



## REQUEST FOR PROPOSALS

October 1, 2015

California's Fourth Climate Change Assessment: Non-Energy Research

Deadline for Submittal is 3 pm PST, Friday, December 4, 2015

**Background:** The State of California has generated three scientific climate change assessments since 2006. These reports have been instrumental in guiding state policy and supporting informed responses to climate change. The state is moving forward with the Fourth Assessment to advance the science that supports sound policy while responding directly to state, regional, and local decision-makers who need information to guide planning.

California's leadership in climate change policy is built on a strong foundation of research addressing the impacts of climate change on the state, as well as strategies to dramatically reduce greenhouse gas emissions. In turn, the state's research responds directly to policy needs related to safeguarding California from these impacts.

California's recently released *Climate Change Research Plan* articulates near-term climate change research needs to ensure that the state stays on track to meet its climate goals. The Fourth Climate Change Assessment is the first inter-agency effort to implement a substantial portion of the *Climate Change Research Plan*.

The California Natural Resources Agency (CNRA) is leading the preparation of the Fourth Assessment that will be released to the Governor, the Legislature, and the general public in 2018. The Climate Action Team's (CAT) Research Working Group is the initial steering committee for the assessment. CNRA, in consultation with the CAT Research Working Group, has identified a core portfolio of non-energy studies for the Fourth Assessment. These studies will be funded primarily by CNRA. CNRA selected UC Berkeley's Energy and Climate Institute (BECI) to manage this solicitation and the overall execution of the non-energy part of the assessment.

For information on the first three assessments see:

[http://climatechange.ca.gov/climate\\_action\\_team/reports/climate\\_assessments.html](http://climatechange.ca.gov/climate_action_team/reports/climate_assessments.html)

For information on the fourth assessment see:

<http://resources.ca.gov/climate/fourth/>

**Overview:** The Fourth Climate Change Assessment will enhance the capacity of local and regional entities to anticipate and plan for projected climate risks, including extreme events. Scientific studies will offer finer spatial resolution as to what impacts might be expected in the next 20 to 40 years while also considering end-of-century climate risks and management strategies (e.g., for forests and working lands) that must consider longer time scales. Regional

case studies will delineate specific examples of addressing local vulnerabilities and financing adaptation options.

The California Energy Commission will support research on energy issues so that the energy and non-energy studies will complement each other and, to the extent possible, use common scenarios to produce internally consistent results and support cross-sectoral integration. A key element of the Fourth Assessment will be its “open” process, with active engagement of stakeholders throughout the process, rather than limited to outreach in the results phase.

**Eligibility:** Only one award will be issued for each listed project. All research institutions are welcome to submit applications including entities from the private sector. However, preference will be given to institutions based in California or that have offices in California, where most of the work should be conducted. For each research project, only one application per Applicant will be allowed. An Applicant refers to a research group. Large research institutions can submit multiple applications for the same project if the applications are associated with different research groups. A research group can submit applications for multiple projects. In this case applications may include a section indicating how the different applications are connected and the benefits of having one group perform multiple studies. However the review committee will evaluate the proposals both as independent units and as interdependent studies.

**Period of Performance:** The Fourth Climate Assessment will be completed and available to the public by spring 2018. Researchers should plan to complete their projects, including peer-review by December 2017.

**Proposal:** Proposals are limited to 25 pages. The proposal must include the following: title, applicable theme and project (see the table at the end of this document), project description (limited to 12 pages), list of researchers and their qualifications, brief literature review, description of local/regional actors if appropriate, proposed schedule, and budget including match funding if available. The proposal must indicate what fraction of the work will be done in California.

**Budget:** Budgets should include the following categories, list of personnel with salaries or hourly rate, salary expense, benefits, subcontracts, travel, miscellaneous expenses, equipment, and indirect costs (overhead). Travel should be detailed. Since the funding comes from a state agency, UC campuses should use a 25% indirect cost rate in their budget. Budgeted travel outside California is discouraged.

