DRAFT REPORT of the Climate Insurance Working Group

EXECUTIVE SUMMARY

California, the United States, and the planet are facing increasingly extreme impacts of climate change. As this report is being finalized in the middle of 2021, the impacts are compounding. California is facing record-setting drought and communities throughout the western US and Canada are facing record-setting heat waves. Wildfires in each of the past four years in California have been record-setting for acres burned, homes destroyed, and tragically, for lost lives. Every county in the state has seen an emergency declaration for flooding since 1992, with 2,600 homes and businesses flooded in a single atmospheric river in 2019.

When severe climate events occur, who is left behind? Without financial resilience and risk reduction, communities are likely to enter a damaging feedback loop where escalating risks lead to increased losses, then financial backsliding, fewer insurance options, and diminished capacity for future resilience. Such a scenario would further exacerbate inequities. At the core of this report is the recognition California must both reduce climate risk impacts and improve recovery after climate-intensified disasters.

Through examination and discussion of recent climate events and their impacts to vulnerable communities, this report identifies four key elements of resilience – risk assessment , risk communication, risk reduction, and risk transfer. Risk assessment and risk communication support community preparation and enable public policies to anticipate events. Early investment in risk reduction reduces future losses, and the expansion of risk transfer options could lead to more affordable and effective insurance concepts. The report then applies these key elements of risk to three specific perils – fire, flood, and extreme heat – and provides specific recommendations for preventing and managing the risks associated with these perils, including closing coverage gaps, and strengthening the role of mitigation investments in reducing mounting climate risks to communities.

Insurance can be an underappreciated cornerstone of community resilience. It not only supports recovery to climate disasters, but can also provide incentives for climate adaptation, such as incentives for fortifying homes or reducing risk in communities, averting some future impacts. This report provides a forward-looking approach to increasing investment in community mitigation, particularly for nature-based approaches that reduce long-term risks by increasing investment in forests, sea grasses, and other natural systems. Such mitigation will reduce some future losses, saving households from damages and making insurance more affordable in the future. Findings from Pew Research indicate that every dollar invested in pre-disaster mitigation saves six dollars by avoiding future recovery costs[1]. When risks and losses are avoided, insurance becomes more available and more affordable. Innovative insurance strategies for responding to climate impacts in this report include harnessing insurance mechanisms, developing new public sector tools and partnerships, and leveraging data

and technology that can be more targeted to address the needs of the most vulnerable; thus creating a more climate resilient future.

The report also explores financial tools, such as insurance, that could make vulnerable communities and the state more resilient in the face of devastating climate impacts. The threat from climate-worsened wildfires, extreme heat, and flooding is growing, yet insurance for each of these perils is inadequate for protecting Californians. With climate-fueled wildfires scorching hundreds of thousands of acres, causing the loss of life and property, wildfire insurance availability has shrunk while the premiums charged have increased. Uptake of flood insurance—typically through the National Flood Insurance Program—is low, although the risk of flooding remains high. Meanwhile, the disruptive impacts of heat waves on health, energy systems, local economies, and other sectors are not commonly measured during or after the events, and largely lack any insurance coverage at all, leaving people vulnerable to such disruptions. In short, California has a widening protection gap—the gap in insurance coverage between insured and uninsured losses. A widening gap leaves communities more exposed to financial costs and less able to recover, which for low income communities and vulnerable populations can be particularly poignant and deleterious. Amidst accelerating climate risks, California needs to build capacity for strong and equitable recoveries, by focusing on low-income communities and communities of color, which experience higher rates of heat-related exposure and deaths[2,3], and greater damages from flooding.[4] If only some communities in California recover fully from climate impacts, the entire state will struggle moving forward.

Climate Insurance Working Group

The recommendations in this report were developed by the Climate Insurance Working Group, required by enacted legislation (Senate Bill 30, Lara, Chapter 614, Statues of 2018). The Climate Insurance Working Group was established in Section 12922.5 of the California Insurance Code in 2019. Pursuant to this law, the California Insurance Commissioner established this working group to examine issues related to climate change, resilience, and insurance. As a first step, the working group agreed upon the following mission for its work:

The mission of this working group is to identify, assess, and recommend risk transfer approaches to reduce the risks of climate change impacts including, but not limited to, insurance incentives that promote nature-based solutions.

The working group chose to focus on climate impacts from wildfire, extreme heat, and flooding because these are three of the largest threats facing the state, and responding to these perils has great potential to build resilience in the state. Drought was discussed but was not one of the initial points of focus. The working group met publicly eight times, often for all day meetings, from 2019 to 2021 to develop the recommendations contained in this report. In publishing this report, the working group acknowledges that further work needs to be completed and the group will continue to meet, both to refine ideas and learn from pilot projects, and also to address additional threats, such as drought.

The impacts and risks of climate change are many, and each issue deserves analysis. This report focuses on the physical and health impacts of climate change to individuals and communities, and ways to reduce or address those impacts, exploring the role of risk transfer tools in managing these risks to health, structures, and properties, as well as to the related financial stability of local governments and businesses. These topics and concepts respond to the legislative language that directed the establishment of the Climate Insurance Working Group. The report does not address transition risks related to investments by insurance companies, which are topics where the California Department of Insurance has multiple existing initiatives. Nor does this report address insurance claims handling, although this topic was addressed in recent legislation, sponsored by the Insurance Commissioner, that made changes to state statute (Assembly Bill 2756, Bloom and Limón, 2020; Senate Bill 872, Dodd, 2020) or litigation risks associated with climate change or some of the existing California laws that apply in the immediate aftermath of disasters, including short-term moratoria on non-renewals, such as those in existing state law (Senate Bill 824, Lara, 2018) that are implemented by the Insurance Commissioner. Those issues are deserving of analysis but were not within the scope of this report.

Wildfires

In just the last few years records have been set in number of acres burned, structures destroyed, people evacuated, and overall costs. This is not anomalous. As the wildland urban interface—areas in which development occurs within or adjacent to wildlands—continue to be developed, in conjunction with increased heat and drought, and the legacy from decades of severe fire suppression in forested areas, high severity wildfires will occur more frequently. The Fourth Climate Assessment found that, if greenhouse gas emissions continue to rise, the frequency of extreme wildfires will increase, and the average area burned statewide would grow by 77 percent by 2100.

A large percentage of homeowners and businesses have insurance coverage for wildfires through standard property insurance. But the wildfires of 2017-2020 revealed growing challenges in this market, smoke impacts to air quality, and substantial evacuations that strained households. Many homeowners and businesses have received insufficient payouts, straining their own financial security and raising concerns about underinsurance and uninsured losses. Simultaneously, insurers have made record payouts, raising concerns about the long-term sustainability of both homeowners and commercial insurance amid climate-intensified wildfires. In the face of such damage, and without effective risk mitigation, insurers may withdraw from offering insurance or raise premiums to levels that make policies unaffordable to those in high-risk areas throughout the state. This phenomenon is already observable in certain parts of California, where non-renewals of homeowners policies are increasing and premiums are rising, sometimes with over 100% increases, in areas vulnerable to wildfire while premiums have remained relatively stable in urban areas.

Many states have a publicly authorized insurance program that guarantees access to insurance for homeowners whose properties face so much risk that coverage is otherwise unavailable in the insurance market. Homeowners have increasingly turned to California's high risk pool, the expensive but available California FAIR Plan (Fair

Access to Insurance Requirements) in high wildfire-risk areas, with the number of policies jumping from 120,000 to nearly 200,000 between 2014 and 2019. While the FAIR plan is a useful backstop for homeowners, it does not address the underlying problem—the ballooning risks from the growing impacts of climate change.

Extreme heat
Heat waves cause direct harm, including deaths, and can worsen air quality and put communities at further public health risk, including asthma and other respiratory illnesses, particularly in communities that are already living in areas with poor air quality. In 2020, California experienced unprecedented temperatures and duration of heat waves across the state, creating heat spikes, especially in urban areas without substantial greenspace, an effect known as urban heat islands. The aptly named Death Valley recorded a temperature of 130 degrees Fahrenheit, reportedly the highest temperature ever measured on the planet. Such an expansive heat wave foreshadows the extreme heat projections of the Fourth Climate Assessment: higher peaks, longer durations, and high night-time temperatures that prevent daily recovery for communities, worsening health impacts.. The power grid was disrupted, thwarting cooling strategies and economic resilience. Going forward, the state is projected to experience even greater extremes of temperature that will stress impoverished communities and communities of color, agriculture, urban and rural workers, water availability, electric-grid performance, and transportation systems, among other things. Yet the economic disruptions and costs caused by heatwaves are very rarely insured. Without available insurance, unmet costs fall to communities and individuals.

Flooding
Without reduction in flooding risks and an increase in flood insurance uptate, the costs of flooding damages and rebuilding will continue to accumulate. The Fourth Climate Assessment projects escalating intensity of high precipitation storms, putting people and properties at risk of growing damages. The combined or successive impacts from pulses of heavy rainfall, faster snowmelt and rising rivers, and sea-level rise, put more communities, especially low-income communities, at increased risk of flooding.[5] Coastal communities are particularly vulnerable to sea-level rise, high tides, and coastal storms, threats that are expected to grow. As climate impacts grow, the potential for recovery is worrying. The uptake of flood insurance has been low: Of the 1.1 million homes with a relatively high risk of flooding (a 1% chance or higher per year), less than half have flood insurance policies. Areas with more moderate flood risks have even lower flood insurance uptake rates, indicating major gaps in insurance for flood risks.

Recommendations in this report

This report recommends that California follow a multidimensional approach to the threat of climate impacts, an approach that considers actions that can be taken from the top down, through direct government leadership, and from the bottom up, fostering disaster preparation, local risk reduction, and affordable insurance for communities and individuals. It will require overcoming common challenges to achieving strong disaster preparedness.[6] Where possible, the threats themselves, wildfire, extreme heat, and

flooding, must be approached in a cross-cutting way, so as not to exacerbate one risk with actions on another. In addition to grouping recommendations by risk assessment, risk communication, risk reduction, and risk transfer solutions, the recommendations fall into these themes:

- Hazard mapping and disclosure
- Land use and building codes
- Closing the protection gap
- Nature-based solutions
- Innovation with mitigation

RISK ASSESSMENT AND COMMUNICATION: EARLY-WARNING SYSTEMS, HAZARD MAPPING, AND DISCLOSURE

Widely-available risk information supports resilience. Decision-makers, including elected officials, home buyers, renters, and insurers, need access to information about climate risks and how they are changing. Therefore, building public understanding of risk and how to de-risk is fundamental. This report identifies opportunities to increase access to hazard mapping, models that project future catastrophic events, and other tools to better understand the risks of wildfires, extreme heat, and flooding, tools which will empower individuals, businesses, and communities to better prepare for and recover from catastrophic events. Although multiple public and private sector groups are providing weather and climate information, that information is often difficult for individuals to find and not easy for the public to understand. The Commission on Climate Adaptation argues that early warnings can enable preparations that save lives and reduce damages. This report recommends earlier disclosures, updates to hazard maps, and the ranking of heat waves.

The state needs to expand access to easy-to-understand information on climate risks as well as linking it to resilience-enhancing actions. California is fortunate to have significant in-state research capacity for providing this vital information in its prominent public and private universities, in conjunction with research organizations and government labs. In particular, publicly accessible and detailed information about the threats faced at specific locations, such as individual communities or small regions, will be especially valuable for enabling local governments, businesses, and individuals to make smart decisions about the future. This report recommends new tools to reduce future losses through public private partnerships and government investments. Lack of clear risk information leads to risky land use decisions and the establishment of developments that will be unprepared financially and structurally for the physical climate risks that are unfolding. Comprehensive risk information will also enable the state to invest in mitigation most effectively and oversee a sustainable insurance marketplace.

RISK REDUCTION: LAND-USE AND BUILDING PRACTICES

Where and how we build and rebuild matters. The clearest path to reducing future losses—which also leads to lower insurance costs—is building better. Affordability

increases when risks are reduced. For too long, development has moved more people and homes into areas at higher risks in the absence of strong building and zoning codes and accurate hazard mapping; this will not solve the state's long-term affordable and equitable housing challenges. Climate impacts can put a family's largest asset at risk. Insurance premiums in those areas can climb to unaffordable levels as risks accelerate. Some homeowners may find themselves with only one option, the FAIR Plan, as insurance companies stop offering certain coverages.

Solving these problems will require lasting partnerships across the public and private sectors and require multiple tools to improve risk reduction. This report includes recommendations for stronger building codes for new construction, in moderate and high-risk areas. In addition, when a home or community is rebuilt after disaster, there is an opportunity to design and build a more insurable property and in aggregate, a more climate-resilient community. Furthermore, these smart adaptation measures need to be balanced by consideration of ways to avoid displacement of communities and state investments are needed to bolster resiliency.

Given the magnitude of this challenge, risk reduction should be incentivized by the state through an overarching state resilience strategy, by local governments through adoption of a broader and stronger building code—including through the incorporation of risk reduction measures in permitting and planning of developments and programs for relocation post-disaster—and by insurance companies through insurance pricing systems that reflect risk reduction measures.

The state's role is vital, since deferring decisions to local governments when the risks are statewide creates patchworks of risk mitigation and local building practices that increase exposure to adjoining communities, as well as volatility in emergency response costs, which wreaks havoc with budgeting. When disasters are severe, local governments have substantial unmet costs and uncertainty in future tax revenues leaving those governments vulnerable. This report recommends actions that the state can take to achieve better land use decision-making, including actions to require more effective recovery planning and risk reduction moving forward.

RISK REDUCTION: NATURE-BASED SOLUTIONS

Investments in natural infrastructure like wetlands urban forests, and ecological forest strategies can reduce damages to health and structures. This report identifies opportunities to link insurance and the mitigation benefits of natural infrastructure, promoting policy development that could recognize nature-based solutions and make insurance and recovery more affordable. Wetlands, for example, can buffer floodwaters to reduce flooding, dunes can absorb storm surges, and green spaces in cities can reduce urban heat islands. Prescribed burn programs and other proactive ecological management of forests can better protect forested communities against the long-term threat of high-severity wildfire. Avoided future losses are important for safety and have tangible economic benefits, including reduced insurance costs for households and businesses. The working group examined ways to recognize those cost-savings through incentives, and considered examples of nature-based solutions for wildfire in the Sierra

Nevada, flooding in the lowlands of Louisiana, and coastal ecosystem insurance concepts. Investments in risk reduction, both in a home and in the surrounding area will reduce costs to households over time.

In addition, the benefits from enhancing natural systems to provide protection go far beyond just the risk reduction. Those benefits include better wildlife habitats, more recreation opportunities, increased carbon sequestration, cleaner air and water, protection of biodiversity, and improved aesthetics. A recent report by the Paulsen Institute, The Nature Conservancy, and researchers from Cornell University advocates a major increase in financing ecosystem restoration as a strategy to promote economic and natural resilience,[7] including investments in nature-based solutions.[8]

One study showed that the coastal wetlands in the northeastern US avoided as much as $625 million in direct flood damages from Superstorm Sandy.[9] The study also showed an estimated average reduction of 16% in annual flood losses by salt marshes; areas at lower elevations showed higher reductions. The challenge, though, is that nature-based investments require additional funding on top of existing state and local budgets. Risk transfer mechanisms, such as insurance or risk pooling, can supplement existing insurance policies and increase investments in nature-based solutions by shifting the abrupt burden of future financial losses away from governments or communities making these investments. Nature-based insurance solutions can also secure funding for restoring natural infrastructure after a disaster without the local government needing to find unexpected additional funding at a time of likely economic strain. This quick funding is crucial to begin restoration immediately, when it is most needed and effective. Among several recommendations to address the funding shortfall, this report recommends establishing new climate hazard abatement districts and developing pilot projects that focus on nature-based solutions at the community scale. Public-private partnerships can leverage local and state dollars and diversify the risks to both communities and natural assets. This report recommends broader investment in nature-based insurance and the development of specific pilot projects that could leverage risk science to link investments in nature to premium savings.

RISK TRANSFER SOLUTIONS: CLOSING THE PROTECTION GAP

To improve the financial resilience necessary for coping with climate change, California should make a priority of closing the disaster insurance gap. Affordability improves when risks can be reduced. Accelerating climate risks threaten insurance affordability and availability. As a result, certain homes in California may be initially affordable to purchase, but are unaffordable to insure. A wide protection gap makes it more difficult for people and governments to recover. Those with insurance tend to recover faster from wildfires, floods, and other disasters.[10] A review of disaster recovery case studies indicates that insurance uptake speeds economic and social recovery of communities.[11] Government financial responses, while important, have historically been slow and incomplete. As a result, if households, businesses, and communities are uninsured or underinsured and reliant on federal relief, then the rebuilding process can be slow and challenging, exacerbating existing inequalities. Every disaster has the potential for significant long-term impacts and backsliding from climate goals if costs overwhelm

governments. Uninsured disasters have significant opportunity costs as well as physical costs, because large amounts of public dollars need to be spent on evacuations, debris removal, emergency responses, temporary housing, and other immediate responses. With disaster losses continuing to accumulate, it will be difficult to maintain public funding for pre-disaster risk reduction and abatement of emissions, and to maintain sustained support for nature-based projects that reduce long-term risks.

Broadly available insurance can help solve these problems. If a high percentage of the total costs are insured, and funds are quickly distributed to claimants, a community can move forward to rebuild rapidly, easing the pain and limiting the devastation of climate-related catastrophes. Unfortunately, too few California residents are fully insured against extreme climate events. Insufficient insurance coverage means that residents must turn to private individual savings or to credit to pay for damage, or rely on community or state-sponsored safety nets, which typically provide assistance with immediate needs but not necessarily long-term recovery expenses. The protection gap is usually largest in communities with lower incomes and fewer resources. As the destruction from climate-related disasters mounts, the lack of strong insurance coverage will make it increasingly difficult for communities to rebuild stronger, or even at all, touching off a vicious cycle of economic vulnerability and decline. Hardest hit will be the most vulnerable, exacerbating already-growing social and financial inequalities.

One strategy for making insurance more affordable is to reduce the risks that homeowners, renters, and communities face. Investments in resilience can avert at least some future losses, lowering rebuilding costs for both individuals and insurance companies, creating a positive feedback loop towards more affordable insurance and greater resiliency. This report underscores the rationale that if California can reduce vulnerabilities by retrofitting homes, fortifying communities, and reducing landscape-scale threats, those actions could reduce insurance costs and thus help close the protection gap. This report also recommends that California should consider how to implement a basic level of disaster insurance coverage for lower-income residents, which would help to make every individual more resilient and serve as an instrument to build the strength of entire communities.

