we must explore alternative solutions, such as restoring wild pollinator populations. Yet, the impacts of climate change on the health and fitness of wild bees, as well as the ecological traits that enable populations to persist and thrive, remain largely unknown. To fill this knowledge gap, this project will assess how temperature conditions and different habitats affect pollinator health. By doing so, it seeks to understand the factors that influence the vulnerability and resilience of wild bee populations.

Climate Research Topic(s) Addressed

- » Impacts and cascading effects of future extreme heat and drought on agricultural productivity including, but not limited to, the effect on crop patterns, pollinator health, food security (cost and nutritional availability), and economic viability. Evaluate how competing uses for water during periods of drought have impacted agricultural production, and the effect of future climate changes, regulations, and water systems.
- » Identification of climate refugia or habitat conditions that can provide increased climate resilience and support species adaption to climate change. This includes, but is not limited to, identification of critical population connectivity, migration pathways and corridors, and habitat restoration and conservation opportunities.
- » Impacts of climate change (including extreme events) on biodiversity and native species, including what factors affect vulnerability and resilience, ways to identify the greatest threats to biodiversity caused by climate change (including but not limited to invasive species and pests), understanding how species or populations will respond to climate change, and identifying techniques and metrics for tracking and monitoring the effects of climate change on biodiversity.

Estimating the Impact of Drought on California's Housing Needs

Lead Principal Investigator

Michelle Miro

Organization

RAND Corporation

Award Amount

\$213,575

plans; yet much of this planning fails to consider local land use plans or other urban development needs. Similarly, housing policy, housing needs assessments and related planning focus on social, economic and demographic factors influencing housing needs and do not consider the constraints on growth due to climate change. There is a core need to better integrate these planning efforts and research communities to consider the direct and indirect effects of climate change. This project will assess the implications of climate change on future water availability with the goal of understanding how that may place limits on growth, as well as developing actionable strategies to address affordable housing in California.

Climate Research Topic(s) Addressed

- » Impacts of drought and water availability on land use development and housing growth, including strategies to improve access to residential water supply efficiency and increase drought resilience.

Summary

The increases in housing supply needed to help address the state's growing shortage of affordable housing sit in stark contrast to the risks of declining water available to meet these housing needs. At the same time, climate change is increasing the frequency and magnitude of drought, resulting in loss of water supply and water shortages across the state. Water suppliers often project out water demands to inform supply development or management

Identifying Climate Change Refugia in Coastal and Pelagic Ocean Habitats

Lead Principal Investigator

Mikaela Provost

Organization

The Regents of the University of California, Davis

Award Amount

\$282,262

Summary

Climate change is impacting California marine ecosystems: rising temperatures, ocean acidification, and deoxygenation. In addition, the impact of episodic marine heat waves, El Niño events, and increasing ocean variability are not uniform across space or time. Climate change refugia are areas characterized by relatively stable climate conditions and therefore have lower environmental stress compared to the surrounding seascape. For species that have limited mobility, regions with lower environmental stress are especially important. Research on climate refugia in terrestrial habitats is rapidly growing. In the oceans comparatively less work has been done to identify climate refugia, especially with respect to their importance for sustaining fisheries. This project will develop methods to calculate environmental stress within the CA Current Ecosystem, with the goal to identify locations of climate change refugia in the future.

Climate Research Topic(s) Addressed

- » Identification of climate refugia or habitat conditions that can provide increased climate resilience and support species adaption to climate change. This includes, but is not limited to, identification of critical population connectivity, migration pathways and corridors, and habitat restoration and conservation opportunities.
- » Effects of increasing water temperatures, varying precipitation patterns, and associated events (such as harmful algal blooms and ocean acidification) on fish and other aquatic and marine ecosystems, including, but not limited to, impacts on species such as chronic and acute physiological changes, sex ratios, and fecundity.

Building an Inclusive Future: A Participatory Approach to Transformative Climate Change Resilience

Lead Principal Investigator

Rachel Hatch

Organization

Institute for the Future

Award Amount

\$438,719

Climate Research Topic(s) Addressed

- » Health (mental and physical) and social consequences (short-term, chronic, and cumulative) of climate change-related extreme events and impacts, including, but not limited to, extreme heat, wildfire smoke and toxicity, water supply and quality, and flooding.