**Match Funding:** Match funding is not required, however extra points will be awarded for match funding. Ten extra points will be awarded if match funding adds at least 50% to the budget requested from BECI (for example the applicant requests \$200,000 from BECI and offers to provide an additional \$100,000 in matching funds), 8 points for 40%, 6 points for 30%, 4 points for 20% and 2 points for 10%.

**Quarterly Meetings:** Applicants will be expected to attend quarterly meetings designed to coordinate the different studies. These meetings may take place in person or remotely.

**Coordination:** Applicants should demonstrate some level of flexibility to foster coordination between and integration of the studies that comprise the Fourth Assessment. To ensure that the Fourth Assessment research results are internally consistent and amenable to cross-sectoral integration, all research projects will use a common set of primary (climate, sea level, socioeconomic, and land-use) as well as secondary (wildfire) scenarios. To increase the likelihood that studies at the local and regional levels are useful to inform decision-making, proposals for local/regional studies should include partnerships with local/regional entities.

**Papers and Publications:** All the papers and reports for the Fourth Assessment will use a common format similar to that used for prior assessments.<sup>1</sup> All of the papers and reports from the different studies will be peer-reviewed. The applicants should reserve some resources to address comments from peer-reviewers in a similar way as is done for scientific and technical journals. The funder, CNRA, may request the submission of data sets produced by the studies and the data may become available via the California GeoPortal, MyPlan for hazard mitigations, the General Plan Guidelines for cities and counties, the State’s Open Data Portal, or other similar tools. The applicants must be willing to interact with the Cal-Adapt team to facilitate the display of results via Cal-Adapt.<sup>2</sup>

**Questions:** Questions about this solicitation can be submitted (via email only) by Friday October 16 to [cca@beci.berkeley.edu](mailto:cca@beci.berkeley.edu). Questions and responses will be posted on the BECI website by Friday October 30.

**Deadline for Submission of Proposals:** Proposals must be submitted via email as a single PDF file. The deadline for submissions is 3pm Pacific Standard Time on Friday, December 4. The email address for submissions is [cca@beci.berkeley.edu](mailto:cca@beci.berkeley.edu). Earlier submission is encouraged to avoid last minute problems in transmittal.

**Schedule:**

Deadline for Submitting Questions	Friday, October 16, 2015
Posting of Responses on BECI website	Friday, October 30
<b>Deadline for Submitting Proposals</b>	<b>3 pm PST Friday, December 4</b>
Anticipated Completion of Evaluation Process	mid-January, 2016

**Proposal Evaluation Process:** Berkeley Energy and Climate Institute (BECI), the California Natural Resources Agency (CNRA), and the Climate Action Team’s (CAT) Research Working

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<sup>1</sup> [http://www.climatechange.ca.gov/climate\\_action\\_team/reports/third\\_assessment/index.html](http://www.climatechange.ca.gov/climate_action_team/reports/third_assessment/index.html)

<sup>2</sup> <http://cal-adapt.org/>

Group will select the winning proposals. Scoring will be based on 100 points. Proposals can earn up to 10 extra points for matching funds as described above. The minimum score will be 70 points. Points are awarded based on the following criteria:

- Scientific/technical merits of the proposal and the practical applications of the proposed research. Describe the goals and objectives of the project. Explain how it will lead to scientific advancement that will help guide climate change policy. This is worth up to 25 points.
- Technical approach to the project and research plan. Describe the research and how it will be performed. Explain how the research goals and objectives will be accomplished. This is worth up to 25 points.
- Impacts and benefits for California. Describe how the project will benefit California and help it address climate change. Studies that are particularly relevant to California are more desirable, especially those that integrate well with previous California climate assessment research and other topics in this solicitation. This is worth up to 20 points.
- Team qualifications, capabilities and resources. Research team has high-level experience successfully conducting applied research projects. Research team is well qualified to understand the diverse and complex science that contributes to California's climate change assessments. Research team has experience soliciting stakeholder input in scoping of scientifically sound studies, working with multidisciplinary groups and coordinating the transfer of information and data. This is worth up to 20 points.
- Project budget is reasonable, appropriate, and cost effective. This is worth up to 10 points.