RISK TRANSFER SOLUTIONS: INNOVATION WITH MITIGATION

Innovative risk transfer concepts can expand insurance access. Even with stronger buildings and investments in resilience, threats to structures, businesses, and governments remain and will impact communities. This report recommends innovative pilot projects and some of the first insurance concepts to address extreme heat. *Parametric insurance policies* are one innovative option.[12] While not a replacement for indemnity-based homeowners coverage, they can improve resilience by providing funds for unexpected disaster costs, such as evacuation, and by helping state and local governments fund their own recoveries, including disrupted tax revenues and infrastructure rebuilding. Another innovative option is to insure *entire communities* for a particular peril to guarantee that all residents have some degree of coverage.[13] Community-level insurance not only pools the shared risks of the community, but can also be used to provide financial incentives for community-wide investments in risk

reduction, especially nature-based solutions. *Nature-based insurance solutions* are a third theme of innovation, taking a communally owned asset, identifying insurable value, and using parametric insurance to increase its resilience. Insurance mechanisms that act earlier, providing incentives or even anticipatory funds to reduce the ultimate impact of a disaster, could strengthen resilience and encourage early investments in resilience across public and private actors.

This report recommends bolstering climate disaster financing by developing innovative insurance products and public-private partnerships, including expanded use of parametric insurance, community-level insurance, and other risk transfer tools. Innovative ideas for applying those strategies to impacts from extreme heat would test a new frontier for insurance. Advancing pilot projects could be a needed first step to speed policy development, especially for risks where insurance is uncommon. This report recommends a catalyst role for the Insurance Commissioner, including initiation of collaborative pilot projects to accelerate insurance policy development to match the acceleration of climate risk impacts. The Insurance Commissioner has an important role to play in making insurance options understandable to communities in the face of climate threats. For insurance to remain an important tool, the costs and benefits have to be well understood and trusted.

CONCLUSION

This report is a first step to improved community readiness and resilience , and is not a comprehensive overhaul of all needed policies. This report is an effort to test and develop mechanisms that improve conditions for communities impacted by climate change, with the intent to scale. Therefore, many of the ideas are complex and will require refinement and added detail for implementation. The threats addressed in this report are not the only threats California faces. Additional threats, such as drought, heavy snowfall, and extreme cold events, will require additional work but can build on the backbone provided in this report.

Box: Nature-based Insurance Solutions. *Existing natural infrastructure provides measurable protection to communities around the world. Coral reefs protect against tidal surges and provide economic benefits through tourism and fishing activities. Mangroves reduce the impacts of tidal surges, capture carbon and provide economic benefits for local fishing communities. Forests capture carbon, protect wildlife ecosystems, provide economic and recreational services. Insurance can protect existing natural infrastructure and nature-based solutions can make insurance for homes and businesses more available and affordable by decreasing risks.*

Box: Renters insurance

The recommendations in this report emphasize the importance of renters insurance , including issues related to potentially more expensive housing after disasters. Renters insurance is less common than homeowners insurance, and this protection gap is addressed several places in this report. First, the uptake of renters insurance is an important piece of future community resilience. Although renters may not own a structure, their possessions, ability to evacuate, and capacity to recover could be

improved by public or private disaster resilience strategies, including resilience. In addition, risk disclosures and mitigation information needs to be communicated to renters, which may require different strategies than communication with homeowners. When a disaster occurs, renters must find additional housing, often times more expensive than the impacted housing. The following recommendations raise the importance of renters insurance, including issues related to potentially more expensive housing, replacement of possessions, ability to evacuate safely, and how to avoid permanent displacement of renters after a disaster.

Box: Insurance as a tool for more equitable recovery. *Closing the insurance protection gap will be essential to supporting more equitable recoveries when future disasters strike. Climate-intensified disasters will repeatedly stress the state, and have the potential to exacerbate existing inequity. Extreme heat is particularly demonstrative. A study from neighborhoods that were subject to historic redlining in the US including over 100 cities show patterns of higher land surface temperatures in formerly redlined areas, indicating racial inequities, especially for Black communities, in extreme heat exposure. In California, exposure to urban-heat-island impacts is higher in Black and Latino neighborhoods than white neighborhoods, as is exposure to air pollution. Fewer Black and Latino households have access to air conditioning or the tree canopies of local parks or urban forests, each of which can mitigate temperature shocks during heat waves. Many low-income communities already pay a disproportionate percentage of their income for energy, and may not be able to afford using air conditioning, or pay for water to cope with hot weather. Moreover, examples from past natural catastrophes show disparate impacts in mortalities and damages.*

- *Black communities saw disproportionate mortality rates in the 1995 heat waves in Chicago.*[14]
- *During the summer heat waves in France in 2019, elderly individuals made up more than half of deaths, and in Quebec in 2018, heat-wave deaths were disproportionate towards isolated, older individuals.* [15]
- *Flooding has had a disproportionate impact on low-income communities and communities of color.*
- *For climate impacts where evacuation is essential, LGBTQ+ individuals, socially isolated individuals and those with disabilities, among others, may face additional barriers to safely evacuating or receiving early warning communication.*

Actions taken to reduce risk and increase insurance options could promote more inclusive recovery from disasters. For example, even though roughly half of California households rent their home, renters insurance is far less common than homeowners insurance, putting renters at risk to losing their possessions and not being able to rebuild their lives after a wildfire or flood or other climate-intensified event. In California, similar to many areas in the US, homeownership is less common for Black and Latino households. In data from 2014, over 60% of white and over 50% of Asian Californians owned their homes, while 35% of Black households and 42% of Hispanic households were homeowners. Moreover, uptake of certain insurance coverages, such as flood insurance, demonstrate racial differences, and households without insurance are less likely to rebuild at all. Black homeowners were less likely than white

homeowners to have homeowners insurance in the aftermath of Hurricane Andrew in Florida (1992).[16] Therefore, closing the protection gap for insurance will strengthen the equity of recoveries in the face of future climate impacts by providing more households with recovery funds when disasters occur.

Box: California Fourth Climate Assessment. *A fundamental resource for the present Climate Insurance Working Group Report is the California Fourth Climate Assessment. Since 2006, California has undertaken four comprehensive climate change assessments, designed to assess the impacts and risks from climate change and to identify potential solutions to inform policy actions. The Climate Change Assessments contribute to the scientific foundation for understanding climate-related vulnerability at the local scale and informing resilience actions. They directly inform State policies, plans, programs, and guidance to promote effective and integrated action to safeguard California from climate change. (About the Assessment - California Climate Change Assessment)*

At a national level, the U.S. Global Research Program is required by law to deliver a report to Congress and the President every four years that analyzes the current and projected effects of climate change on the United States. To date, four National Climate Assessments have been completed. The Fourth National Climate Assessment, published in 2017, is comprised of two volumes. The first analyzes how climate change is affecting the physical earth system across the United States and projects major trends and changes in temperature, precipitation, sea-level rise, and other climate outcomes. The second volume examines effects on human welfare, society, and the environment and provides examples of actions underway across the country to reduce risks associated with climate change, increase resilience, and improve livelihoods.

The Fourth Climate Assessment is comprised of dozens of chapters, including the changing climate; water; energy; land use; forests; ecosystems; coastal effects; marine and ocean effects; agriculture; the built environment, urban systems, and cities; transportation; air quality; human health; indigenous peoples and tribes; international concerns; sector interactions; adaptation measures; and mitigation opportunities. It also contains several regional chapters.

Box: *Urban heat island effect*
The US Environmental Protection Agency defines Heat islands as urbanized areas that experience higher temperatures than nearby outlying areas, with higher daytime and nighttime temperatures. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. The California Environmental Protection Agency notes that Heat islands are created by a combination of heat-absorptive surfaces (such as dark pavement and roofing), heat-generating activities (such as engines and generators), and the absence of vegetation (which provides evaporative cooling). Urban areas, where structures are more concentrated and where parks and tree canopy is often limited, become "islands" of higher temperatures relative to outlying areas.

FULL REPORT

WORKING GROUP BACKGROUND

The Climate Insurance Working Group was convened by Insurance Commissioner Ricardo Lara, implementing Section 12922.5 of the California Insurance Code (Chapter 614, Statutes of 2018).[17] The Honorable Alice Hill and Dr. Carolyn Kousky were appointed Chair and Vice Chair, respectively. The first meeting took place on September 10, 2019, with subsequent daylong meetings in November 2019 and February, May, July, August, and June 2021. Meetings began in September 2019 are accessible to the public, and meeting minutes and reference documents are posted to the Climate Insurance Working Group website after each meeting.[18]

After initial discussions, the Climate Insurance Working Group developed the following mission statement: *The mission of this working group is to identify, assess, and recommend risk transfer approaches to reduce the risks of climate change impacts including, but not limited to insurance incentives that promote nature-based solutions.* Further, the working group decided to split into three subgroups to concentrate their efforts on 1) wildfire, 2) extreme heat events, and 3) flooding, including storms and sea-level rise. In addition, the members developed a plan to provide recommendations in a report and identified core questions that each group should consider to link the groups together. Contributing members to each of the subgroups are listed in Appendix 2. The views expressed in the report and the recommendations represent the collaborative effort of the working group as a whole and do not necessarily present the views or recommendations of any individual working group member. The working group reached consensus on the recommendations.

At subsequent meetings, the working group examined and discussed existing examples of risk transfer mechanisms, California local government climate-risk-planning laws, and additional materials to develop proposals, recommendations, building codes, nature-based risk reduction solutions, and actions that align with the mission statement.

TABLE OF CONTENTS

INTRODUCTION

Many of the most vulnerable communities in California are projected to face the most destructive consequences of climate risk impacts.[19] If California does not make significant progress on risk management, climate change impacts will exacerbate existing inequities. This report relies on California's existing codified definition for vulnerable communities (Public Resources Code 71340 (d))[20], and may be further refined as additional information is gathered related to specific perils. When a disaster occurs, the magnitude and speed of financial response can be crucial to recovery.[21] Yet, disaster aid can often be limited and delayed. Such a gap hurts the most vulnerable, those without a robust financial backstop. Access to adequate insurance is critical but becoming more costly. Without insurance, the financial costs of climate impacts will fall hardest on vulnerable individuals and on local jurisdictions that struggle to preserve stable funding for recovery.

Expanding insurance coverage to areas where it does not exist is therefore important for equitable climate resilience. In the existing insurance marketplace, insurance protection is common for some scenarios, such as wildfire impacts to homes, and not others. For example, insurance policies for extreme heat impacts are uncommon and insurance for flooding has low uptake, even as the National Flood Insurance Program is available through the federal government, which leaves communities more vulnerable than one might expect at first glance. Research shows that both past lack of insurance availability[22] and redlining contributed to low-income communities being concentrated high risk areas and that legacy continues to create disparate impacts.

Building climate resilience requires both reducing risks and building the capacity to recover. The best long-term resilience strategy is a dramatic reduction in the emissions that cause climate change. Yet even if we are able to quickly move to a low-carbon economy, past emissions have already locked in rising temperatures for the foreseeable future, and we need to seize every opportunity to adapt to and bounce back from climate-intensified events. The insurance sector is central to both sides of resilience: it is a tool for incentives to reduce physical climate risks and drive behavioral change, and a contributor to economic recovery. The strength of insurance coverage is therefore crucial, especially for vulnerable communities. Research shows households and communities with strong insurance uptake recover more quickly and more completely after facing catastrophes, helping to preserve economic health and stability.[23, 24]

The COVID-19 pandemic has provided a sobering backdrop for this report, tragically underscoring many of the existing vulnerabilities and inequities of people and communities. Similar to climate risks, COVID-19 has revealed that existing planning and programs are much more accustomed to respond to immediate, tangible local risks, and consistently struggle to anticipate and respond to global risks. This pandemic has disrupted supply chains and complicated emergency responses, firefighting, evacuations, and medical care. It increases economic vulnerabilities and reduces rebuilding capacities; furthermore, it doubly impacts those who are already financially fragile. As we write this, although California and many economies have largely reopened, the future effects and consequences of the pandemic remain unknown.

This is a report about how we empower the public and all stakeholders with risk science, invest more in pre-disaster assessment and risk reduction, and foster insurance markets that support a strong rebuilding process. Public and private opportunities to advance climate adaptation exist yet need stronger coordination and innovation. This report focuses on four key essential elements (*Figure 1*) of risk management—risk assessment, risk communication, risk reduction, and risk transfer–to arrive at an extensive set of recommendations, including roles for state and local governments, the insurance sector, the public, and the Insurance Commissioner. State government is unlikely to be able to do this alone. It needs the complementary and reinforcing actions from federal and local counterparts, from homeowners and the general public, and from private sector players, including from the insurance and reinsurance industry.

Assess risk

An understanding of climate threats, vulnerabilities, and impacts requires a robust foundation of risk assessments. This understanding can then guide decisions about risk reduction, as well as underpin the design and pricing of insurance and other risk transfer instruments. In the absence of robust risk assessments, determining which approaches to prioritize remains a challenge. Such risk assessments must include forward-looking analyses of how hazards are evolving in light of climate change and where there are opportunities for nature-based risk reduction.

Improve risk communication

Once a strong risk assessment is in place, that information must be widely shared with all decision-makers. Markets are only efficient with full information, and individuals can only make optimal decisions when they are aware of the risks associated with their choices. Risk communication is necessary to support pre-disaster mitigation of risk. If communities can reduce or even avoid damage from future disaster events, then recovery costs become more manageable, much suffering is avoided, and future insurance costs are lowered. This is the positive feedback loop that, under the best cases, risk communication facilitates. Without accurate information about risk—including maps, robust and publicly available models, broadly available disclosure information, and collection of home-attribute data—understanding risk becomes much more difficult. Prioritizing risk communication with the vulnerable populations in mind also attempts to build equity. Understanding the burdens of recovery is also an important component of risk communication, as individuals and local municipalities can make

more resilient decisions if the opportunities and limitations of federal or state backstops are more clear.

Reduce risk

Pre-disaster risk mitigation can be cost-effective and avoids tragic losses. Public policy in the area of risk reduction, however, remains fragmented and misaligned. Risk reduction to address the growing threats from climate change requires large-scale adjustments that will provide systemic and effective incentives to (1) reduce risk for individual properties through improved building practices, (2) reduce risk at a community level through local to regional level mitigation investments, and (3) harness nature-based approaches where feasible to lower losses. To ensure a stable insurance market in the long term, communities must accelerate their investments in and their understanding of all three approaches. Public policy—including public investment priorities, building codes, regulations surrounding insurance pricing, and publicly created and distributed risk information–should reward and push homeowners and communities towards cost-effective approaches to lower risk. In addition, resiliency planning by local, state, and federal governments is crucial.

Transfer Risk

Resilience is not just about prevention but also about improving the ability to recover. Insurance availability and affordability is central to post-disaster financial resilience, since it guarantees funding for repairs and rebuilding. Closing the protection gap by increasing insurance coverage will spread the risk of disaster events. It has multiple benefits, including strengthening the backstops throughout society, reducing the exacerbation of inequality, accelerating repair and recovery, and preventing backsliding in restoring ecosystems. For example, after a wildfire, if insurance companies reimburse most costs, individuals and businesses have access to funds quickly and can begin to rebuild their lives. Fewer public funds are diverted to the disaster recovery, thus making it possible to support more long-term projects aimed at major public benefits, such as the restoration of local parks. As climate change impacts intensify, as they are projected to do, risk transfer will likely become an even more important tool to protect communities. Insurance also serves as a social safety net for financially vulnerable individuals. Since the Federal Reserve reported in 2020 that 37% of American have less than $400 in savings, having insurance to weather shocks and stressors is critical for marginalized populations.[25]

Box: *How to read this report.* As a guide to reading this report, this introduction is followed by four chapters of recommendations: recommendations that cut across all three of our examined perils, wildfire recommendations, extreme heat recommendations, and flooding recommendations. Each chapter is organized into the four essential elements (risk assessment, risk communication, risk reduction, and risk transfer), and provides specific recommendations for the Insurance Commissioner, for the legislative and executive branches in California, for local government, and for the private sector, including the insurance industry. Each individual recommendation includes both *the motivation* for the recommendation, and *the recommendation* itself. Finally, the report concludes with short- and long-term priorities for the Insurance

Commissioner, state and local governments, and the insurance sector. These recommendations will continue to be refined as the group continues to work and learn.

Box: Insurance related terms. This report uses the terms risk, hazard, exposure, and peril. **Risk** refers to the ultimate impact arising from multiple factors, including the intensity of a hazard, as well as the vulnerability and value of the structure or community. **Hazard** describes the probabilities of occurrence and severity of a particular **peril**, such as wildfire, flooding, or extreme heat, at a given time and place.

Box: *Climate vulnerability describes the degree to which natural, built, and human systems are at risk of exposure to climate change impacts. Vulnerable communities experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts. These disproportionate effects are caused by physical (built and environmental), social, political, and/ or economic factor(s), which are exacerbated by climate impacts. These factors include, but are not limited to, race, class, sexual orientation and identification, national origin, and income inequality.*

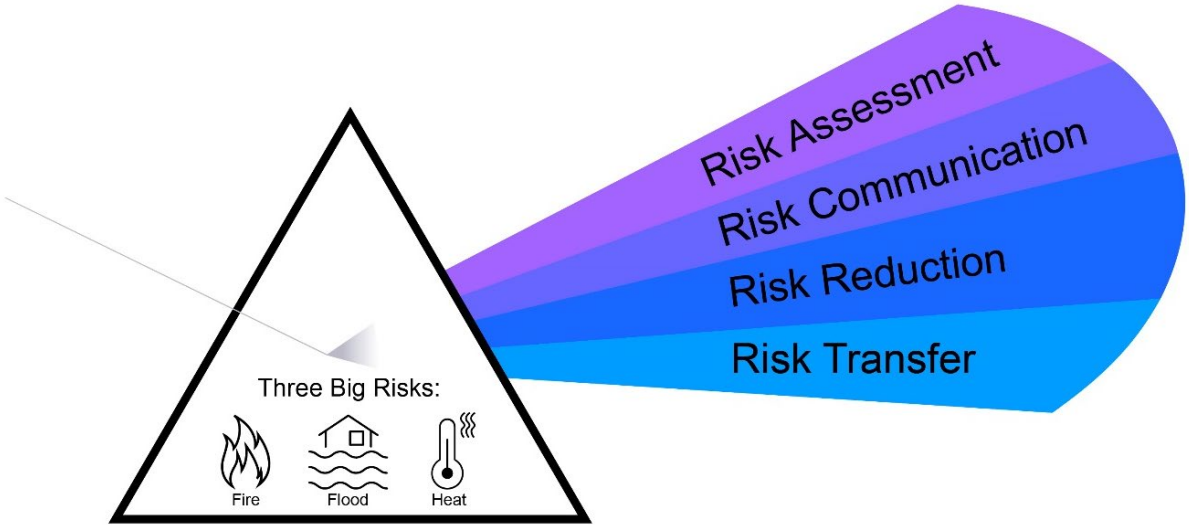

Figure 1. Four elements that provide a consistent framework throughout this report for considering risk and policy alternatives.