Summary

The unevenly distributed future of climate change means that some people are on the frontlines today. How they are learning to respond, adapt, and find resilience will matter to all Californians in the next decade—from households to policy decision-makers. This research project asks: what if we center and amplify low-income voices; the Californians least able to look to the market for solutions and responses to climate change? The methodology used is community-based foresight. This project will identify themes around the health (mental and physical) and social consequences of climate change-related extreme events and impacts, with an eye to strategies for how low-income residents are responding. The project will produce a set of key questions for decision-makers to consider in order to contribute to more future-ready regions.

Evaluation of Climate Change Adaptation Strategies for California's Adjudicated Groundwater Basins to Assess Impacts on Water Sustainability for Vulnerable Communities

Lead Principal Investigator

Ruth Langridge

Organization

The Regents of the University of California, Santa Cruz

Award Amount

\$277,181

Climate Research Topic(s) Addressed

- » Self-proposed topic.
- » Evaluation of climate change adaptation strategies to understand the equity implications and potential unintended consequences on vulnerable communities, including potential for job loss as well as workforce opportunities in emerging and expanding industries and technologies.
- » Impacts of drought and climate change-induced aridity on surface and groundwater supply, changes to surface-groundwater connections, and recharge potential, including the economic and equity impacts of these changes.

Summary

Groundwater is a critical water supply source for many communities and an essential back-up source of water during droughts. Over a century, the volume of groundwater withdrawn generally exceeded recharge with concomitant negative impacts to vulnerable communities and the resource. Climate change projections of increased temperatures and more extreme droughts will exacerbate impacts. In 2014, the Sustainable Groundwater Management Act (SGMA) established new requirements for high and medium-priority groundwater basins in overdraft or vulnerable to overdraft to develop sustainable management programs with state oversight. But adjudicated basins are exempt from SGMA with limited exceptions. Adjudicated basins encompass a very large area of Southern California where sustainable groundwater management is critical due to limited precipitation and climate change projections of reduced imported surface water supplies relied on by many areas, and where there are a large number of disadvantaged communities (DACs). This project will analyze whether and how adjudicated basins are aligning with SGMA sustainability goals and whether Watermasters are incorporating vulnerable communities and DACs into decision-making processes and will detail potential institutional and management strategies to better achieve state goals.

Weathering the Weather Unsheltered

Lead Principal Investigator

Sophia M. Charan

Organization

RAND Corporation

Award Amount

\$310,549

Climate Research Topic(s) Addressed

- » Health (mental and physical) and social consequences (short-term, chronic, and cumulative) of climate change-related extreme events and impacts, including, but not limited to, extreme heat, wildfire smoke and toxicity, water supply and quality, and flooding.

Summary

As the climate changes, California will experience more dangerous and frequent heat waves, incidents of toxic wildfire smoke, and flooding from heavy precipitation events. During these hazards, public health advice often centers around encouraging people to stay home or stay inside. This is not always easy or possible for the over 110,000 people in California living unsheltered, who are at particular risk of serious acute and chronic health impacts from these events. This project will seek to understand the challenges that arise with current harm mitigation strategies (e.g., evacuation orders, clean air and cooling centers, etc.) and provide recommendations for best practices for organizations and policymakers focused on assisting unsheltered individuals to improve communication about, reduce risk from, and prevent health impacts from extreme heat, wildfire smoke, and flash flooding.

The Potential for Long-Term Soil Carbon Sequestration from Compost Amendments to California Rangelands

Lead Principal Investigator

Whendee Silver

Organization

The Regents of the University of California,
Berkeley

Award Amount

\$308,131

Summary

Rangelands cover almost 40% of the land area in California and have demonstrated potential to contribute to climate change mitigation and adaptation. However, the lack of long-term data has hampered the wider incorporation of these lands into climate action planning. This project will use a 15-year experiment to determine the long-term effects of compost amendments to rangelands in two bioclimatically distinct regions that are broadly representative of approximately 9 million hectares of California's rangelands. The project will address questions of the long-term viability of compost amendments for soil carbon sequestration and the improvement of soil and ecosystem health indicators indicative of ecosystem resilience to climate change.

Climate Research Topic(s) Addressed

- » Self-proposed topic.