**Final Selection and Contracting:** BECI, in consultation with CNRA and the Research Working Group, will prepare a final scope of work and final budget based on the information provided in the proposal for each one of the selected projects or combination of projects. Only one award will be issued for each of the eighteen listed projects. If an agreement on the statement of work, budget, and terms and conditions cannot be reached between the parties, BECI reserves the right to work with the applicant that received the next highest score until reaching a successful outcome. If no satisfactory applications were received for a project, BECI reserves the right to not issue an award for that project.

**List of Research Projects and Anticipated Funding:**

For a summary description of each project see Attachment 1.

For the full description see:

*California's Fourth Climate Change Assessment: Conceptual Sketches of Projects for the Non-Energy Research Portfolio* found on the BECI website at:

[http://beci.berkeley.edu/Conceptual\\_Sketches.pdf](http://beci.berkeley.edu/Conceptual_Sketches.pdf)

<i>Theme</i>	<i>4<sup>th</sup> Climate Change Assessment Projects</i>	<i>Anticipated Funding</i>
<b>1. Climate Change, Habitat, and Wildfires: Impacts and Management Options</b>	A. Impacts of Wildfires in California on Homeowners' Insurance	\$300,000
	B. Reducing Wildfire-Mediated Health Impacts	\$150,000
	C. Migration Corridors and Refugia as Adaptation Strategies: Critical review	\$150,000
	D. Fuel Treatment for Forest Resilience and Climate Mitigation: Critical review	\$75,000
<b>2. California's Working Lands: Carbon Sequestration for Adaptation and Mitigation</b>	A. Economic Potential and Climate Benefits for Carbon Sequestration on Rangelands & Croplands	\$400,000
	B. Use of Composted Food Waste and Livestock Manure to Enhance Agricultural Resilience While Reducing Greenhouse Gas Emissions	\$200,000
	C. Mapping Forest Carbon for Sequestration and Adaptation	\$500,000
	D. Economic and Environmental Costs, Benefits, and Risks of Adaptation in California Agriculture	\$200,000
<b>3. Sea-Level Rise, California's Coast, and Ocean Ecosystems</b>	A. Improving Coastal Vulnerability Assessment to Account for Sea Level Rise and Vertical Land Movement	\$700,000
	B. Identification of Natural Infrastructure Options for Adapting to Sea Level Rise	\$200,000
	C. Developing Impact Indicators of Ocean Acidification and Hypoxia in Marine Protected Areas	\$50,000

<b>4. Water Security and Long Droughts</b>	A. Adaptation Options for California's Water System: Improving models of human-hydrological interaction for climate adaptation	\$300,000
	B. Adaptation Options for Local "Self-Sufficient" Utilities	\$300,000
	C. Lessons from the Current Drought: Adapting to increased water stress	\$100,000
<b>5. Forecasting to Support Climate-Resilient Decision-Making</b>	A. Preparing Public Health Officials for Climate Change: A Decision Support Tool	\$200,000
<b>6. Preparing for Emergency Management in a Changing Climate</b>	A. Climate Change and Emergency Management in California	\$375,000
<b>7. Funding and Implementing Adaptation Projects and Measures in California</b>	A. investigation of Practical Opportunities to Fund Adaptation	\$100,000
	B. Overcoming Barriers to Adaptation: A Case Study	\$150,000

# Attachment 1

## Summary Description of Research Projects

### For the full description see:

*California's Fourth Climate Change Assessment: Conceptual Sketches of Projects for the Non-Energy Research Portfolio* found on the BECI website at:

[http://beci.berkeley.edu/Conceptual\\_Sketches.pdf](http://beci.berkeley.edu/Conceptual_Sketches.pdf)

*Note that all projects must use a common set of climate and sea level rise scenarios and wildfire projections for the rest of this century, as described in the Conceptual Sketches document.*

### ***Theme 1: Climate Change, Habitat, and Wildfires: Impacts and Management Options***

Interactions between changing wildfire regimes, habitat, and landscapes will impact several sectors, including California's insurance industry, public health, the energy sector, as well as urban users of natural resources. Ecological resources will also be affected by climate change, and forest management practices must evolve to contend with projected changes in wildfire risks in California.

Research is needed to shed light on the magnitude, timing, distribution, and economic implications of these changes and to inform management decisions at the state and local levels. Studies in this area will leverage a common set of "secondary" wildfire scenarios that are based on the most up-to-date downscaled climate projections for California.

#### **A. Impacts of Wildfires in California on Homeowners' Insurance**

Climate change represents a significant challenge for the insurance industry as well as California homeowners at risk of wildfires. Accordingly, it is essential to assess, and to the extent possible, protect against the impact climate change will have on insurers and consumers. This research will inform policymakers of additional steps needed to protect against the risk of wildfire-mediated insurance losses and will assist insurers in maintaining affordable and available coverage. The research will make use of updated climate scenarios and regional wildfire projections to estimate when the homeowners' insurance market may start to be significantly impacted by the effects of climate change. The research will also analyze the likely set of industry responses, including changes in rates and availability.

#### **B. Reducing Wildfire-Related Health Impacts**

Climate change is the preeminent threat to public health in the 21<sup>st</sup> century. Substantial increases in wildfire risk are predicted for California, and the recent increase in high-profile wildfires in

California has turned the state's attention to the potential impacts of smoke and other air-borne pollutants on public health. This research will explore public health vulnerabilities to wildfires by making use of updated climate scenarios and regional wildfire projections to explore regional transport of pollutants; ambient concentrations of fine particles and other pollutants; and impacts to public health. Results can be used as a basis for public health adaptation measures to climate change.

### **C. Migration Corridors and Refugia as Adaptation Strategies: Critical review**

Under an unprecedented rate of climate change, species that have evolved to migrate with moderate or slow rates of change must now relocate at greater speeds to find appropriate habitat. This challenge is compounded by the highly modified and fragmented (due to manmade infrastructure) landscape through which species must move. To support resource management objectives articulated in *Safeguarding California* (2014), this research will critically review existing efforts designed to identify migration corridors and temporary refugia that may dampen the deleterious effects of climate change on species of concern in California. This research is not limited to a literature review, but requires an in-depth critical review of existing methods and practices that are being used by different groups to identify migration corridors in California as an effort to ameliorate climate impacts. If matching funds are available, this work may identify critical habitat linkages (or corridors) and climate refugia to increase the likelihood of species survival and reduce overall climate risks to California biodiversity in one or more regions in California informed by the insights gained from the critical review. For example, the study may show that current methods using monthly climate information fails to reproduce results with daily resolution. Maintaining connectivity through migration corridors and "stepping-stones" will facilitate the movement of species between currently suitable areas and to newly suitable areas over time as the climate changes.

### **D. Fuel Treatment for Forest Resilience and Climate Mitigation: Critical review**

Due to its ability to act as a carbon sink or source, the forest sector plays an important role in climate change policy. Climate change is expected to increase the frequency and intensity of wildfires (carbon source). On the other hand, forests managed for fire suppression are characterized by increased tree density; however, research suggests that denser stands actually store less carbon. This research is not limited to a literature review, but requires an in-depth critical review of available research to clarify what is known about the effects of fuel treatments on carbon cycling in California's forests and outline what new knowledge will be needed to make sound fuel treatment decisions to increase both forest resilience and carbon sequestration. This research will improve estimates of the effects of forest management activities on forest carbon sequestration and avoided wildfire emissions. This research will help agencies; fire safe councils and land management companies decide how to optimally allocate limited funds for forest management activities to achieve the co-benefits of improved resilience and climate mitigation.