PART 1: CROSS CUTTING RECOMMENDATIONS

Assess the Risk

Even as the impacts of climate change grow, many local communities are unaware of the nature of the accelerating risks in their locality. Understandable climate risk information is therefore imperative for governments, communities, businesses, and individuals. That information can inform decisions critical to the future resilience of

Californians, including decisions regarding land use, disaster risk reduction strategies, and the development of climate-resilient communities with access to the protection provided by insurance. Public and private sectors require strong and accessible risk science tools to guide investments in nature, homes, and infrastructure. Such tools are most useful when they are understandable to the public and insurers alike, and can identify where risks are greatest or more moderate, and what measures can reduce risks.

Ability to assess risk makes early warning systems more effective. The National Weather Service warns the public when possible in advance of extreme weather events. But by the time such an event is about to strike, mitigation measures and options are limited. That is why effective risk assessment far in advance of a catastrophe is essential, empowering individuals, governments, and insurance companies to plan ahead, and become more resilient.

Cross-cutting *Recommendation* 1 *Develop a publicly available mitigation model that can be used by local governments and state mitigation investments*

Motivation: Risk reduction is essential for wildfire, heat, and flooding. For example, more than 25 million acres of California wildlands are classified as under very high or extreme fire threat, and approximately one in four residential structures are located within or near high or very high fire hazard severity zones identified by CAL FIRE. However, the current fire hazard severity maps developed by CAL FIRE do not define risk or measure the mitigation activities that improve community resilience. A public mitigation model could increase understanding of community and parcel-level actions could accelerate mitigation at homes and in neighborhoods. One successful example can be found in Colorado, where a parcel-based risk model is used to inform homeowners about relative risk in different locations and specific actions they can take to reduce wildfire risk.[26] If California had such a mitigation model, it would help local communities understand their wildfire risk and reduce it. Furthermore, such a model may be able to also consider flooding and heat risks, enabling local governments to plan for multiple climate risks as at once. Planning for cool roofs, tree canopy, and water retention in an integrative way will be most effective for reducing risks to people.

Recommendation: To identify and optimize mitigation priorities and community nature based investments, the Insurance Commissioner should convene a task force of public and private partners to establish a publicly available mitigation model that identifies areas for optimal mitigation investments, including nature-based strategies, and recommends how the state can provide incentives or requirements for its use by local governments. In particular, publicly available risk information could also strengthen planning to assist vulnerable populations, such as those with disabilities or elderly populations, who may have more difficulty during evacuations. FEMA's Building Resilience Infrastructure and Communities (BRIC) program may be crucial to funding the resulting mitigation investments and empower local communities to develop mitigation ideas for their specific area, therefore partnership with the Governor's Administration, including CalOES, would be essential.

Cross-cutting 2 *Consider the advantages and disadvantages of utilizing catastrophic modeling in the Department's programs and processes*

Motivation: Commissioner Lara has held two public meetings related to wildfire risks and mitigation actions, laying out specific questions to be investigated, including: How – if at all – would the use of catastrophe modeling in ratemaking help to make homeowners' insurance more affordable and more widely available to homeowners? Insurance pricing should continue to reflect the changing nature of risk so that Californians can make better-informed decisions about where to live, what measures to take to better protect themselves where they live, and how to financially plan for a future of climate-related risks. On one hand, historical losses do not directly account for the growing risk caused by climate change or direct mitigation measures by homeowners and communities, and only react to losses after they occur. On the other hand, modeling could decrease affordability for consumers and policyholders and use of modeling includes transparency concerns. Overall, modeling could inform the public on ways to optimize risk reduction strategies, including nature-based solutions, thereby reinforcing an emphasis on building resilience and limiting insurance market disruptions.

Recommendation: The Insurance Commissioner has been focusing public attention on wildfire risks through public meetings in 2020[27]. Consistent with that approach, the Commissioner should continue to convene public meetings and discussions, examining existing departmental approaches, and comparing those that rely on past loss experience to the potential application of catastrophic models, giving the Commissioner and the public an opportunity to discuss and assess this policy tool. The topics would include, but would not be limited to, the reliability of scientific tools to model future wildfire losses, including probabilistic wildfire models that incorporate atmospheric and environmental science; vegetation, topography, and wind data; geographic location and proximity of structures to the Wildland Urban Interface; and the impact of parcel-level mitigation (including defensible space and home hardening) as well as community-based risk reduction. In doing so, the Insurance Commissioner should assess how wildfire mitigation measures, including ecological forest management and prescribed burns, community buffers, and home hardening, are integrated into catastrophe models.

Where possible, catastrophe models should include the mitigating impact of nature-based solutions. Where the science does not exist to make this possible, the Insurance Commissioner should identify gaps and support research efforts to fill them. For example, the risk reduction power of wetland restoration, ecological forest management including prescribed burns, and community wildfire mitigation should be included in models. This issue is particularly acute in the area of wildfire (*see box*).

The Insurance Commissioner's continued approach to public meetings could provide an opportunity for Californians to discuss policy implications and for the Insurance Commissioner to assess and consider how to address important regulatory questions, including but not limited to, data transparency, public understanding of catastrophic modeling approaches, consideration of trade secrets, and model evaluation by public expert panels, as well as questions related to model accuracy, precision, and validation. Public understanding of complex tools will support decision-making about the

application of such tools. Expert input and public discussion could foster understanding of how the Department currently approaches models used by insurance companies in select rate filings for certain risks, such as the fires that may result from an earthquake, and the use of catastrophic models for monitoring insurer solvency or use by the California FAIR Plan in projecting future losses, among other applications of predictive modeling.

<u>Box:</u> Wildfire Catastrophe Models

Wildfire risk is one example of the broader challenge facing regulators when making policy choices. One factor that affects insurance pricing is whether there is an estimate of the costs that catastrophes will add, to smooth the impacts of those catastrophes over time. Proposition 103 vests sole authority in the Insurance Commissioner to limit how insurance companies calculate insurance rates so that the rates charged are not excessive, inadequate, or unfairly discriminatory. Currently, California employs a system of using the actual loss history. One alternative could be using the projections from catastrophe models. Catastrophe models for wildfire are not currently allowed by the Department of Insurance for projecting future losses in the calculations that govern insurance rates. Use of models over the existing process raises questions for insurance affordability and transparency. On the other hand such tools could be a better assessment of risk and allow for further integration of risk reduction actions with insurance pricing.

Risk Communication

Hazard mapping and disclosure

Two cross-cutting themes of risk communication are hazard mapping and disclosure. For wildfire, California has state-developed hazard maps that delineate moderate, high, and very high-risk areas in some but not all areas. There are flood maps for the state from the Federal Emergency Management Agency (FEMA) that depict areas with at least a 1% annual chance of flooding. Yet all these maps are incomplete and do not include future risk worsened by climate change and potential development patterns. Gaps in the existing hazard maps create loopholes in public policies, such as where building codes are required by state law or how local governments approve new developments. Without public information, only those with financial resources in the private sector, including insurance companies, will have access to hazard information, creating an imbalance with the public at large. However, the state should also consider the unintended consequences, particularly related to inequitable displacement of residents after disasters. Strengthening community resilience should address the potential for displacement. Better risk communication and mitigation can reduce abrupt displacement, and California has existing climate programs, including the Transformative Climate Communities program, which can inform broader risk reduction policies.

Timely climate risk disclosure could drive more informed market-based decisions in the housing market, and this report makes recommendations for making disclosures more effective. For many people, their greatest asset is their home. California has existing

disclosure laws for flood and wildfire, whereby sellers of property need to disclose to potential buyers information on the hazards facing the property if that property is in a high-risk zone for wildfires or floods. The state's disclosure laws also apply to all leases and rental agreements for residential property. While California thus has fairly comprehensive disclosure, there is room for improvement in providing information on prior flood events, and also risk outside the 100-year floodplain. In addition, risk information should be provided sufficiently early in the homebuying process to allow for reasonable decision-making by all parties.

The private sector has begun to address some of these issues. As of 2020, Realtor.com has listed flood risk information beyond the FEMA Special Flood Hazard Areas (SFHA) at the point of listing, which allows potential buyers to understand some aspects of their flood risk in advance of putting an offer on a home.

Cross Cutting 3 *Providing the public with a common risk resource to prepare for climate impacts*

Motivation: In the long-term, public risk understanding for multiple climate perils will help people reduce or avoid climate impacts. Without public access to risk information, only those individuals with substantial resources will have the information they need to avoid high risk areas. Hazard maps, models of physical risk, and available disclosures should be easily accessible to all people and decision-makers, and California can make these tools easier to use. The National Weather Service synthesizes vast information and provides actionable weather information, most notably for events with the potential to cause disasters, that is broadly available to the public. This information assists preparation but does not communicate underlying hazard information. With similar urgency to public forecasts of weather events, California should approach up-dating hazard maps and other risk tools to make risk more understandable to the public. Without such an effort, climate hazard information will only be available to those who purchase private analyses. One useful model is Pinellas County, Florida, which has an online one-stop tool for information on flooding risks, including disclosures and certifications, as well as hazard maps.[28]

California has existing tools (e.g., "*myhazard*" mapping tool, Cal-Adapt climate projection tool, and urban heat index) that could become the foundation for a user-friendly, one-stop shop of risk information for the public. The existing "*myhazard*" tool has an overlaid map with 100-year flood maps, earthquake maps, and very high wildfire hazard designations—all in one place. However, this tool considers only the highest risk zones and uses existing hazard maps, which do not effectively reflect the threats of climate change. Without a robust and integrated cross-peril approach, Californians may unintentionally move away from high wildfire risk and into moderately high flood risk or extreme heat areas. A one-stop shop for climate risk information can help homeowners optimize investments in retrofits and risk reduction measures and help communities get on a path to stronger resilience. Such a hub could also strengthen understanding between the public and insurance companies, which use probabilistic models for underwriting decisions, thereby encouraging decision-making that considers future insurability of communities.

Recommendation: The Insurance Commissioner should encourage a one-stop approach to hazard communication by working with other state agencies to create a publicly accessible, web-based repository for 1) publicly available hazard maps, whether generated by the state or a private entity, 2) disclosures, and 3) heat-related tools. This is an opportunity for intra-agency collaboration, especially between the Department of Insurance and CalOES to promote insurance accessibility and affordability. With such a system, property owners, business owners, or renters could enter their addresses and find links to the most recent hazard maps, output from publicly available catastrophe or risk models, and climate hazard disclosures. The effort could leverage the research and development already done by California universities regarding state climate risk. In addition, the Governor's Office of Planning and Research should develop an overall resilience risk rating system based on wildfire, flooding, extreme heat, and earthquake risks to be included in the one-stop resource. As the resources are developed, they should be assessed for unintended consequences.

Cross-cutting 4 *Improve hazard maps to inform decisions*

Motivation: When hazard maps are incomplete, or risks have changed since their completion, people do not have the information they need to make safer climate-related decisions, and existing zoning and building codes will be misaligned with the level of risk. People need access to information to decide whether to live in an area and communities need to know whether to build in an area. At a local level, this information can improve preparations and community health. Without public information, only those with financial resources in the private sector, including insurance companies, will have access to hazard information, creating an imbalance with the public at large.

Recommendation: Existing wildfire and flooding maps need to be updated more frequently, include all areas of California, and be available in the one-stop shop described in Cross-Cutting Recommendation 3. Heat tools need to be improved, such as in Extreme Heat Recommendation 2 and 3. These maps have to better reflect current and projected risks, especially in the areas of moderate to moderate-high risk for California to become more resilient. Additional details regarding the hazard maps for specific perils are found in the wildfire and flooding sections.

Cross-cutting 5 *Require climate risk education for professionals in real estate*

Motivation: Home buyers rely on realtors to highlight important information about prospective homes. Climate impact information will be better utilized and more widely understood if real estate agents, appraisers, assessors, and insurance brokers understand the information and can help their clients interpret the information early in the process and take action accordingly. Pinellas County in Florida is attempting to improve risk education for real estate professionals related to flooding risks.[29] In the Pinellas County program, flooding information is located in an easy-to-access place for real estate agents, and a brochure is available for agents to provide flood information to prospective buyers. Training classes were developed by the county, and are available for

agents to learn about flooding risks and tools, such as a GIS mapping app for the county, and the program is administered by the county.

Recommendation: The State Legislature should establish a statewide requirement for initial education and continuing education in climate impacts for real estate agents, assessors, and insurance agents who interact with home buyers and sellers. The details of implementation would need to be developed and would include multiple state agencies to administer and enforce this requirement. Real estate agents should be further required to share the one-stop climate risk website in Cross Cutting Recommendation 3 with prospective buyers of property prior to that buyer placing an offer.

Cross-cutting 6 *Promote earlier risk disclosures for homes*

Motivation: California is one of only two states in the US with disclosures related to wildfires. However, these disclosures can be improved. Disclosure information often comes too late in the process to effectively inform potential buyers of climate risks. The ideal risk communication for home buyers would be to have access to publicly available maps and models, disclosures of prior wildfires or flooding, and disclosures of existing risk reduction strategies, as well as through insurance pricing that reflects current risks. California has disclosure tools such as Cal Enviroscreen that communicate additional risks, like hazardous toxic sites or air quality.

Recommendation: As part of the one-stop shop in Cross Cutting Recommendation 3, the state should store information regarding previous damage from wildfire and flooding in the single publicly accessible database so that potential home buyers can search for flooding and wildfire risk information for a specific property prior to making an offer. The state should also consider how hazards disclosures could be made available at the time of listing, so that potential buyers can consider information before making an offer. Such requirements would require collaboration with state agencies that map flooding and fire events, and also likely with local governments.

Box: The Wildland Urban Interface (WUI)
The wildland urban interface is defined by the US Forest Service as a place where humans and their development meet or intermix with wildland fuel, meaning trees and grasslands. A useful tool developed by academic researchers at the University of Wisconsin for visualizing the WUI can be found at:
http://silvis.forest.wisc.edu/data/wui-change/

Box: Existing Flood Disclosures
A number of different entities disclose flood risk, resulting in a patchwork system that can confuse buyers, and no disclosure systematically alerts buyers to a home's full prior flood history. At the federal level, existing law requires lenders to inform those taking out a mortgage in a FEMA-mapped 100-year floodplain that they are in a so-called "Special Flood Hazard Area" (SFHA). The State of California has its own existing law requiring sellers to provide a Natural Hazard Disclosure, which includes

whether a home is in a SFHA, whether the seller knows of prior flood damage, whether there are known flooding problems, or whether the property is in an area at risk of flooding if a dam fails. However, California law does not require disclosure of earlier flooding of the home when it was owned by prior owners. Existing flood disclosures are also required to include where to obtain more information and a notification that the owner's insurance does not cover flood damage to the tenant's possessions.

Box: Minimize unplanned displacement through thoughtful and proactive policy-making.

As the state attempts to strengthen communities with investments, it must prioritize achieving greater equity. Unfortunately, disasters often exacerbate inequities and can lead to displacement of both individuals and households that do not have sufficient funds to recover. In some cases the costs to rebuild are so high that households can no longer afford to stay. In addition, a slow rebuilding process strains those who have had to relocate and may not be able to move back. State and local governments must be mindful not to initiate disaster-response or prevention policies that inadvertently lead to displacement and inequality. Many communities, including Los Angeles, are pursuing post-disaster rebuilding plans to co-locate affordable housing and greenspaces in order to reduce future risks of heat and flooding. The California Transformative Climate Community program includes anti-displacement strategies as part of its grant guidelines to rectify environmental and social justice inequality and build resilient communities. At the same time, some communities are exploring the option of planned relocation efforts, particularly for slow-onset climate risks. Post-disaster recovery policies and state assistance should increase the ability of individuals and households to be able to recover, with flexibility to rebuild or relocate to safer areas.

Risk Reduction

Land Use Decisions

Land use decisions in the past are one of the causes of insurability problems today. Where and how Californians build and rebuild has consequences for the severity of losses, the degree of economic and physical resilience, and the insurability of properties, both now and in the long term. Housing in risky areas can sometimes be less expensive; but housing that burns down or repeatedly floods is not an affordable or equitable option because it leaves vulnerable people exposed to danger and the destruction of their possessions. Furthermore, for the availability of insurance to flourish, risks need to be extensively assessed, communicated, and reduced at the point of approving development. Once developments are built, the risks of additional emergency, insurance, and rebuild costs are passed on to future homeowners, the community, and the state, and insurance options may be minimal for the homeowner.

Although the state government provides planning guidance related to climate risks, the authority to permit new development in California largely rests with cities and counties. In deciding whether to approve such development, it is important from a social point of view that local jurisdictions consider the full costs of development and future occupancy. If they do not, additional costs may be borne by state or federal taxpayers

when disaster strikes, thus potentially creating a perverse incentive to approve development that is ill-advised.

Many local jurisdictions currently charge service and impact fees for single- and multi-family development to recoup the costs to the public sector associated with development. There are not systematically higher fees in areas at risk of natural disasters, however, to offset response costs. Service fees cover the costs of the jurisdiction's role in the development process, such as the costs of plan review and inspections. Impact fees offset the costs of new development, such as the need for new roads, schools, or other infrastructure. Some jurisdictions charge fire and public safety fees, which go toward the expansion of fire and public safety systems. A recent study found, however, that fire and public safety fees were charged by only two of the seven California cities examined.[30] Even the fees that do exist likely do not consider the California Department of Forestry and Fire Protection (CAL FIRE) or the U.S. Forest Service response costs or the costs of evacuating and providing temporary housing to evacuated residents. While special districts, such as levee districts, may have fees to cover certain risk reduction actions or specific rebuild costs for infrastructure, there are not hazard-related fees associated with covering the costs of disaster recovery.

Cross-cutting 7 *Identify areas to invest in conservation to reduce risks*

Motivation: High-risk development can create significant public costs in the future, and therefore should be scrutinized with climate impacts in mind prior to approval. Through the Coastal Barrier Resources Act, federal spending is prohibited in designated lands to encourage conservation of hurricane-prone, biologically-rich coastal barriers. Most new or substantially improved residences, businesses, and other development in the Coastal Barrier Resources System (CBRS) are not eligible for certain federal funding and financial assistance, including insurance coverage under the National Flood Insurance Program (NFIP) and federal disaster-recovery funds. No CBRS areas exist in California because hurricanes do not impact the state. Atmospheric rivers (*see box*) and other high precipitation events, however, cause substantial damage. The CBRS approach to avoiding future vulnerability does not prevent development or impose restrictions on development conducted with nonfederal funds, but it does effectively contain public costs over time by removing incentives to build. Recent research indicates that the CBRS reduced federal coastal disaster expenditures by $9.5 billion (in 2016 dollars) between 1989 and 2013 and that future savings because of the CBRS approach would be between $11 billion and $108 billion by 2068.[31] A similar approach to address the wildfire risks of communities in the Wildland Urban Interface could positively impact the resilience of communities while also minimizing loss of human life and reducing state disaster costs.