## ***Theme 2: California's Working Lands: Carbon Sequestration for Adaptation and Mitigation***

Increasing temperatures, changes in precipitation patterns, and other climate changes affect the distribution of vegetation, health of ecosystems, carbon storage potential, and disturbance regimes, including wildfire. The fate of carbon in forested ecosystems and in California's rangelands is a complex interaction between many variables. For example, the fate of carbon in forests is affected by wildfire emissions; tree mortality from various sources including drought, disease and wildfire; timber harvests; and forest growth and development. Additionally, climate change will lead to the conversion of forested land to other land types, including shrub and grasslands. Climate change also poses risks to existing grasslands, rangelands, and working landscapes in California.

Disturbances as a result of climate change will affect the health of forested ecosystems, rangelands, and croplands, and thus the services that they provide through habitat and carbon storage and water supply for urban communities, among other services. While forests and rangelands (and, to a lesser extent, croplands) have been demonstrated to have high potential for sequestering carbon, successfully managing these working lands for carbon storage will require developing California-specific understandings of ecosystem dynamics in a changing climate as well as economic dimensions of and institutional barriers to preserving working lands in a manner that provides adaptation benefits while sequestering carbon.

Additionally, this area of research includes economic and environmental analysis of adaptation options for the agricultural sector.

### **A. Economic Potential and Climate Benefits of Carbon Sequestration on California's Rangelands and Croplands**

Rangelands, including publicly and privately managed land, comprise a significant portion of the land base in California and is calculated to be among the lowest GHG emissions per area among the productive uses of land. Although varied research has been conducted on the capacity of rangeland soils to store carbon, this work must be enhanced to better estimate how climate change would affect long-term carbon sequestration in rangelands and how increased soil carbon can be used as a climate adaptation option. Similarly, enhancing soil carbon in cultivated cropland offers the potential to reduce greenhouse gas emissions and improve agricultural yields. This California-specific research will assess the economic and climate benefits of management techniques for rangelands and potentially for croplands that maximize carbon sequestration and build resiliency to climate impacts.

## **B. Use of Mulch and Composted Food Waste and Livestock Manure to Enhance Agricultural Climate Resilience and Water Conservation While Reducing Greenhouse Gas Emissions**

The state of California is currently in an extreme drought, and agricultural operations are experiencing a lack of water for food crop production. Improving soil water retention, which is one of the benefits of application of mulch and composted materials to agricultural lands, may help California address future droughts and adapt to climate change. This research will investigate the potential of application of aerobically composted livestock manures and food wastes as well as mulch to agricultural lands to enhance climate resilience (e.g., improve soil water retention). The research will also quantify the greenhouse gas emissions reductions associated with these strategies compared to existing management practices.

## **C. Mapping Forest Carbon for Sequestration and Adaptation**

Recent preliminary research indicates that wildfires may be contributing to California forests and shrublands becoming a source of greenhouse gases rather than a sink. However, the methods used so far lack detailed measurements afforded by aerial remote sensing monitoring. This field study will help firm up the recently reported carbon budget for California lands, at least for selected regions in California. This study may also help confirm, or not, a hypothesis that less dense forest can retain more carbon while reducing the likelihood of catastrophic fires. This research will help resource managers better understand the co-benefits or trade-offs of mitigation and adaptation strategies involving forest carbon by developing and evaluating innovative, repeatable methods to improve mapping of carbon stocks of California forests.

## **D. Economic and Environmental Costs, Benefits, and Risks of Climate Change Adaptation in California Agriculture**

Climate change effects that are expected to impact California agriculture include decreased yields due to increased temperatures, flooding, more intense droughts, increased pests and reduced pollination services. One of the high-priority recommendations noted in the CDFA Climate Change Consortium final report (CDFA, 2013) is to determine the economic and environmental costs, benefits, and risks of several potential adaptation measures through a comprehensive research strategy to accounts for the diversity of crops and farming conditions in the state. Results from this project will help facilitate development of agricultural management practices for specific crops and locations in California to address climate change.

## ***Theme 3: Sea Level Rise, California's Coast, and Ocean Ecosystems***

The geography of California's coastline is changing with sea level rise. Rising salt water combined with patterns of prior development and outdated infrastructure puts residents, ecosystems, and property at risk. Sea level rise and salt water intrusion likewise creates major adaptation challenges for the inland communities of the Sacramento-San Joaquin Delta.

Similarly, climate change impacts in the form of ocean acidification and hypoxia are threatening California's Marine Protected Areas.

Sea level will continue to rise along California's coasts. More research must be done to help facilitate beneficial adaptation measures to the consequences of that change across multiple sectors and geographies. This research can then be used to inform planning decisions at multiple levels across both the public and private sectors.

At the same time that sea level rise threatens freshwater and terrestrial resources, marine ecosystems will be challenged by acidification and hypoxia. Developing early indicators for ongoing monitoring and management strategies will be crucial to maintaining oceanic ecosystems.

### **A. Improving Coastal Vulnerability Assessment to Account for Sea Level Rise and Vertical Land Movement**

Although sophisticated process models can simulate coastal flood risk as a function of several factors including sea level, tidal state, storm surge, and beach form, there remains a gap in connecting state-of-the-art science and site-specific assessments of coastal vulnerability that are undertaken by, for example, coastal engineers. To more accurately estimate the threat posed by sea level rise and intense storms to coastal infrastructure, practitioners need a synergistic approach accounting for changing climate patterns, erosion rates, shifting beach forms, and vertical land movement. This research will develop methods to support site-specific, project level assessments of coastal vulnerabilities to sea level rise through integration of models of projected sea level rise and climate scenarios, coupled with local and regional-scale erosion rates and vertical land motion estimates.

### **B. Identification of Natural Infrastructure Adaptation Options for Adapting to Sea Level Rise**

The proposed research will provide scientific, economic, and other analysis that will support on-the-ground initiatives to stabilize California's shorelines in the context of coastal erosion. This erosion is driven by natural processes combined with extensive urban development along the shore, all of which will be increasingly vulnerable as sea level rise continues to affect wave patterns and inundation zones. Specifically, this research will address practical barriers to non-structural stabilization as well as regulatory and ecological concerns. Overall, this research is expected to produce valuable information about: (1) the feasibility of various non-structural stabilization techniques, and (2) the likelihood that these techniques will be suitable under sea level rise projections. State and local entities will be able to use this information to scale up strategies that are expected to produce long-term benefits.

## **C. Developing Impact Indicators of Ocean Acidification and Hypoxia in Marine Protected Areas in California**

Climate change may profoundly affect California's marine ecosystems through ocean acidification and hypoxia. Scientists have already demonstrated serious impacts on shell-building organisms, among others; and a diverse set of stakeholders is beginning to express concerns about these emerging threats to local ecosystems, communities, and coastal economies. The proposed work will illuminate how California's Marine Protected Areas can be leveraged to foster adaptation to effects of ocean acidification and hypoxia. Specifically, this work will develop indicators relevant to acidification and hypoxia to support monitoring and climate resilient management.

### ***Theme 4: Water Security and Long Droughts***

Extreme events, including prolonged drought, exacerbated by climate change have significant consequences for the quantity and quality of available fresh water resources in California. Water scarcity places increased pressure on multiple competing uses, from aquatic ecosystems and agriculture to urban water delivery.

Lessons can be learned from the current drought to better adapt water utilities, modeling tools, and California's allocation system to extreme events. Studies will include both quantitative and qualitative analysis of select case studies to clarify what can be learned from this and prior extreme events, as well as to create tools for adaptation planning.