Recommendation: If land use and safety elements align with regard to hazard mitigation, local governments will be better positioned to access federal pre-disaster mitigation funding. Local governments should reassess their land use element of their general plan to consider climate risks and approaches to better land use, including the mitigation measures that reduce risk. When reassessing, local governments can focus on the unintended consequences of different approaches, given the climate risks that are projected for the local areas. Using the CBRS as a model, California should consider

establishing a multi-agency approach to designate lands where risk from climate disasters is too high for state dollars to be used to support new development and new infrastructure. Furthermore, because public infrastructure is often self-insured, local jurisdictions should analyze and report climate risk when taking on new debt to build infrastructure, such as low-lying wastewater plants and water distribution systems.

Cross-cutting 8 *For new developments, align insurance incentives with mitigation requirements*

Motivation: Avoiding future losses requires thoughtful building practices. Because insurance is required to obtain a homeowners mortgage, new developments in high-risk areas must be insurable to be practical. The California FAIR Plan ensures insurance availability, albeit often very expensive insurance, to all homeowners in the state. The NFIP plays a similar role for flooding risks to properties throughout the US. This is an important protection for existing developments because homeowners can lose their homes if their insurance disappears. However, for new developments that expand homes in high-risk areas, when insurance availability is guaranteed to all new developments, then homes may be built in areas where no private insurer may be willing to write insurance, either now or in the future. Guarantees of insurance availability for new homes enables further developments in high-risk areas associated with fires and flooding without need for following state guidance or community mitigation, with risks and future costs borne by renters, homeowners, and the public.

Recommendation: Given the predictions of increased future climate impacts and damages, the more sustainable path forward is for the FAIR Plan to provide essential insurance access for existing homeowners, but not to provide incentives for building new high-risk developments that increase both public and private exposure to future losses by expanding development into the highest risk areas. The State Legislature should consider changing insurance rules of the state FAIR plan to promote more responsible land use. To reduce incentives for development in high-hazard areas, the State Legislature should consult information from the Insurance Commissioner and the Governor's Office of Planning and Research, and consider whether future residential development built in defined high-hazard areas after a specific future date should be ineligible for the FAIR Plan as the first insurer, unless preconditions related to risk mitigation are met. The Insurance Commissioner should work with the Governor's Office of Planning and Research to develop possible preconditions that are likely to address a portion of the risk in question. Preconditions could include: 1) commitments by local governments to fund future wildfire response costs in such new developments, 2) implementation of the full mitigation guidance of the Governor's Office of Planning and Research when designing new developments, and 3) locating all new developments in the high- and very high-hazard areas in spatial designs that are least vulnerable to wildlife.

Similarly, the US Congress should consider reforming the NFIP so that it avoids providing incentives for new developments in high-flood risk areas. For the suggested policy shifts in either California or through the NFIP, an appropriate phase in time would be necessary, with 5-10 years of lead time. An example of this type of approach is

the Flood Re program in the United Kingdom (*see box*), which establishes important insurance protections for existing developments, but avoids promoting new high-risk developments.

Cross-cutting 9 *Create an iterative process for more effective building standards*

Motivation: Building codes have been used to reduce damages and are often a cost-effective tool to reduce disaster losses over time. Codes are no guarantee that homes will avoid damage or destruction, but homes built to stronger codes have a better chance of escaping with less damage. Indeed, with growing disaster losses, California needs to continue to adopt more resilient codes and more resilient community redevelopment strategies. Building more resiliently can avoid future displacement because of intense climate events. The private sector and local governments may desire the certainty of a consistent code, but we need an iterative process with regular advancements because homes are rebuilt each year, and with each rebuild there is an opportunity to adopt the latest codes to bolster resilience.

Existing California building codes for wildfires, largely dating back to 2008, indeed have helped reduces losses. Experimental research by the Institute for Building Home Safety, modeling research coordinated by the National Association of Insurance Commissioners, and post-disaster assessments by the National Institute of Standards and Technology point to the value of building codes.[32] Additionally, a 2019 analysis by the Sacramento Bee found that of the homes in the path of the Camp Fire, one of the most destructive in California history, 51% of those built after 2008 survived undamaged—compared to only 18% of those built before. The disparity shows the value of building codes, as well as the need for further improvements. Given the recent wildfire experiences, California would benefit from codes designed to reduce risks from ember-driven fires. Those codes would include requirements for the siting of homes in a neighborhood, the location of neighborhoods within a community, and the performance of designs.

Current building standards for floods are also a minimum requirement that applies in the 100-year floodplains for communities participating in the NFIP. As discussed further below, this minimum flood code may not be sufficient for the expected future increases in risk.

Recommendation: This recommendation has multiple parts: 1) Given the accelerating climate risks, some areas will be unaware of increased threats, and therefore, codes should be more broadly applied to not only the high risk areas, but moderate hazard areas as well. As noted in the wildfire section, research indicates that rebuilding with the current California codes is cost-effective. 2) The State Legislature should require future code iterations to include neighborhood and community factors, and should require that building codes related to climate resilience be revisited more frequently, especially for climate-worsened events including heat, landslides, wildfire, flood. Such updates should include communication plans that prioritize vulnerable communities so that households are more likely to know about new codes, especially because many retrofits, such as replacing vents, can be made in existing homes to reduce risk prior to the next wildfire. 3) In addition, California should make funding retrofits of existing homes and

communities a stronger focus to reduce future risks. Details for improvements on wildfire codes can be found in the wildfire section.

Cross-cutting 10 *Create an overarching disaster resilience strategy that includes local and state actions and incorporates nature-based solutions*

Motivation: The importance of pre-disaster mitigation investments is accentuated when more impacts are expected. CalOES coordinates and provides resources to local governments to promote pre-disaster mitigation. Although California has programs to reduce climate impacts, the state does not have an overarching disaster mitigation strategy or consistent funding for pre-disaster risk reduction. Scaling up mitigation projects can become a cross-jurisdictional challenge because federal, state, and local decisions on the lands they oversee can influence disaster mitigation. Making pre-disaster mitigation more coordinated at the state level can help optimize public and private funds. FEMA's Building Resilient Infrastructure and Communities (BRIC) program aims to invest money in pre-disaster mitigation, with the intent to reduce the overall losses from disasters, a goal that would align well with a coordinated risk mitigation effort by the state. The flexibility and adaptability of the BRIC program is key, as it establishes a framework under which a streamlined and scalable grant program can be executed, providing minimal administrative burdens on states and local governments. Under these guidelines, applicants can exercise maximum flexibility and creativity to transform the risk profiles of their communities, regions, and states In its first year, FEMA offered $500M through the BRIC program. While this number was significant, the program received more than seven times that amount (approximately $3.6 Billion) in project requests. With the program increasing in funding for 2021, California should endeavor to review the initial round of program awards and use expertise and data to inform and improve CA applications going forward to maximize their chance of success and foster individual and community preparedness in the state. Insurance expertise and data could help inform and improve BRIC applications from California.

Recommendation: The Insurance Commissioner should collaborate with other state agencies, including CalOES, the Governor's Office of Planning and Research, and the California Natural Resources Agency, to develop a multi-agency Climate Pre-Disaster Mitigation Vision. This vision should include accelerating urban greening projects, and large-scale natural and working lands projects. A good initial step is for California departments and agencies to expand agreements with the US National Forest Service and FEMA to increase large-scale risk reduction projects, including wetland restoration, urban greening, ecological forestry, prescribed burn projects, and drought management projects. In addition, the Insurance Commissioner and CalOES already have substantial public outreach efforts and should continue to engage and collaborate with the most vulnerable communities in the state to ensure that pre-disaster mitigation opportunities can meet the needs of local communities. The Insurance Commissioner should work with CalOES to develop robust applications for BRIC funding, and with insurers to identify opportunities for public-private partnerships, including nature-based risk reduction and improved community design and redevelopment over time. Insurance

companies should collect data on their underwritings and home hardening to contribute to these efforts and to the BRIC applications.

Cross-cutting 11: *Invest in risk reduction programs for homeowners and businesses*

Motivation: Since insurance pricing responds to the level of risk, encouraging home retrofits that reduce risks could be a pathway to more affordable insurance in the future. However, homeowners need guidance for best practices and also in some cases cannot afford the recommended retrofits without financial support. South Carolina offers grants with multiple tiers based on income of applicants, Colorado offers tax write-offs, and Connecticut offered low-interest loans to provide funds to homeowners for risk reduction actions. The effectiveness of such programs in reaching all communities and encouraging pre-disaster retrofits would help California develop its own programs.

Recommendation: The Insurance Commissioner should consult with the National Association of Insurance Commissioners (NAIC) and contract for a study that examines which of these state-level approaches is best for providing financial incentives and technical assistance to reduce risks to homes and structures in California. An important part of this effort is to outreach to elderly and disabled populations that may be less able to do risk reduction maintenance themselves, and also to renters who are at risk but often not a focus of risk reduction programs.

Box: Flood Protection Standards for Infrastructure
Under the Obama Administration, the National Flood Standard was established, requiring federally funded infrastructure, such as hospitals and water treatment facilities, built in high-risk areas to be elevated or built in accordance with the best available science to better prioritize the safety of the structure. In Norfolk, Virginia, new public infrastructure has to meet resilience criteria, including flood risks.

Box: Roof replacement, Big Bear, California
The risks from wildfires can likely be reduced through retrofits of suburban and rural homes in the Wildland Urban Interface. For example, the Big Bear Fire Department's Mountain Area Safety Taskforce implemented a Wood Shake/Shingle Roof Replacement Grant Program from 2008 to 2019 for the San Bernardino County Mountains in southern California. The program, funded by more than $5 million in grants from CalOES, FEMA, and CAL FIRE, replaced more than 600 wood shake or wood shingle roofs with more fire resistant alternatives, out of a total of about 3,000 homes in the area.

Box: The Flood Re Approach to Land Use
The Flood Re program in the United Kingdom is designed to assist insurance policy holders with flood insurance in the near term and to provide an incentive to limit state-subsidized insurance benefits to homes built pre-2008. The program sunsets in 2033 in an attempt to promote a phase out of high-risk residences over time.

Box: The California FAIR Plan
Established in 1968, in large part to address insurance availability in urban areas, the California FAIR Plan is not a state agency, but rather a state-mandated insurance

program. All insurance companies writing homeowners insurance in the state must be a member of the FAIR Plan and are required to replenish FAIR Plan resources if it runs out of money. Insurers cannot include the cost of any FAIR Plan assessment in their admitted market insurance rates and the State's General Fund does not subsidize the FAIR Plan or insurers. FAIR Plan policies provide coverage for structural fire losses and meet collateral requirements for mortgage lenders, but the FAIR Plan does not include the other coverages that come with a comprehensive homeowners' insurance policy, such as liability and theft coverage, as well as protection against water losses (like leaking pipes). FAIR Plan customers can purchase supplemental policies (known as "Difference in Conditions") for these non-fire risks from many regular insurers. As an "insurer of last resort" that has a much higher percentage of its policyholders living in high fire risk areas than regular insurance companies (known as "adverse selection"), the FAIR Plan's typical cost is more expensive than the cost at a regular insurer. The FAIR Plan is unlikely to be a permanent and an affordable solution for many policyholder. FAIR Plan policy counts vary over time and act as one indicator for overall insurance availability. If the FAIR Plan policy counts increase, that is a sign that insurance availability is a challenge in the regular insurance market for at least some areas.

Box: ***The National Flood Insurance Program***

The National Flood Insurance Program (NFIP) was established in 1962 to provide an option for homeowners to insure against flood risks. The NFIP provides flood insurance to any homeowner who wishes to purchase it, although flood insurance is most commonly required by banks offering mortgages to homeowners only within Special Flood Hazard Zones, established by the Federal Government. The pricing of NFIP policies has been a very contentious issue and the program has been operating with substantial debt, currently in the tens of billions of dollars.

Box: ***Atmospheric Rivers***

One important source of flooding risk in California is a meteorological phenomenon known as "atmospheric rivers." Atmospheric rivers are long, narrow regions of the atmosphere that transport water vapor, sometimes referred to as "rivers in the sky." While atmospheric rivers are a key component of the global water cycle and contribute significantly to California's water supply, they can also cause heavy precipitation and present serious flood risks. Extreme atmospheric rivers can disrupt travel, induce mudslides, and cause catastrophic damage to life and property.[1] Research has found that atmospheric rivers are responsible for the majority of flood damage in the West, with average damages at about $1 billion per year. Although hurricanes and tropical storms are well categorized, atmospheric rivers are not. Recent research by the state and federal government is now beginning to better understand and assess this risk. But an effective warning system has not yet been developed.

Closing the Protection Gap

One vital step for improving resilience to the impacts of climate change is closing the protection gap, the difference between the total amount of property damage and the amount of damage that is insured. Some perils, such as erosion or flooding, are not

covered at all in standard property policies. Closing such a protection gap can support the most vulnerable communities. For wildfire, a peril that is included in standard policies, there is still a large community protection gap due to underinsured homeowners and renters and the many non-property costs wildfires impose, such as evacuations. For example, the overall losses from wildfires in 2017 and 2018 exceeded $45 billion, but only $35 billion of those losses were actually insured.[33] This leaves substantial costs for households and businesses, and the public sector. Evacuations themselves are costly for individuals. Moreover, in addition to property losses and direct costs during a disaster, individuals and governments have longer term incurred expenses and lost tax or other revenue.

To strengthen the effectiveness of insurance solutions, risk transfer tools and products should also promote investments in risk reduction—both improving the building of individual structures and investing in community-level risk reduction. These should also include nature-based solutions. Healthy forests, wetlands, dunes, reefs, and other natural ecosystems can reduce the effects of climate threats, and can at times be remarkably cost-effective. Insurance industry-based models have shown that every $1 spent on restoring marshes and oyster reefs on the American Gulf Coast reduces storm damages by $7, for example.[34]

Cross-cutting 12 *Encourage increased uptake of renters insurance through outreach and disclosure*

Motivation: Renters insurance has less uptake than homeowners insurance because it is not required in many cases and renters generally have a much smaller pool of assets to insure. In California, approximately 2.2 million renters insurance policies were written in 2019, a number that is less than some estimates of the number of renters in Los Angeles alone. However, renters face significant economic vulnerability. If renters lose all their possessions in a wildfire or flood, they are more likely to face financial challenges to recovery. In addition, renters face the challenge of finding affordable housing after disasters.

Recommendation: The Insurance Commissioner and the state of California should prioritize increasing the uptake of renters insurance throughout the state. To this end, the Insurance Commissioner should launch an analysis of renters insurance uptake in the state and use that data to develop a public outreach program for renters vulnerable to moderate to high flooding and wildfire risks. Insurance companies should consider the costs and payment requirements associated with including a limited amount of funding for evacuation or post-disaster rental costs in renters policies. In addition, programs that aim to enhance community resilience, such as the Transformative Climate Communities program in California or the City of Chicago's program to co-locate libraries with affordable housing, should consider how to incentivize greater uptake of renters insurance to promote long-term resilience and reducing the risks of displacement after disasters.

Cross-cutting 13 *Support basic protection for low-income renters and homeowners post-disaster*

Motivation: Federal governments can use public funds or public-private risk sharing to promote insurance coverage. For example, Morocco recently passed a law providing natural disaster risk insurance to those who are economically disadvantaged, funded by a tax on all insurance policies.[35,36,37] The law establishes a Solidarity Fund against Catastrophic Events (*Fonds de Solidarité contre les Evénements Catastrophiques* (FSEC)) to provide partial compensation to uninsured households for personal injuries and losses of principal residences from catastrophic events. New Zealand approaches earthquake insurance using a public-private approach, with the state covering the first $150,000 of damages. Such a policy reduces the financial risk to insurers, encouraging increased insurance availability for damages beyond the $150,000 threshold. Mexico has established a disaster resilience fund, known as FONDEN, which has been used to appropriate regular funding for disaster response and mitigation.[38]

Recommendation: The State Legislature should consider establishing a solidarity fund for assisting the lowest-income homeowners and renters with insurance premium payments for a basic level of personal disaster risk coverage. The Insurance Commissioner should establish a task force to study such coverage. In addition to coverage for property loss, the task force should consider coverage that addresses the costs of disruption to renters and homeowners from natural hazards, including business disruption, income disruption, and evacuation costs.

Cross-cutting 14 *Support proof of concepts for parametric and community insurance*

Motivation: As the impacts of climate change intensify, the protection gap will likely widen. To reduce financial stress, risk transfer policies and public-private partnerships need to be developed now in order to be in place to meet the future demands of surging costs. New tools, including parametric and community insurance concepts, could reduce the impacts of such costs and close the protection gap (see boxes). One value of innovative parametric policies would be to protect against threats where insurance is uncommon, such as extreme heat impacts or flooding. They also can be targeted to assist vulnerable populations, for example through microinsurance policies, or to stabilize local government tax revenues in the aftermath of disasters. Parametric earthquake coverage is currently being explored in California. Community insurance, moreover, is likely the ideal scale for nature-based solutions, and therefore would provide opportunities and incentives for community-wide mitigation investments.

Recommendation: The Insurance Commissioner should consult with independent experts and the NAIC to develop the concepts for parametric and community insurance pilot projects in multiple parts of the state. Such products should be used as models of insurance solutions for other risks, such as parametric drought protection or a risk transfer to protect against economic disruptions caused by strong snowstorms or high rainfall events. Specific examples of innovative insurance product concepts are detailed in the individual peril sections.

Cross-cutting 15 *Initiate policy development for nature-based insurance solutions*

Motivation: Nature-based insurance solutions can include ecosystem restoration projects, such as urban wetlands. California could emphasize a state-wide risk reduction strategy to align the goals of restoring ecosystems services for the full lifetime benefits to carbon storage and restoring ecosystems for risk reduction.

Existing nature-based solutions linked to the insurance sector are few. Perhaps the most well established are focused on reducing flooding impacts and the consequences of storm surges from waves (*see box*), although concepts exist for wildfire and heat. Canada is pursuing a top-down, nature-based solutions strategy, with coordination among individual provinces. This strategy includes pilot projects on seagrass and sand dunes, as part of a substantial effort to reduce flood risks and increase flood insurance availability in large portions of the country. The pilot projects will to explore county and municipality level solutions, provide long-term risk reduction, and create opportunities for public-private partnerships. In a similar fashion, California can leverage existing federal and state programs to develop potential risk transfer policies that include nature-based solutions.