The three proposed research projects in this area are briefly described below. Climate and hydrologic scenario(s) will be available with realistic decadal and multi-decadal droughts that recent research suggests are more probable with a warming climate in California. This "worst" case scenario (s) will also include years with very heavy precipitation conducive to flooding.

### **A. Adaptation Options for California's Water System: Improving models of human-hydrological interaction for climate adaptation**

The goal of projects in this area is to improve tools for understanding and forecasting how human decisions will impact, and/or can address, water security. Human decision-making, economic markets and institutional behaviors are not realistically characterized in current optimization models. Another approach based on simulation models assumes that existing rules and regulations will not change in the rest of this century, which produces unrealistically pessimistic impacts. Due to these shortcomings in existing models, additional work is needed to support effective decision-making. Projects will incorporate information, for example, about common practices for water purchasing and regional markets and realistic potential adaptation options, to increase the credibility and reliability of models as adaptation tools.

## **B. Adaptation Options for Local "Self-Sufficient" Utilities**

Smaller utilities that are not connected to California's major water delivery systems (the Central Valley Project (CVP) and the State Water Project (SWP)) face multiple challenges in adapting to water scarcity, saltwater intrusion, and the myriad effects of climate change. The purpose of projects in this area is to investigate barriers to and possibilities for adaptation for "at risk" water utilities. Projects will take a social science approach to studying problems faced by smaller utilities in periods of prolonged water scarcity—as in the current drought—and the potential for adaptation measures, like groundwater banking to reduce vulnerability to water scarcity. Focused and in-depth case studies from these projects can help local utilities as well as state policymakers respond to and plan for projected water scarcity.

## **C. Lessons from the Current Drought: Adapting to increased water stress**

Understanding how California's water allocation system has functioned, or not functioned, to mediate between competing uses in the current drought can provide valuable lessons for climate adaptation as California faces increased water stress and water scarcity. Projects in this area will use rigorous social science methodologies to examine the realities of allocation decision-making in practice as well as the laws and regulations that determine water allocation. Information from these projects will be crucial for water managers, utilities, and policymakers as California attempts to adjust its water allocation and management systems to the realities of climate change.

### ***Theme 5: Forecasting to Support Climate-Resilient Decision-Making***

By the end of this century, climate patterns are expected to have substantially deviated from their historical norm. Accordingly, new decision support tools and management protocols must be developed to support climate resilience. For example, "probabilistic" seasonal and decadal forecasts can aid decision makers in a variety of climate-sensitive sectors that must adapt to unfamiliar climatic conditions.

Prior state-sponsored research has established that probabilistic seasonal and decadal forecasting based on state-of-the-art regional climate projections could be incorporated into water resource management in a manner that reduces risks, enhances benefits, and saves money. Moreover, the results indicate that integration of probabilistic forecasting into water management protocols would be "no regrets", as it would improve outcomes both under current and expected future climate variability.

The proposed research project in this area will leverage planned energy-sector research that will produce probabilistic forecasting to improve energy sector planning.

## **A. Preparing Public Health Officials for Climate Change: A Decision Support Tool**

Extreme heat in California is already a substantial threat to public health, and heat waves are projected to increase dramatically in magnitude and frequency in the coming decades. Although

the National Oceanic Atmospheric Administration (NOAA) generates short- and medium-term climate forecasts for the United States, public health warnings tailored to California’s local and regional conditions are not available. This project will develop a decision support tool for public health officials using probabilistic short-and medium-term weather/climate forecasts<sup>3</sup> designed to assist the public health sector with adapting to climate variability and change.