Recommendation: To increase the development of nature-based investments that reduce insured losses, the Insurance Commissioner should opportunities to develop risk reduction concepts and increase the data that can be used to incorporate nature-based solutions into models, including those used by insurance companies for underwriting. Insurance companies should support further advancement of nature-based solutions in underwriting approaches, including models, so that the impacts of risk reduction projects can be recognized and incentivized. Furthermore, the Insurance Commissioner should consider creating options that allow the insurance sector to contribute to long-term resilience through its own investments or through relatively small fees on insurance policies to reduce long-term flooding and wildfire risks before losses occur. Finally, the Insurance Commissioner should establish a working group to formalize design criteria for nature-based solutions and use these criteria to pursue a statewide strategy.

Cross-cutting 16 *Catalyze new Climate Hazard Abatement Districts*

Motivation: Special districts like Hazard Abatement Districts have provided many benefits to the communities where they exist by focusing preparation, pre-disaster mitigation, and recovery on the local hazards. For climate disasters, the optimal scale for nature-based solutions and risk transfer mechanisms is localized, but may be different than city or county boundaries. Often, pre-disaster mitigation, such as for flooding, may be most effective and most economical at a watershed scale. A similar problem was faced because of geologic hazards, and to address those risks, California developed Geologic Hazard Abatement Districts (GHAD) in order to prevent, mitigate, and abate geologic hazards and fund the rebuilding of areas after a geologic event. [39] GHADs are one type of special district that impacts land management, along with Resource Conservation Districts and Park Districts. Similarly in part, communities recognized as "Firewise" by the National Fire Protection Association have self-determined boundaries for their communities and the risk reduction actions they will pursue.[40] Such

boundaries can stretch beyond one government jurisdiction. Firewise communities have wildfire risk mitigation plans and invest money towards meeting the goals in those plans.

Recommendation: The State Legislature should establish Climate Hazard Abatement Districts (CHAD) as an extension of the existing system of GHADs. This report recommends that the state support both CHADs and local jurisdictions to pursue pilot projects for community insurance solutions that blend risk transfer and risk mitigation at the community and landscape levels.

The reasons why CHADs have potential to increase the effectiveness of climate adaptation versus the existing system of local and state governments are that CHADs would operate at an ideal scale and would focus holistically on climate risks. They also would have taxing authority to fund projects at this scale. At such a scale, CHADs are well positioned to link avoided future losses to early investments in risk reduction, especially nature-based solutions at the watershed scale.

To jumpstart the CHAD approach, the Governor's Office of Planning and Research and Insurance Commissioner should identify three FireWise communities, and three additional communities selected to improve flood resilience, in the state to encourage and provide technical assistance to become CHADs. FireWise communities are already spending $2 per person per year on wildfire mitigation projects, and becoming a CHAD would likely expand their opportunities to receive grants and consider risk transfer. Converting to a CHAD will leverage the existing organization and also take a more holistic approach, with the tools to levy taxes and plan for not only risk mitigation but recovery as well. These three CHADs would serve as a proof of concept and, if successful, as a template to scale to other areas of the state.

Cross-cutting 17 *Establish business investments in nature-based community resilience*

Motivation: Nature-based solutions benefit more than just homeowners and local governments; businesses and insurance companies also have an interest in investments that make communities more resilient and sustainable. Local businesses, especially corporations headquartered in certain communities, have a vested interest in the resilience of those communities, because it affects both the resilience of their workforce and the sustainability of their business. These businesses have an interest in the safety and productivity of their employees. In the face of wildfires, heat waves, and flooding, ensuring the safety of the workforce is a growing challenge. Nature-based solutions and resilient public infrastructure safeguard against climate disruptions for businesses because they allow workers to get to work, customers to access goods, and supply chains to remain intact.

Recommendation: Local governments and the state should consider commercial tax rebates or other incentives for investments in resilience bonds, risk transfer products, and restoration projects to encourage the private sector to invest more in nature-based approaches. The insurance industry should be an important leader by considering

opportunities to invest some their surplus in investments that strengthen risk reduction and sustainability, such as resilience bonds and other opportunities.

Cross-cutting 18 *Include nature-based solutions in local planning*

Motivation: While gray infrastructure, such as levees and sea walls, depreciates in value over time due to age and wear and tear, green infrastructure like urban forests often appreciate. For example, a riparian area bordering a river reduces flooding and will perform better as the trees grow and mature, and urban trees are better able to reduce the urban heat-island effect as they grow.[41] These activities also help address the longer term risk of climate change by sequestering carbon. Living shorelines, which include marshes and wetlands rather than sea walls, last longer and do not require as intensive repairs as concrete bulkheads, on average cost about one-third as much as concrete bulkheads, $361 per linear foot of living shorelines versus $1,022 per linear foot for concrete bulkheads.[42] In the face of accelerating risks of flooding, designing adaptation pathways can assist planning and can help spread costs over time. One study has analyzed potential adaptation pathways to address the flood risks in the coastal zone of Los Angeles County.[43] The pathways were predicated on maintaining beaches and dunes, recognizing their value for flood protection. If nature-based solutions like sand dunes can eliminate a portion of anticipated risks, insurers will be more likely to write policies and costs will be more affordable for consumers.

Recommendation: Nature-based solutions should be prioritized by local governments, homeowners associations and community organizations, insurance companies, and investors as instruments of long-term risk reduction. Local government plans, such as land use planning elements, should consider nature-based solutions for increasing resilience to fire, flooding (including from sea level rise), or heat at the scale of a community or county, and should take into account the greenhouse gas reduction value of such investments. Such planning could better position local governments to receive federal funding through the BRIC program and reduce long-term risks and costs. Where the state offers incentives or matching funds for investments in resilience, the contribution and priority should be higher for long-term risk reduction like nature-based solutions rather than short term fixes that reduce long-term risks. Finally, local governments should assess their recovery plans for public assets and lands, how insurance or reserves will facilitate recovery, and whether pre-disaster mitigation or insurance uptake can be increased to promote long-term resilience.

Cross-cutting 19 *Develop a public resource for sharing community risk solutions*

Motivation: California currently has a clearinghouse of state planning documents related to climate change but no such clearinghouse of information on public-sector insurance policies.[44] Insurance approaches are rare in state climate adaptation guidance documents or in large-scale agency action plans. Such products could be tailored to specific community needs and respond to local climate risks. Yet risk transfer products could assist local jurisdictions or the state for insuring infrastructure, ecosystems, or communities. Although at present there are few products of this kind, a resource for

local leaders could galvanize interest and provide assistance to planners. The Department of Insurance maintains several public tools for comparing insurance pricing, finding insurance in high risk wildfire areas, and comparing insurance company underwriting and consumer complaints to make informed decisions.

Recommendation: As public-private insurance options are put in place, the Insurance Commissioner should produce a database for public-private risk transfer policies that are proposed or in use. This clearinghouse of community and state-level risk transfer programs, including international examples, will help communicate basic principles of such policies. Access to such a database could encourage consideration by local governments and special districts to develop new risk transfer approaches.

Figure 2. The combination of nature-based solutions and risk transfer mechanisms can strengthen resilience across the state.

Box: ***Community Insurance***

In a community insurance program, a public entity, such as a municipality or a special purpose district, purchases insurance for a group of properties in its jurisdiction. The concept of community insurance is being actively explored by researchers and practitioners as a way of closing the disaster insurance gap, securing affordable coverage, and better linking risk reduction and risk transfer.[1] There is enormous flexibility in how a community insurance program could be designed and in the role it plays in the financial recovery of residents.

Box: ***Parametric Insurance***

Typical property insurance in the United States is what is referred to as indemnity coverage; this means it reimburses the insured for the amount of damage sustained. For instance, if you have homeowners insurance and a tree falls on your house, your insurance company will send an insurance adjuster to estimate the cost of repairs and that will be the amount of funds (subject to deductibles and coverage caps) that you receive. Parametric insurance, in contrast, is event based and pays a set amount of

money to the insured based on a pre-agreed and objective measure of the disaster itself—called the trigger.[1] For instance, a parametric insurance product for hurricanes might pay a certain amount when a given category of storm crosses within so many miles of the insured's home. This could provide cost-effective funding for preparation for an impending storm. The benefits of parametric insurance for disasters are that they can provide funds much faster and the payouts can be used flexibly for any needed and unanticipated expenditures, deductibles, or lost revenue, which are typically insurance gaps. The downside is that the actual payout may be more or less than the damages sustained.

***Box: Geologic Hazard Abatement Districts** (GHAD) were authorized by the State of California under the provisions of the 1979 Beverly Act (California Public Resources Code 26500). The primary purpose of a GHAD is to effectively abate a landslide hazard that crosses property boundaries by providing property owners a mechanism to cooperate in solving a common problem. In addition, a GHAD could be more cost-effective solution than a parcel by parcel approach, requiring only one geotechnical engineering firm and one mitigation plan to solve the problems that impact several landowners.*

***Box: Park Districts**. Recreation and Park Districts may be established subject to this the Cortese-Knox-Hertzberg Local Government Reorganization Act of 2000, and require a vote by the local constituents of the proposed district. Such districts follow pre-established guidelines for the goals of the special district, can apply for grant funding, and enter into collaborative projects. For example, the Conejo Recreation and Park District is located in and around the Santa Monica Mountains and has entered into a joint powers agreement with another special district.*

***Box: Resource Conservation Districts** were first founded in the 1930s to connect federal and state funding and technical assistance to farmers and ranchers to promote local collaboration on community challenges, including voluntary conservation of water and soil on individual parcels of land.*

***Box: Coral Reef Insurance.** Natural infrastructure can be a foundational part of how the insurance industry models, manages, transfers and finances the risks brought with climate change. Innovative projects and products that insure nature are likely to gain increasing significance over the coming decades, as sea levels rise and the likelihood of adverse weather events increases. The Coastal Zone Management Trust in Quitana Roo, Mexico aims to continuously maintain the coral reef and local beaches and also buys an insurance policy. The reef insurance pays out when a certain windspeed crosses the area covered by the insurance to fund the repair and rebuilding of the coral reef, restoring its protective power and hence its financial benefit to the local economy. Such a policy has protective benefits for the community, because reef preservation enables the local hotel industry and ecotourism to thrive, and with it the services, income and jobs on which the community depends, and because there is less beach erosion, and reduced risk to hotels, businesses, and homes. Government benefits because increased coastal resilience means fewer costs from infrastructure loss, and more resilient coastal industries.*

***Box:* Restoration Insurance Services Company (RISCO)**
Funded initially by the Climate Innovation Lab, RISCO will be the first enterprise to assess and monetize the coastal asset risk reduction value and carbon storage benefits of mangroves. Jumpstarted by grants, equity, and loans, RISCO aims to become self-financing by using insurance and blue carbon revenue streams. RISCO will contract directly with insurance companies or insurance associations and will secure an annual payment for continued, verified conservation and/or restoration of mangroves. The annual payment will be linked to a site-specific calculation of the flood reduction benefits provided by the mangroves.

PART 2: RECOMMENDATIONS FOR SPECIFIC PERILS

WILDFIRE

Wildfire events impose shocking costs on all types of property owners, homeowners, renters, businesses, and cause disruptions and declines in local economies. The cumulative costs of structure damages, evacuations, and smoke cause substantial strain on low-income communities, who are more likely to have work disrupted and greater exposure to smoke. Catastrophic wildfires have evacuation costs and the evacuations themselves can last for weeks. Renters often are left with more expensive housing as their only option. Moreover, California's wildfires cause air pollution that has negative impacts on human health, particularly among the more vulnerable. Many areas of California already have dangerous air quality, including the California Central Valley, and lingering smoke can exacerbate health impacts for those people who work outside or are not able to avoid the smoke-filled air.

The costs associated with recent wildfires have been staggering, with$25 billion of insured losses in 2017 and 2018 combined, substantial firefighting costs, and widespread additional costs that are difficult to measure. In response to the recent severe wildfire years, California has enacted several new laws aimed at better managing wildfire risk: 1) a state fund to provide financial assistance to homeowners making home hardening retrofits (Chapter 391, Stats. of 2019), 2) enhancements to California's prescribed fire capacity and goals (Chapter 624, Stats. of 2018), and 3) a new requirement on utilities to prepare wildfire mitigation plans to prevent, combat, and respond to wildfires in their service territories (Chapter 626, Stats. of 2018). In addition to these new laws, California has many fire prevention resources, including existing defensible space rules enforced by the California Department of Forestry and Fire Protection (CAL FIRE) and a list of low-cost home retrofits published by the State Fire Marshal.

Meanwhile, the state's growing population and an urgent housing shortage are contributing to the demand for housing in the wildland urban interface (WUI), where support for development can be easier to obtain. Redevelopment in existing urbanized areas is often more expensive than development into areas of the state without existing

infrastructure, making new housing in the WUI often more affordable to build. California has existing building codes for new housing known as the Chapter 7A Building Codes.

Making existing homes safer is thus essential to a more resilient future. Most of the building codes, however, apply exclusively to new construction, and not in all moderate or high fire risk areas. Retrofits to address risks from wildfire range from relatively economical to very costly. For example, replacing vent coverings and clearing brush is far more affordable than replacing a roof or removing large trees. The collective decisions of a community influence wildfire risk as well. If you establish defensible space and your next-door neighbor does not, you will still be at higher risk. That is why community-scale risk reduction measures are often the most effective, and programs aimed at community resilience will need to outreach to all populations.

Risk Assessment

Recommendations related to risk assessment for the threat of wildfires are included in the cross-cutting section.

Risk Communication

State law currently directs CAL FIRE to map areas of fire hazard based on fuels, terrain, weather, and other relevant factors.[45] Those areas, called Fire Hazard Severity Zones (FHSZ), show the "hazard" -- the likelihood that an area will burn over a 30 to 50 year period based on current conditions, without considering modifications such as fuel reduction efforts. Modifications like defensible space, sprinklers, irrigation, or building materials are not reflected in the FHSZ maps. The FHSZ maps are largely intended to be used for a number of important decisions, including:

- Implementing wildland-urban interface building standards for new construction
- Natural Hazard real estate disclosure at time of sale
- 100-foot defensible space clearance requirements around buildings
- Property development standards such as road widths, water supply, and signage
- Considered in city and county general plans

Local governments then have discretion in adopting these maps from CAL FIRE. Once they do, the maps are used as a basis for building standards for new construction and property development standards for roads and water supplies, and provide the basis for disclosure of risk when properties are sold. In California, the financial responsibility for fire prevention and suppression depends on geography, with areas mapped as state responsibility areas (SRA) or local responsibility areas (LRA).

Significant areas of California are not currently included in the FHSZ maps because the maps were intended to guide the building of new homes, primarily in the SRAs. As a result, the maps have geographic gaps, especially in LRAs, where there is no established hazard rating. Therefore, not being in an official hazard zone does not mean that no fire hazard exists. Wildfire building codes are required in all Very High Hazard Severity Zones, whether in SRAs or LRAs. However, this misses moderate and high severity

zones in the LRAs where hazard maps have gaps, and wildfire building codes are not required.

Wildfire 1 *Existing Fire Hazard Severity Maps should be more comprehensive, including moderate, high, and very high hazard designations for the entire state, rather than only for the State Responsibility Areas*

Motivation: Although hazard maps are costly to update they are important tools, and the FHSZ maps have not been updated in over 10 years. Some areas do not have publicly available ratings for moderate or high risks because they fall in local responsibility areas, and some local jurisdictions do not adopt the state FHSZ maps. The consequence of these gaps is that some areas with moderate risk are not currently required to build to the wildfire risk building codes. This problem is most visible when areas that were recently burned in wildfires are being rebuilt to less than the current wildfire building codes. Building or rebuilding without applying wildfire building codes is a missed opportunity to reduce risk in areas with moderate and higher wildfire hazard.

Recommendation: The State Legislature should specify that:

- CAL FIRE update Fire Hazard maps at least every eight years to align with updates to local planning documents.
- All areas of the state should be assessed and mapped for fire hazard, including the areas that are omitted from the existing maps.
- All the maps should identify the level of risk as being "moderate," "high," or "very high," as is currently done for all SRAs.
- Should direct that CAL FIRE designations trigger automatic adoption of wildfire related building codes.

The most up-to-date map should be available in the one-stop resource from Cross Cutting Recommendation 3 and this wildfire recommendation is related to Cross Cutting Recommendation 4.

Risk Reduction

Reducing wildfire risk cannot be done with one approach on its own; all opportunities at the parcel, community, and landscape level should be evaluated. Expanded ecological forest treatment including prescribed burns, buffer of open space around communities, creation of defensible space around properties, and construction with fire resistant materials, particularly on roofs, all contribute to risk reduction. Community actions are essential and many communities are already approaching wildfire risk reduction through FireWise Communities—areas where residents have agreed to develop and follow a wildfire mitigation plan recognized by the National Fire Protection Association (NFPA)—or through local ordinances enforced by local governments.

Building codes typically only apply to new construction, or perhaps during rebuilding, leaving existing homes more vulnerable. So while these stricter building codes have made progress toward preventing fire damage for buildings built after 2008, buildings constructed beforehand are still at great risk. As the Sacramento Bee outlines, while the

initial proposed 2020 budget included $101 million to help retrofit older homes, the pandemic and its resulting financial crunch quickly extinguished this idea—and the owners of older buildings have thus never received any funding to mitigate their fire risk. Furthermore, owners of older buildings in high fire severity zones—which are usually more rural—are often not financially able to do these retrofits on their own. These retrofits do make financial sense, however. A recent report from the International Code Council explains that the National Institute of Building Sciences (NIBS) found that retrofitting structures in Wildland-Urban Interface Fire Areas to provisions of the 2018 IWUIC (International Wildland Urban Interface Code)—a code largely similar to that required of new buildings in CA fire zones—provides a "conservative benefit of $2 for every $1 invested but could yield as much as an $8 benefit." Reducing wildfire severity helps protect individuals with existing respiratory conditions by reducing smoke and other health impacts.

Requiring additional fireproofing for new buildings would also not necessarily impose large costs. In a November 2018 study, Headwater Economics, a consulting firm, found that "a new home built to wildfire-resistant codes can be constructed for roughly the same cost as a typical home," and that "some of these materials have added benefits such as longer lifespan and reduced maintenance." While they acknowledge that state and local governments must "weigh many issues" when considering new regulations, their findings suggest that "the cost of constructing to comply with wildfire-resistant building codes" should not be one of these issues.

Wildfire 2 *Increase and optimize open space to reduce wildfire risks*

Motivation: Increasing open space of forest or working lands to create buffers between neighborhoods, can reduce home to home transmission. Redevelopment of communities in wildfire risk areas, however, can be challenging because buildings are already sited and constructed. Governments have opportunities to promote risk reduction through redevelopment when properties are not rebuilt after loss and available to be purchased at reduced cost. In the aftermath of wildfire losses, certain homeowners may not return, leaving properties undeveloped amidst a rebuilding development. In addition, some agricultural properties are retired to meet water management requirements. These lands could be purchased by the state or local governments or by non-profit organizations and used as open space to increase wildfire resilience for existing developments, reducing future costs to homeowners and renters.

Recommendations: The two overriding goals to strategically plan buffers to reduce wildfire risk should be: 1) utilizing existing open space and newly available former working lands, such as ranches, farms, and parks, and 2) purchasing vacated lots to provide additional open space for strategic wildfire buffers. The Insurance Commissioner should convene public policy experts to initiate a process that would enable both non-governmental organizations and government agencies to share information and identify vacated properties, including nature-based and formerly natural working land options, to be acquired and restored as natural risk reduction buffers. In communities with manufactured housing or challenges to evacuate during a

disaster, such buffers could be critical to wildfire safety for people, in addition to structures.

Wildfire 3 *Wildfire building codes should include neighborhood factors and building codes should apply to moderate and higher hazard areas throughout the state, not only the State Responsibility Areas*

Motivation: In the fire footprint of recent northern California wildfires, homes are not being rebuilt to the current state wildfire building codes.[46] While these homes are in areas with moderate or higher wildfire risk, adherence to wildfire building codes were not required. This points to the need to expand the geographic scope of areas that fall under California's wildfire building code and to update the code to stronger standards.

Recommendation: This recommendation is in three parts: 1) The State Legislature should require fire resistant building codes for all new and rebuilt homes in all areas in the state that are moderate and higher wildfire risk. Anticipating that risks are increasing, the rebuilding process after tragic wildfires should result in a more resilient home, built to the most up-to-date standards. 2) At the next revision of the California wildfire building codes, the State Legislature should specify that codes consider risk mitigation standards beyond the parcel-level, assessing existing research[47] on the siting and spacing of structures to reduce wildfire vulnerability. 3) The Insurance Commissioner should work with local governments, insurance companies, and others to develop better data collection on the loss experience of homes that have employed risk reduction measures to accelerate the development of performance-based mitigation measures. The Insurance Commissioner should consider a specific survey of insurance companies to gather data on homes that have taken mitigation actions, such as home hardening, as well as compile current mitigation discounts being offered by insurance companies to their policyholders. The state can leverage this process to develop better data collection and analysis tools to inform the planning of new and rebuilt structures.

Wildfire 4 *Close the community wildfire mitigation gap with stronger planning and documentation of successful home and community mitigation*

Motivation: As California and other states have recently experienced, wildfires can be tragic and destructive. Avoiding repeat devastation is in the best interests of communities. In addition, community redevelopment to reduce future risks is often most achievable when rebuilding is occurring. In the aftermath of wildfires, local governments have an opportunity to provide the incentives and rules to encourage the strongest possible rebuilding process, while also addressing the potential for displacement. In some cases, new safety strategies will avoid displacement by enabling safe and affordable housing. In particular, a local government can rebuild in a way that adds additional buffers and defensible space.

Recommendation: California should establish an independent wildland urban interface commission to advise on community mitigation and rebuilding plans. Such a commission could be implemented through the existing California Catastrophe Response Council or a separate entity. After a wildfire that results in large losses, local

governments should re-evaluate their general plans, local ordinances, and the codes that govern rebuilding to promote community risk reduction as homes are being rebuilt. For example, following recent fires in Paradise, CA, local officials and community members are contributing to rebuilding plans that aim to reduce risk of future fire to encourage the community to rebuild. Furthermore, California should consider revising state law to provide a process for land easements for the specific purpose of wildfire risk reduction to be recognized by land trusts and tax laws, providing further incentives for rethinking community risk reduction during the rebuilding process and also avoiding displacement of local communities.

In addition, for long-term resilience it is important to address mitigation and prepare before the next climate disaster event. Strong community risk reduction plans can position communities for BRIC funding and the combination of planning and funding should produce important community risk reduction. FireWise Communities are an existing governance structure that should be strengthened. This report recommends that FireWise Communities should include nature-based solutions in the community assessments that are conducted to create community mitigation plans. FireWise Communities should also strengthen documentation of successful risk reduction measures to inform future community risk reduction actions in that local community and also others. The working group will continue to discuss this concept to forma more in-depth recommendation.

Risk Transfer

Although the number of homes with wildfire coverage is relatively high and insurance availability is largely guaranteed by the California FAIR Plan, there are reasons to expect that many homeowners have insurance coverage that will not fully cover the costs to rebuild. In the aftermath of recent wildfires, the Department of Insurance has received numerous communications from consumers frustrated by the costs to rebuild outpacing their insurance coverage. This problem is not unique to California. A recent research article estimated that the majority of homeowners in the US have less insurance coverage than it would take to rebuild their homes.[48] Such a trend will cause the greatest harm to low-income homeowners who face rebuilding after destructive wildfires.

Wildfire 5 *Develop proof of concept for a nature-based solution combined with community insurance*

Motivation: Pre-disaster mitigation efforts and nature-based solutions can reduce risks associated with climate change and are recognized to be cost effective. However, these approaches are less effective at the single-structure level. Rather, they are best addressed at the community scale. Public-private investment in community-scale nature-based mitigation efforts could be a complementary strategy to indemnity insurance. Together, a nature-based community insurance solution could help close the protection gap by simultaneously reducing and transferring risk. A pilot project emphasizing nature-based solutions to reduce risk and community based insurance to transfer risk would provide proof of concept.

Recommendation: To reduce risks and close protection gaps, the Insurance Commissioner should convene insurance experts and stakeholders and support the development of a pilot project that would combine nature-based risk mitigation with a community insurance solution in one or more high wildfire risk areas of California, with the following components:

- Work with local communities, wildfire ecologists, the current Wildfire Partnership convened by the Insurance Commissioner, and researchers such as the Institute for Building Home Safety to identify the regions and natural infrastructure needed to reduce wildfire risk;

- Develop a public-private partnership to invest in nature-based strategies to reduce wildfire risk at a community level;

- Invite climate experts, insurers, and reinsurers to participate in providing multi-year risk transfer solutions, including creation of a community risk pool. The risk pool would be insured and would provide a predetermined primary portion of coverage limits for homeowners living within the identified community.

- Amortize the reduction in premium associated with the implementation of the nature-based mitigation into the initial investment.

- Identify, over the course of time, additional risk mitigation measures that can further reduce the wildfire risk for the region. As studies quantify the benefits of the risk mitigation, the risk transfer mechanisms can incorporate the projected risk reduction impacts of the mitigation actions into pricing, thus reducing the premiums over time.

Wildfire 6 *Focus attention and collaboration on reducing the frequency of underinsurance*

Motivation: Insufficient coverage contributes to a wider protection gap and is likely to become a more visible problem if insurance continues to become less affordable.[49] In the aftermath of recent wildfires, some insured homeowners whose homes were destroyed had insufficient coverage limits for meeting the rebuilding costs of their homes. A wider protection gap impedes recovery and hampers California's resilience to wildfires. Given that a small increase in coverage limit could make a significant difference to resilience, this problem needs to be better understood and remedies identified. In 2020, the Insurance Commissioner sponsored legislation to address some causes of underinsurance (Chapter 261, Statutes of 2020).

Recommendation: The Insurance Commissioner should convene insurance companies and consumer organizations, among other stakeholders, in the state and determine how best to compare coverage limits with the rebuilding costs for homes damaged or destroyed in the 2017-2020 wildfires. In addition, the Insurance Commissioner should

prioritize outreach and education of consumers on coverage limits, helping consumers evaluate whether coverage limits are adequate to cover the cost of rebuilding or relocation in the wake of wildfire.

EXTREME HEAT

Each year, extreme heat is the largest cause of weather-related deaths, and the Fourth Climate Assessment projects that extreme heat events are increasing in frequency, intensity, and duration.[50] Many low-income communities of color in California are located in areas of higher risk, exacerbated by the repercussions of historic redlining, which resulted in racial segregation in housing.[51,52] Construction practices that did not include insulation, a lack of infrastructure and investments in urban forestry or greenspaces, limited ventilation, and inability to afford high cost of temperature control during extreme heat events contribute to greater suffering. This report puts particular focus on urban areas, where more than 87% of Californians live, and where urban-heat-island effects escalate peak temperatures, limit night-time cooling, and can produce localized temperatures several degrees higher in communities of color. Vulnerable, low-income families also commonly lack the resources to reduce their exposure to heat, including a lack of resources to cool their homes, according to a recent study of Los Angeles by researchers at the University of Southern California. A forthcoming assessment in Los Angeles County shows that not only is high heat exposure impacting communities, but that many communities have limited capacity to adapt to such conditions, resulting in vulnerability to extreme heat. While some data needed to identify populations most vulnerable to extreme heat is available such as income and location, additional data like existing health issues and social isolation should also be collected to better understand heat vulnerability.

The anticipated health impacts are projected to be substantial: increased hospitalizations due to heat-related illnesses and significant increases in kidney and other renal problems to be treated.[53] Kidney disease is expected to increase more than 10% by 2050, resulting in over 500,000 additional cases. Without risk reduction, hospital capacity could be insufficient, businesses risk lost revenue due to disruptions, and local government costs will likely spike. A study by the Natural Resources Defense Council in 2011 found that a 2006 heat wave in California resulted in nearly $179 million in costs due to hospitalizations, out-patient visits, and emergency room visits.[54]

In addition to public health impacts and costs, heat also increases the strain on energy grids, decreases labor productivity, and threatens to disrupt the agricultural industry.[55] Without stronger preparation and planning, such impacts will create costs and disruptions that will lead to further inequity. Therefore, reducing risks to heat impacts will help safeguard health and the long-term sustainability of local economies.[56]

Insurance solutions for heat waves exist in part for crops and under the umbrella of health insurance, but are insufficient to address other heat-related problems. Crop insurance exists through the federal government, but is incomplete in coverage. For example, the federal program does not cover some specialty crops, which are important

parts of local and state economies in California. Furthermore, the combination of deductibles and coverage limits, and the lack of insurance for downstream economies, such as the transport and processing of crops, leaves a concerning protection gap for individuals and local economies. In addition, despite the fact that health coverage is widely held by many but not all Californians, the costs to individuals in lost income and long-term chronic health impacts, and the anticipated costs to health systems and the economy from repeated extreme heat waves could be overwhelming. The current health infrastructure is likely unable to support the escalation in health impacts, and even if vulnerable individuals have access to health coverage, they may lack accessibility to health resources or not realize they need care until the situation becomes an emergency.

Assess the Risk

A more comprehensive assessment on the impacts of extreme heat is needed to build consciousness around the risks of extreme heat exposure and to develop better solutions for the future. California has multiple assessment tools of the heat *threat*, including the Cal-Adapt tool and the Urban Heat Index. Yet, assessments of the *impacts* of heat events are far less common. Particular to California, one study that estimated health impact costs of a 2006 statewide, ten-day heat wave event found the direct health costs to be approximately $179 million U.S. dollars based on hospitalizations, emergency department visits, and outpatient visits[57]. In addition, a 2014 study estimated that the worker productivity of individual days declines roughly 1.7% for each 1.8°F increase in daily average temperature above 59°F, and that a weekday above 86°F costs an average county $20 per person.[58] Better assessments of the financial and health costs from extreme heat events are essential for designing and funding public programs to reduce the climate impacts from heat waves in California.

Extreme Heat 1 *Perform extreme heat public sector cost analysis*

Motivation: In recent years, the ability of researchers to more accurately calculate the diffuse effects of extreme heat has improved as economic and climate modeling techniques have advanced, and larger amounts of data have become available on specific economic sectors and regions.[59] These developments all provide an opportunity to increase the understanding of extreme heat costs–a critical step in preparing for and developing financial resilience to extreme heat and risk transfer instruments. An economic analysis that delves deeply into the costs of extreme heat events to cities, counties, and the state would inform the needed size and adaptability of specific local funds or potential insurance coverages to consider in planning decisions by local and state authorities.

Recommendation: The Insurance Commissioner should convene university researchers, other insurance regulators, insurance companies, and other experts to develop a method for estimating extreme heat costs from past events, an approach known as "backcasting," and apply it in multiple California cities or counties. The analytic method should also include the capability to use the backcasting findings to forecast future costs from an extreme heat event to allow decision makers to compare future heat-related costs with the costs of mitigation efforts.

- First, reliable meteorological data encompassing a past heat event and data representing associated outcomes in a sector (e.g., hospitalizations, reduced productivity, financial market trends) must be identified.

- By analyzing outcomes (financial, health-related, government and business interruption) over time, cost impacts and implications of extreme heat events can be isolated.

- Data from multiple communities and cities can be examined and compared among locations to identify discrepancies due to extreme heat.[60] The cost of a specific indicator (e.g., a single emergency room visit) can be established based on information from local authorities or existing research on the subject. Recently, the New York Department of Health partnered with NASA Earth Science to study past heat events for identifying thresholds, and the results of the study led to New York changing its heat advisory threshold from 100°F to 95°F.[61]

The result of this work would not only be an understanding of total extreme heat cost, but also the development of a clear methodology and identified best practices to do this analysis in any location or municipality, which will enable improved decisions leading to greater financial and physical resilience.

Extreme Heat 2 *Strengthen insurance coverage to account for costs of extreme heat events*

Motivation: Extreme heat spikes can cause both acute and cumulative economic stress. In California in 2020, extreme heat events and forecasts prompted the Governor to make an emergency declaration, the first of its kind. The events disrupted the energy supply, businesses, and supply chains.[62] Many businesses carry supply chain or business interruption insurance coverages, but it remains unknown if common policies cover heat-related events. Heat is also correlated with decreased economic productivity and increased workers compensation claims.[63] Looking forward, the increased prevalence of extreme heat events may have measurable impacts on payouts from existing insurance policies. The inclusion or exclusion of such costs in existing policies should be a consideration by the businesses purchasing these policies, and also by the local jurisdictions planning for extreme heat events because heat has economic impacts. If extreme heat events have unmet costs to local businesses, energy systems, tax revenues, government operations or health care, they could threaten fiscal sustainability of local governments. The consequences of unmet local costs will further disrupt the important services that local governments provide to support and protect local communities.

Recommendation: The Insurance Commissioner should work with state agencies, scientists, consumer groups, insurance companies, and international organizations to consider the implications of extreme heat for existing insurance lines that may be vulnerable to a surge of claims or periodic disruption by extreme heat events, such as insurance products related to health, energy outages, workers compensation, or supply

chain disruptions. The Insurance Commissioner should also consider whether existing risk transfer solutions available in the market to reduce risks of supply chain disruptions or to alleviate the drain on past workers compensation to focus on newer risks.

Risk Communication

Even with existing data, risk communication for heat must be urgently expanded. The Fourth Climate Assessment found that, in California from 1999 to 2009, 19 heat-related events occurred that had significant impacts on human health, resulting in about 11,000 excess hospitalizations. However, the National Weather Service issued Heat Advisories for only six of the events. Heat-Health Events (HHEs), defined using an existing California tool.[64] In addition, California has developed several tools, including the Urban Heat Island Index and the Office of Emergency Services (CalOES) online resources that link to National Weather Service advisories, but it does not appear that those resources are commonly used by state or local governments for action plans at this time.

Extreme Heat 3 *Improve communication of heat threats and potential impacts*

Motivation: Although public education programs for extreme heat exist, further coordination and collaboration is needed to reach people and avoid health impacts. For local governments and the state to reduce heat impacts, communicating the threat and ways to reduce impacts, whether to human health or the economy, requires a coordinated policy response and adequate resources. Even though the state has tools, it is unclear whether they are being used. In particular, federal and state agencies have spent years producing warning systems and communication plans for emergency flooding, fires, tornadoes, and earthquakes, among others. California needs successful communication of risk with communities for the state's programs to have a positive impact.

*Recommendation***:** The Insurance Commissioner should liaison with the California Department of Public Health, the California Office of Environmental Health Hazard Assessment, CalOES, and other relevant state agencies to launch an Extreme Heat Risk Communication Campaign with state and local partners (*see Appendix 3)*. Information like emergency warnings should be shared in multiple languages to ensure critical information reaches linguistically isolated communities. Strategies should consider how people with poor or no broadband will be able to access the information in addition to people who are hearing and seeing impaired. Cooling centers and other emergency shelters should also be accessible to communities that need them most, particularly for residents without access to reliable transportation. Because extreme heat is an international challenge, the Insurance Commissioner should work with local, state, federal, and international groups.

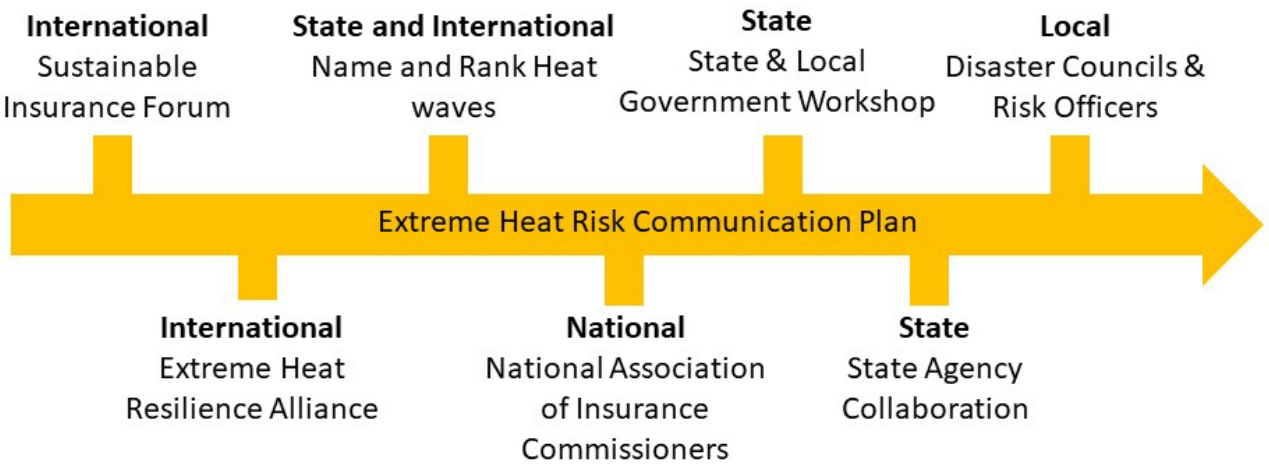

Figure 3. Communicating the threat of heat requires a unique multi-jurisdictional effort, including local, state, national, and international partners. Partnerships among insurance regulators, such as the Sustainable Insurance Forum, and among public policy experts, such as the Extreme Heat Resilience Alliance, can produce a more effective warning system and communication strategy.