## ***Theme 6: Preparing for Emergency Management in a Changing Climate***

California’s capacity to respond to disasters depends on the integrity of critical facilities such as emergency operation centers (EOC’s), fire stations, hospitals, transportation routes, utilities, government buildings, and hospitals; as well as the functionality of transportation systems, including public transit and active modes, both of which can be critical during and after disasters or extreme events. Although prior research based on seismic vulnerability identifies and seeks to address risk in state-owned buildings with critical functions that are vulnerable to earthquakes, no such effort has been undertaken to identify state-owned and operated critical facilities that are subject to risks associated with climate change. Ultimately, the state must integrate the prospect of climate-related extreme events into its efforts to prepare for handling simultaneous incidents that may rapidly exceed the State’s routine capacity for emergency response.

### **A. Climate Change and Emergency Management in California**

Systematically assessing the condition of the state’s critical facilities and infrastructure is an essential step toward enhancing California’s capacity to endure and recover from a natural disaster, or multiple natural disasters, the risk of which may be substantially increased by climate change. This project will undertake a regional or statewide risk assessment of existing state-owned and state-operated structures critical to response and recovery operations that are currently located in areas of high risk and subject to impacts of climate change. A secondary goal is to investigate ways to make critical transportation systems more resilient to weather-related emergency events.

## ***Theme 7: Funding and Implementing Adaptation Projects and Measures in California***

A critical pragmatic need felt at all levels of government is the question of how to fund adaptation initiatives. The California Adaptation Advisory Panel offered initial ideas, but they have never been examined systematically.<sup>4</sup> State, regions, and local governments have identified funding constraints as among the biggest barriers to adaptation. To address this void, a suite of

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<sup>3</sup> Forecasts one more than about a week in advance are identified as “climate forecasts.” Weather forecasts refer to forecasts for the next several days.

<sup>4</sup> *Preparing for the Effects of Climate Change—A Strategy for California*. A Report by the California Adaptation Advisory Panel to the State of California on Critical Steps Needed to Adapt to the Effects of Climate Change. Pacific Council on International Policy. Available at: [http://www.susannemoser.com/documents/PCIP\\_AdaptationReport\\_ExecutiveSummary\\_Final.pdf](http://www.susannemoser.com/documents/PCIP_AdaptationReport_ExecutiveSummary_Final.pdf).

alternative options should be explored through systematic research, including private sector contributions, payments for ecosystem services, public goods charges, fees, and insurance.

Proposed research in this area is in the form of a wide-open solicitation to identify practical, California-specific opportunities for supporting adaptation measures and projects.

### **A. Investigation of Practical Opportunities to Fund Adaptation**

In general, prior state-wide economic studies strongly suggest that climate change costs could be substantially lower if sound adaptation measures were adopted in a timely fashion.<sup>5</sup> However, there is almost no information about potential funding mechanisms and/or financing models that could be implemented to make these adaptation measures a reality. This research will (1) investigate economically and politically realistic funding possibilities and financing models for climate adaptation and (2) explore potential barriers to financing as well as ways to overcome them.

### **B. Overcoming Barriers to Adaptation: A Case Study**

It is now clear that in order to translate results from adaptation studies into practical implementation of adaptation measures, it is necessary to identify regulatory, legal, scientific, socio-economic, institutional, and financial barriers, as well as options to overcome them. Here we define barriers “as obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, institutions.”<sup>6</sup> This project will involve a sectoral case study (or studies) to identify barriers as well as means by which barriers to adaptation can be overcome. Because past California Assessments included exploratory studies for the water and coastal sectors, this project will address a different sector(s).

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<sup>5</sup> Franco, G., D. R. Cayan, S. Moser, M. Hanemann, M. Jones. 2011. Second California Assessment: integrated climate change impacts assessment of natural and managed systems. *Climatic Change*. See also the errata for this paper. *Climatic Change* (2012). 113: 1099-1100.

<sup>6</sup> Moser, S. C. and J. A. Ekstrom (2010). “A framework to diagnose barriers to climate change adaptation.” *Proceedings of the National Academy of Sciences*, vol. 107, no. 51.