Further detail: Heat is an international threat that needs to be planned for and communicated with communities in rural and urban settings. It is thus necessary to put together a specific plan to convene government and non-government organizations to elevate extreme heat as a climate impact and to build a communication strategy with vulnerable communities. The Insurance Commissioner should aggressively pursue an Extreme Heat Communication Plan that convenes groups at the international, national, state, and local levels.

International and National

The Insurance Commissioner should work with the Executive Climate Risk and Resilience Task Force at the National Association of Insurance Commissioners, the Sustainable Insurance Forum, and the Insurance Development Forum to learn how other Insurance Commissioners and insurance companies are thinking about extreme heat in the context of insurance, and explore whether those strategies are applicable to California.

In partnership with the Extreme Heat Resilience Alliance, the Insurance Commissioner should promote legislation to determine the most effective way to achieve the identifying, ranking, and communication of extreme heat events to encourage preparation and efforts to mitigate the impacts on human health and the economy.

- Informative models for consideration include California's "red flag" warnings, the U.S. Environmental Protection Agency Air Quality App, and the naming system for tropical storms and hurricanes by NOAA.

- The heat event name should include categories, and communications about the event should include details related to geographic location and measures of severity and potential duration to make it easier to track.

- The different categories should be accompanied by recommended precautions for the public to take based on the intensity of the heat event with additional precautions for vulnerable populations. For example, for a Category 2 heat event warning, the public should limit time outdoors and wear loose, cool clothing and a hat and sunglasses. Vulnerable populations like the elderly and others that are especially susceptible to the heat impacts may need to take additional measures.

- Consider whether the declaration of a heat event can trigger any laws relating to insurance, such as a grace period for the public to pay insurance premiums or other implications associated with economic disruption.

State

The Insurance Commissioner should partner with the Governor's Office of Planning and Research through their Integrated Climate Adaptation and Resilience Program (ICARP) to co-host a workshop to (1) share key messaging on extreme heat risks developed in Recommendation #1; (2) learn of approaches local officials are currently undertaking to address extreme heat and what issues remain unaddressed; (3) get feedback and information from local officials about challenges that make it difficult to address extreme heat and where there may be interest in using insurance as part of an extreme heat mitigation strategy; and (4) develop strategies in collaboration with local governments to incorporate extreme heat into their local planning efforts, including those required in Government Code Section 65302.

The Insurance Commissioner should convene a meeting with key state agencies involved in extreme heat planning and response to coordinate messaging and benchmarks, and to determine how insurance concepts or approaches can be used to support those strategies and actions.

The Insurance Commissioner should work with the California Office of Health Hazard Assessment and other agencies within the California Governor's administration to develop a public education campaign targeted to the general public on the impacts of extreme heat, similar to the public education campaign that California developed to promote statewide water conservation goals.

- The campaign should include partnerships with community-based organizations serving communities that are most vulnerable to extreme heat,

including low-income communities, communities of color, the elderly, disabled persons, farmworkers, and other vulnerable subpopulations.

Local

Promote *Heat Readiness* as an application of existing and future emergency preparedness planning.

- For example, Phoenix, Arizona initiated a *HeatReady* program, the nation's first program of its kind. The program treats heat readiness like hurricane readiness and heat waves like temperature tsunamis, alerting residents with text notifications and offering emergency cooling centers.

- California's existing and planned efforts to augment preparedness on wildfires can be adapted to pilot a heat readiness program.

The Insurance Commissioner should meet with the members of local Disaster Councils and the cities' risk managers to discuss opportunities to use insurance concepts or products.

Extreme Heat 4 *Improve warning systems by naming and ranking heat waves*

Motivation: Advance warning of disasters save lives and provide a window of opportunity for protecting property or avoiding harm.[65] Such systems have historically been critical assets for facilitating evacuations and risk reduction measures. California's "red flag" warnings for wildfire conditions, the U.S Environmental Protection Agency Air Quality App, and the naming system for tropical storms and hurricanes by NOAA could serve as templates for naming and ranking heat waves. For example, early warning of an approaching hurricane often prompts boarding up windows and placing sandbags. Even though weather forecasting from the National Weather Service provides advance information, California's early warning systems for extreme heat are not demonstrably effective, in part because extreme heat is not often viewed as an event for which to prepare and react. California has existing tools, including an urban heat index and Heat Health Event calculator, but no coordinated warning system. At multiple levels of government, extreme heat events appear to surprise policy makers. In a very recent example, even with advance warning, the heat waves of 2020 in California caused disruptions to the state's highly sophisticated electricity grid.

Recommendation: The Insurance Commissioner should work with state agencies and the State Legislator to establish a state system to identify and rank heat waves, and to provide information to the public about the projected impacts of each. Clear categorization of heat waves could enable public policy makers to craft prevention strategies, risk reduction measures, and response strategies to specific thresholds. Such a system could allow the state to track the impacts of specific events more easily and communicate the results to the public more effectively. A heat wave categorization system should include the following elements:

- The heat wave designation should include categories of magnitude, and communications about the event should include details related to geographic location, measures of severity, and potential duration to make it easier to track.

- The different categories should be accompanied by recommended precautions for the public to take based on the intensity of the heat event, with additional precautions described for vulnerable populations. For example, for a Category 2 heat wave warning, the public should limit time outdoors and wear loose, cool clothing and a hat and sunglasses. Vulnerable populations like the elderly and others that are especially susceptible may need to take additional measures.

Risk Reduction

One of the recommendations from the Global Commission on Adaptation Report is to expand green space in and around cities to reduce heat risks.[66] Increasing urban forests, changing materials used to build streets, and providing incentives for cool roofs can all moderate the temperatures experienced by communities and can be integrated into state and local planning and spending priorities. Such measures are important to reduce the risks to communities that do not have existing parks or tree canopy and reduce the unmet costs to both the public and private sector, stabilizing budgets for businesses and local governments alike.

Extreme Heat 5

Motivation: The burden of addressing extreme heat falls heavily on local governments, and in response, many are developing heat action plans. Yet implementing a comprehensive approach carries costs and risks to local governments, which require supplemental, ongoing funding. Bonds can move money forward in time, which is critical for extreme heat impacts that are projected to grow. A Social Investment Bond is a finance tool that could help a city improve health outcomes in a vulnerable community by reducing peak day and night temperatures, while providing data on the efficacy of implementing a heat action plan. Such data will help clarify insurance opportunities for local governments while reducing impacts.

Recommendation: The Insurance Commissioner should collaborate with national and international partners to develop and propose a Climate Resilience Bond Financing Concept for Local Heat Action Plans. A model pilot project, in which a comprehensive heat action plan would be implemented in a vulnerable or disadvantaged community, could provide valuable lessons in reducing heat risks. The project would be financed through an innovative Climate Resilience bond with a risk transfer mechanism based on the "Pay for Performance" construct. Such an approach has been recently used to promote green infrastructure in Washington D.C. (*see box)*[67] The bond would be paid for by a combination of local and state funds. The bond would be structured as follows:

- If the reduction in temperature or other relevant metric in the pilot area compared to the city at large falls within the estimated range, the city pays back the investors per the terms of the bond without a contingency fee.

- If the temperature reduction is greater by a predetermined amount, the government pays the contingency fee to the bond purchaser for assuming the risk.

- If the project underperforms and the reduction in temperature falls below the estimated range, the purchaser pays an additional risk payment—the contingency fee—to the City.

If successful, the pilot project would provide a proof of concept for resilience bonds that could scale, demonstrating that a comprehensive heat action plan can reduce public health risks during extreme heat events, while also showing the potential benefits of transferring a portion of their risk from extreme heat through an innovative parametric insurance instrument. A successful pilot may motivate the local government use such a parametric insurance instrument.

Risk Transfer

California likely faces a financial gap in meeting the anticipated increase in hospitalizations, disruptions to business, the need for additional cooling centers, and the electricity to power those centers. Insurance is a financial planning tool that can address some, but not all, of the specific heat-related risks. The proposed framework (*Figure 4, below*) offers an approach to identifying points of stress or shock and designing interventions, and is meant to demonstrate concepts that can be tailored to state or local government needs. At each point in the curve, the local jurisdiction could develop risk transfer policies or employ intense risk reduction to alleviate the escalating impacts.

Extreme Heat 6 *Develop pilot projects for extreme heat*

Motivation: California should initiate an overarching pilot project approach to insurance product development now so that the types of policies that can provide financial protection could be in place as climate impacts on health accelerate. Without insurance policy development and risk mitigation, unplanned costs will fall on overwhelmed local governments and their individual constituents. Furthermore, proactive risk mitigation and intervention through insurance products is necessary to reduce the impact of these events; indemnifying for catastrophic impacts after the fact misses the opportunity to reduce individual suffering and community cost.

Many extreme heat costs fall to local governments, health systems, and individuals. Timely funding is needed to support intervention services when extreme heat waves occur. Jurisdictions with the mandate to provide needed public services during heat waves can incur unanticipated and unmet costs. In the short term, counties and cities might have to deploy healthcare staff to check on vulnerable individuals and provide

cooling centers for people to find shelter, or run transportation services at a higher cost. In the medium term, hospital emergency rooms may be overwhelmed by individuals seeking care. Because many vulnerable individuals lack air conditioning, or the ability to pay to run air conditioning, it may be unsafe to send them home. Greater hospital admissions and longer hospital stays, in turn, escalate expenses to counties and cities that own and manage public hospitals. In the long term, the cumulative impact of illnesses exacerbated by heat conditions, such as diabetes and kidney disease, can be tragic for communities and create significant costs for local jurisdictions in social services. If counties, cities, hospitals, and utilities are not able to reduce climate impacts, then repeated economic disruptions and long-term damage to health will ensue.

Recommendation: The Insurance Commissioner should convene potential partners and put out a Request for Proposals to conduct a proof of concept for an extreme-heat-risk transfer and risk-mitigation strategy. The effort should identify 1 – 3 potential urban locations to implement and test risk mitigation and risk transfer solutions. The effort should consider insurance solutions at the individual level to incentivize early intervention as well as at the jurisdiction level to reduce the financial and health impact to a community.

Although a risk transfer product for hospitals should be considered, the overall goal should be to develop the strategies that could be considered to preserve stability for health systems, energy systems, cooling systems, and public sector budgets in the face of successive heat waves. *Please see Appendix 3 for specific proposals.*

Extreme Heat *7 Establish a California extreme heat risk pool*

Motivation: Recent large-scale events like Hurricane Harvey in Houston and Superstorm Sandy in the northeastern US demonstrate the inequity following disasters where risk pools, insurance, or other recovery policies are not in place. Extreme heat is causing deaths and health impacts, and heat events are becoming more common and frequent. Developing effective strategies for reducing risks from heat events offers an opportunity to open a new frontier in resilience planning—the establishment of risk pools. During each heat wave, while health costs may be met by an individual's health coverage, the cost to a city or county in reduced tax revenue from lost economic activity, in electricity outages, and in the need for interventions, such as cooling centers and proactive medical outreach, can be abrupt and disruptive to budgets. A risk pool strategy is the type of solution that invests money upfront, and builds the capacity to better react to future heat waves, potentially preserving health and saving money in the long term. Risk pools for natural disasters have been tested around the world (e.g., African Risk Capacity) as a method of quickly and consistently delivering funding to local and national governments when disasters strike.[68] Risk pools are often further backstopped by state funds, catastrophe bonds, reinsurance markets, or a multi-state pooling strategy.

Recommendation: In order to reduce the health and financial risks of extreme heat, California should consider establishing an extreme heat risk pool, which would transfer aggregated risk from counties or cities to the state. The Insurance Commissioner should

review existing captives and risk pools, consult with the NAIC, international regulators from the Sustainable Insurance Forum, consumer groups and insurers, and identify the appropriate stakeholders and experts to convene for policy proposal development.

A California statewide financial risk pool would enable a timely and forward-looking response to extreme heat, by 1) granting access to critical and immediate capital directly before or immediately after an extreme heat event, and 2) preventing the need to drain existing budget allocations or accrue debt from bank loans to finance extreme heat response. A parametric insurance model would increase the speed at which disbursements reach governments by relying on a set "trigger" based on reliable data to quickly release payments. The case of the Caribbean Catastrophe Risk Insurance Facility (CCRIF)[69] illustrates the value of parametric insurance—since 2007, all of the facility's payouts to member governments have been made within two weeks of the triggering events (*see box*). Such timeliness is critical. Mexico's FONDEN,[70] a fund for natural disasters, demonstrates the effectiveness of a risk pool coordinated across multiple levels within a single country (*see box*). FONDEN has been previously funded by the federal government and created an incentive at the federal, state, and local level to jointly manage risks and transfer risks. In the case of CCRIF and FONDEN, payments are made to insured governments by the facility or program. In the context of California, payments could go directly to counties or cities.

To provide liquidity for heat event preparation, public interventions and lifesaving activities, payouts could also be shifted to pre-event actions by relying on increasingly accurate forecasting, as the Red Cross has done in Vietnam (*see box*). Though the Red Cross delivers philanthropic—not insurance—money, its work demonstrates the value of funds arriving before the peak of a disaster event for evidence-based preparation measures, such as setting up cooling stations and initiating community outreach programs. Partnerships should be formed with research and academic institutions that monitor relevant data to develop a robust trigger protocol.

A trigger protocol could be developed in California in partnership with meteorologists, climatologists and others, building on the Urban Heat Island Index for California developed by the Office of Environmental Health Hazard Assessment at the California Environmental Protection Agency.[71] Based on this tool, a trigger would be set for when payment from the risk pool's parametric policy would be made to the local government jurisdiction a few days prior to, during, or immediately after the heat wave. The local jurisdiction would decide how to use the funds.

Box:* *Vulnerability to Extreme Heat

In California, vulnerability to climate impacts, and especially extreme heat events is exacerbated by existing inequalities. Research on ten heat events in the U.S. 2001-2010 indicate that costs for heat-related in hospitalized were greater among Black, Hispanic, and Asian and Pacific Islander communities. Individuals hospitalized for heat-related illnesses were more likely to reside in the lowest zip-code income quartile, not have insurance, and be hospitalized in rural areas.[44] In addition, a recent study that analyzed maps of redlined vs. non-redlined neighborhoods, which were used

beginning in the 1930s and outlawed in 1968. By comparing maps of redlined vs. non-redlined neighborhoods with maps of recent temperatures, the study demonstrates that 94% of studied areas from over 100 cities show patterns of higher land surface temperatures in formerly redlined areas, indicating racial inequities, especially for Black communities, in extreme heat exposure.[45]

Box: Heat-related Illnesses

Mitigating extreme heat events will save lives and reduce hospitalizations. An assessment of hospitalizations related to heat exposure in California found that every 10°F increase above the mean ambient temperature is accompanied by a 393% increase in hospitalization for heat exposure, a 3% increase in hospitalization for ischemic stroke, and a 15% increase in acute renal failure hospitalizations.[45]

Box: Pay for Performance Bond Concept

In Washington D.C., the Water and Sewer Authority has created a municipal bond with an innovative structure that invests in green infrastructure to reduce the incidence and volume of sewer overflows, and covers the potential unexpected downsides. The performance risks of the green investments are shared among The DC Water and Sewer Authority and the investors (See writeup on concept by NRDC).

Box: FONDEN

As part of the country's disaster finance strategy, Mexico established a fund for natural disasters, known as FONDEN. When funded, after a disaster, the fund can be used for the rehabilitation and reconstruction of: 1) public infrastructure (federal, state, and municipal); 2) low-income housing; and 3) specified actions to restore the natural environment. A portion of the FONDEN fund supports disaster risk reduction.

Box: CCRIF

The Caribbean Catastrophe Risk Insurance Facility was formed as the first multi-country risk pool in the world. The CCRIF is backed by a parametric policy that limits the financial impacts of tropical cyclones, earthquakes, excess rainfall, and the fisheries sector to Caribbean and Central American governments

Box: Vietnam and the Red Cross

In Hanoi, the Red Cross partnered with the Institute of Meteorology, Hydrology, and Environment (IMHEN) to develop a trigger protocol for delivering philanthropic dollars for extreme heat impacts. The trigger protocol requires that the Heat Index reaches its 99th percentile value for two consecutive days, and that the maximum temperature forecast is higher or equal to 37 °C both six and three days before the forecasted extreme heat event.

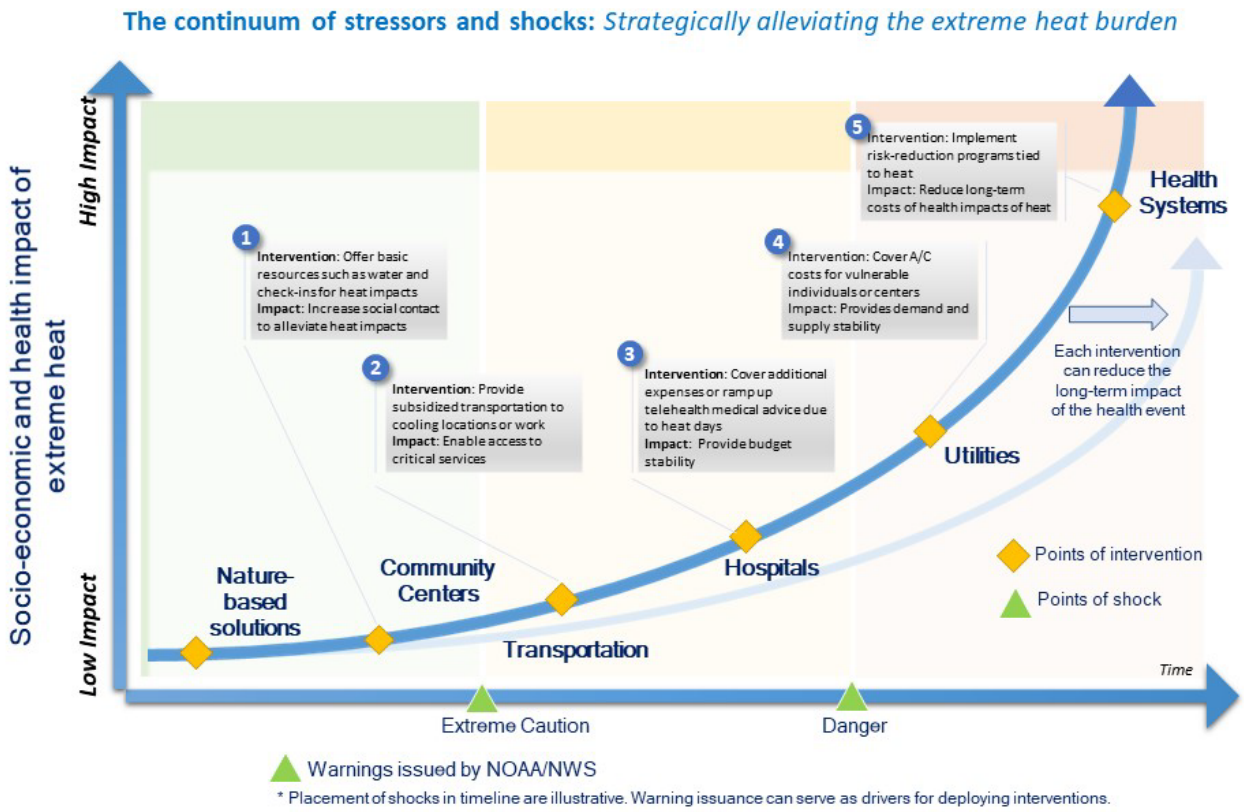

Figure 4. For extreme heat events, the magnitude and duration of the episode increase moving up the X-axis and the socio-economic and health impacts increase moving up the Y-axis. The curve indicates the escalating impact of the heat episode with increasing time and severity; this impact can be curbed through interventions, such as a public outreach campaign and mitigation actions. However, each point requires additional costs, which could be paid through fund reserves or a risk transfer product. Local jurisdictions or the state would identify points where risk reduction and risk transfer could be effective and design a solution. Such a framework can be adapted to the needs of each jurisdiction.

FLOODING

Flooding is responsible for the most damage from all natural hazards in the United States. Reducing risks to vulnerable communities and also addressing the potential for displacement of communities are critical to equity and climate resilience. Strong storms can close down businesses and force households to evacuate, and recoveries from large storms have often been slow, further exacerbating inequities. Some recent examples may demonstrate effective approaches. After Superstorm Sandy, the City of Hoboken, New Jersey began creating joint greenspace housing developments that strive to provide affordable housing, by requiring at least 10% of housing meet a certain affordability threshold. The greenspace can retain 450,000 gallons of water to reduce flood risks. California faces threats from a number of different types of flooding, depending on the

region. Those types include river (or fluvial) flooding, coastal tidal and storm surge flooding, rainfall (or pluvial) flooding, and flooding from the failure of protective infrastructure such as dams and levees. The risks from all these sources is increasing, due to a combination of climate changes, increased development, and infrastructure in need of repairs and upgrades. According to the Fourth Climate Assessment, for example, there will be more frequent flooding and inundation in certain regions, as well as increased cliff, bluff, dune, and beach erosion.[72] Higher precipitation-related flood risk is also driving increases in landslide and mudslide risks, particularly post-fire when the vegetation on the slopes has been burned and reduced. The risks are not just to homes, but to all types of infrastructure as well, such as roads and railways, harbors and airports, power plants and wastewater treatment facilities, and thousands of businesses and homes.[73]

Even aggressive reductions in greenhouse gas emissions will not eliminate the risk to California of extreme sea-level rise from Antarctic or Greenland ice loss, particularly if glaciological processes reach tipping points.[74] The Fourth Climate Assessment estimates that close to $18 billion in residential and commercial structures could be inundated from sea-level rise by 2050. Many inland communities that may not consider themselves vulnerable to sea-level rise can also expect to see inundation, saltwater intrusion, and disruptions to supply chains and to access to goods and services.[75] Sea-level rise will interfere with California's $44 billion ocean economy, including coastal recreation and tourism, as well as ports and shipping.[76] California's coastline has concentrated areas of economic activity and assets, including ports and cold storage, tourism, and fishing.

Not only will California face greater risks of flooding because of climate-intensified rainfall and snowmelt, the state also may suffer greater effects and damage from floods because the nature-based "sponge" capacity of the state's landscape has been largely diminished over the course of the state's history. California's major rivers were once flanked by miles of floodplains, which allowed floodwaters to spread, meander, and pool. Land use conversion and development has eliminated many of those protective floodplains, and the hardening of banks and levees has fundamentally altered how water flows through the state, exacerbating flood risks. In addition, the United States Geological Survey estimates that California has lost approximately 95% of its historical wetlands, further reducing the natural water retention capacity of the landscape.

The State of California has tried to reverse these negative trends by improving floodplain management,[77,78] and made some progress restoring nature-based floodways and flood bypasses.[79] Large-scale preservation of floodplains requires acquiring and connecting large tracts of land and maintaining land uses compatible with flood management.[80] While expensive, these practices are already implemented in California through various programs, including state and federal laws protecting wetlands, local zoning, government-funded incentive programs, and acquisition of land by governmental entities, nonprofit organizations, or partnerships dedicated to land preservation.[81] There have also been federal-local partnerships on these types of nature-based solutions, such as the Napa "living river" project.[82] Acquired lands may generate

revenue by continuing in agricultural production or by taking advantage of emerging markets for groundwater recharge or carbon sequestration, a process by which natural lands incorporate carbon dioxide from the atmosphere into plants, animals, and soils.[83]

Assess the Risk

At the state level, the Department of Water Resources conducts risk assessment, primarily related to snowmelt, precipitation, and atmospheric rivers as a means to manage water supply and flood control from gray infrastructure. Localized risks have historically been managed by local governments, many of which work with FEMA and state agencies to produce hazard mitigation plans. One exception lies in the Central Valley, where flooding from rivers and examples of failed flood prevention infrastructure prompted the State Legislature to mandate a regionally focused risk assessment. Starting in 2012 and updated every five years subsequently, the Central Valley region develops a flood protection plan for each of six major rivers. This plan establishes zoning requirements for new development based on flooding risks. However, other jurisdictions in the state do not establish such plans and residents may not have access to insightful maps or models. Looking forward, federal risk assessment tools will be critical for assessing the various risks of flooding in California. Some of the most sophisticated risk assessment is focused on coastal flooding, the United States Geological Survey (USGS) has published the Coastal Storm Modeling System (CoSMoS), which makes detailed predictions of storm-induced coastal flooding, erosion, and cliff failures over large geographic scales.

Flooding 1 *Conduct high rainfall event vulnerability analysis*

Motivation: The vulnerability of a home to flooding from large storms, such as those caused by atmospheric rivers, is a fundamental piece of information for homeowners, communities, and the state, in order for appropriate risk reduction actions to be adopted. Currently, there is poor understanding about the risk of structures to these types of catastrophic flood events.

Recommendation: The Insurance Commissioner should initiate a "Request for Proposals" for a vulnerability analysis of possible impacts from major atmospheric rivers. The analysis could draw upon historical data from the Great California Flood of 1861 and 1862 and couple it to forward-looking modeling to anticipate the impacts of similar, or even greater, atmospheric rivers in the future. The report should also examine available mitigation strategies. The vulnerability analysis could be instrumental in setting building standards for new construction and in guiding community disaster resilience planning. This vulnerability analysis should be used to prioritize local flood mapping and modeling efforts.

Risk Communication

Much flood risk communication is done through the Federal Emergency Management Agency (FEMA), since it is the home for the National Flood Insurance Program (NFIP). FEMA produces flood hazard maps that depict various flood zones. Property located in a FEMA-mapped 1% annual chance floodplain, also referred to as a Special Flood Hazard Area (SFHA), with a federally-backed loan or a loan from a federally-backed lender must purchase flood insurance. As part of the program, lenders must disclose when a property is located in the SFHA. Many states, including California, also require sellers to disclose when a home is located in a SFHA.

Unfortunately, the existing FEMA maps for flood risk in California are outdated and incomplete. They typically fail to include the flood risks from extreme rainfall flooding (pluvial flood risk) as opposed to river flooding, and also create a false sense that flood risk is binary, depending on whether one is "in" or "out" of the SFHA. Those people who live in areas with out-of-date maps, or outside the coverage area of the FEMA maps, may have moderate or substantial risk, but may not know about that risk. Recent local construction, changing hydrology, and stream maintenance may result in the existing maps being poor reflections of true risk.

Flooding 2 *Make risk reduction information more accessible*

Motivation: Risk reduction is often the key to averting some future losses, yet information on flood risk reduction is difficult for the public to obtain. Even when lists of possible mitigation actions are available, it is challenging for homeowners to know how to identify which mitigation options are best for them, and then to prioritize these actions, obtain cost estimates, secure funding, and find a trustworthy firm to do the work.

Recommendation: The Insurance Commissioner should develop consumer-focused tools that can assist in risk communication and in encouraging homeowners to understand their risk mitigation alternatives. This could be an online tool that provides information on flood risk, as well as possible mitigation and insurance options, their cost, and certified professionals to assist in the work. An example of this type of tool is https://www.floodhelpny.org, which helps people understand possible flood retrofits, certification systems for elevating a home to reduce flooding risks, and flood insurance. Such a tool can be linked with potential local or state grant funding. Furthermore, the Insurance Commissioner should work with FEMA to do outreach to those people living in areas where landslides and mudslides could occur in the aftermath of wildfires.

Flooding 3 *Make NFIP pricing more visible*

Motivation: The overwhelming majority of flood insurance is provided through the NFIP. While different insurance firms will write a NFIP policy, the price is the same across firms as it is set by FEMA. It is incredibly difficult for a potential buyer of a new home to get an estimate of the cost of flood insurance *before* making an offer on a

property. This is problematic as it is a key component of the cost of ownership, and price is a communication point for homebuyers.

Recommendation: The Insurance Commissioner should create a NFIP flood insurance premium calculator, perhaps in partnership with FEMA, where individuals can enter property addresses or information about their property and immediately get a price quote. This should be done in conjunction with an expansion of the current *Insurance Finder* Tool, now focused on homeowners insurance, including flood insurance options from the NFIP and the private insurance market. Launch of this tool should be combined with a communications strategy to reach a wider audience, including the Insurance Commissioner meeting with local communities to better understand how to make such a tool more accessible.

Flooding 4 *Provide temporary assistance for purchasing flood insurance*

Motivation: As noted earlier, uptake of flood insurance is generally low in California. Barriers to increased uptake may be poor risk communication, lack of public understanding of flood insurance options, and cost. Achieving greater uptake of flood insurance also likely requires public policies that address the role that inertia and other commonly observed reactions to risk can play in human decision-making.[84]

Recommendation: In order to attract more households to purchase flood insurance, the State Legislature should consider establishing a 3-year program to subsidize flood insurance premiums for low and middle income Californians who purchase flood insurance. Such a program should focus on communities where insurance uptake is low, and should put added emphasis on reaching out to renters.

Flooding 5 *Synthesize existing maps and clarify risks for the public*

Motivation: Flooding risks are more pervasive than is commonly recognized in existing planning. The federal government provides flood hazard maps, but these do not show the full gradation of risk, focusing primarily on designating just the 100-year floodplain, or the area of at least a 1% annual chance of flooding. Furthermore, these maps have been criticized as being out of date and not including all sources of flood risk—notably, they often do not include rainfall-related flooding, sea-level rise, or groundwater flooding, nor risk of mudflows and landslides. Finally, the maps are inherently backward looking and provide no comprehensive information on future flood risk. To fill in gaps in information, several non-governmental organizations, private sector firms, and academics have provided more comprehensive flood risk information and projections of future flood risk. Many possible users, however, are unaware of all the information available or unsure how to compare and evaluate the different models to meet their needs. A private organization, the First Street Foundation, has created comprehensive flood risk information for all properties in the U.S., as well as projections of flood risk over the next thirty years, and now made that risk information available through their own website and Realtor.com. Households deserve to have access to publicly available risk information, but more detailed maps could further exacerbate inequities, which is an issue discussed in the accompanying box (*see box*).

Recommendation: To support the one-stop approach for climate risk information in Cross-Cutting Recommendation 3, the Insurance Commissioner and the Department of Water Resources (DWR) should work together to make flood mapping resources more comprehensive, both for understanding the risks and for guiding mitigation investments by the state to reduce the risk. In particular, DWR should consider the flood mapping information that currently exists and endorse high quality public (e.g., FEMA) and private options (e.g., First Street Foundation), and report these endorsements to the State Legislature and other state agencies. Local communities may have local maps or vulnerability assessments, and therefore, meeting with local governments and community organizations can strengthen this effort and identify potential unintended consequences, such as exacerbating the risk to low income communities and communities of color. Because flooding can have multiple sources and cause multiple threats, the Insurance Commissioner and DWR should work with federal partners to make hazard maps more extensive, bringing together the existing maps of high flood risk areas, high erosion risk areas, and sea-level rise zones, and areas critical to mitigating the effects of climate change. In particular, the Insurance Commissioner should work with FEMA to ensure that areas where landslides and mudflows are high risk, especially after wildfire, are incorporated into future maps. The most up-to-date maps endorsed by DWR should be included in the one-stop-shop resource in Cross-Cutting Recommendation 3.

Risk Reduction

Local zoning, building standards, and natural infrastructure all play roles in California's approach to risk reduction for flooding. California has specific zoning rules for homes in the 100-year floodplain in the Central Valley area, which is where large rivers and water infrastructure collide. Starting in 2009, specific building codes and zoning rules were developed to reduce the risk of flooding to homes. But these development rules do not extend outside of the Central Valley area. All communities that participate in the NFIP must adopt minimum floodplain management regulations. These require that new development in floodways not be allowed if it increases flood heights and that all new construction (or substantially improved or damaged structures) in the FEMA-mapped 100-year floodplain be built above the base flood elevation (or the estimated height of waters in a 100-year flood). There are further requirements in areas subject to storm surge. Some stakeholders have argued that in the face of increasing flood risk, these minimum regulations should be strengthened.

Flooding 6 *Create a market for natural infrastructure investment to reduce flooding risks*

Motivation: As we restore wetlands we will reduce risks, and those investments should be valued. California has laws to prevent wetland destruction, and additional incentives could enhance wetland restoration. Supplemental investment in nature-based solutions is needed to reduce risks and to meet the land conservation and biodiversity protection goals as stated by multiple governments, including by the California Governor. Such

restoration investments produce a number of additional co-benefits, including habitat, recreational opportunities, and carbon sequestration, where the nature-based solution is actually removing carbon dioxide from the atmosphere. One way to increase the provision of nature-based solutions to flood risk is through a market for natural infrastructure that more effectively values wetlands and floodplains, allows for greater cross-jurisdictional pooling of investments, and could provide a mechanism for including blue carbon, a measure of carbon held in oceans and bodies of water, accounting in decision-making. Such markets are created through public policy, which requires "credits" that can then be traded, and contribute to the creation of a supply of nature-based solutions for flood risk reduction.

Recommendation: The Insurance Commissioner should work with the California Natural Resources Agency and other relevant state and federal partners to consider proposing the creation of a market mechanism in natural infrastructure credits to finance proven nature-based climate-resilience measures. The Insurance Commissioner and partners should determine if the state has the data and modeling capability to establish such a currency, including the capacity of existing nature-based solutions to slow and store water. In one recent example, North Carolina passed legislation to create a first-of-its-kind marketplace to create and sell flood reduction credits.[85] The program builds on the state's existing stream and wetland mitigation program as a way to provide further incentives to reduce flooding risks with investments in nature-based solutions, using floodplain storage capacity as a common currency. The mechanism used by North Carolina, including a reverse auction purchasing mechanism could be a consideration.

Risk Transfer

California faces a sizeable flood insurance gap—this refers to the difference between total economic losses and the share of those losses that are insured. More simply, many people at risk of flooding in the state do not have flood insurance. FEMA maps show that approximately 500,000 California properties are in Special Flood Hazard Areas (SFHAs), with a 1% chance of being flooded in any given year. (The private flood insurance market, while growing, still represents less than 10% of the overall policies in force in California.) Yet Californians are severely under-protected for even those flood risks. As of Sept 2019, only 227,000 homes in the state were insured for flood by the National Flood Insurance Program (NFIP). With about 12 million housing units in California, that means less than 5% of all California homes have flood insurance. As discussed above, these maps are often outdated and limited; a recent extensive study by the First Street Foundation estimates that the actual number of properties at a 1% risk is much greater, at 1.1 million, and that an additional 150,000 properties will meet that threshold in the next 30 years, mainly because of rising seas and associated flooding events. Absent widespread insurance to provide financial protection post-flood, large atmospheric rivers, coastal storms combined with storm surges and sea-level rise, or rain-on-snow events can be expected to cause further economic damage and pose major threats to household, local, and state fiscal stability.[86]

Flooding 7 *Map distribution of low flood insurance uptake*

Motivation: Low insurance take-up rates for flooding risks in California may have multiple causes—price, lack of information about flood risks, failure to understand the role and importance of insurance in recovery, and an overly optimistic view of low-probability risks. In addition, trust and understanding of insurance approaches can be a barrier to purchase insurance. The Insurance Commissioner has an important role to help make insurance decisions understandable to the public, and flooding is an area where the role may be even more important. Detailed information about flood insurance take-up rates could inform the state on how to best approach reducing the protection gap.

Recommendation: This recommendation has multiple parts: 1) First, the Insurance Commissioner should undertake a detailed and granular analysis of take-up rates for flood insurance to better identify flood insurance gaps in the state and make the results available to all stakeholders. Meeting with local communities to understand local approaches to flood mitigation are also essential to understanding the larger picture of flood insurance decision-making. The Commissioner should also promote flood insurance options, even among those outside the SFHA or inside the SFHA but without a mortgage and not subject to the federal mandatory purchase requirement; 2) Once maps of flooding risks are improved, for communities where flood risk is high and insurance uptake is low, the state of California should consider requirements for communities or individual property owners to purchase at least a low coverage limit of flood insurance. Community policies, the NFIP, and private insurance options should be evaluated, and data-sharing between Federal and state government will likely be important to inform this potential discussion. If flood insurance uptake remains low and flooding costs to households continues to rise, the State Legislature should consider requiring at least a low-coverage limit, based on common damages from recent flooding events, of flood insurance for all properties within the 500-year floodplain. This would require mapping of the 500-year floodplain across the state in advance of such a rule.

Flooding 8 *Develop proof of concept for a wetlands nature-based solution and risk transfer*

Motivation: For community insurance policies to be fully evaluated, pilot projects must be conducted to develop the science and policy elements needed to conduct thorough analysis of costs and benefits. Recent research has explored combining risk mitigation and risk transfer for coral reefs.[87] California does not have coral reefs but has approximately 2.9–3.8 million acres of wetlands, some of which may be well suited for being incorporated into risk transfer mechanisms for either the community or the wetland (*for example, see* this recent study).[88] Wetlands can be both a mitigator of flooding damages to homes, businesses, and infrastructure, and also a natural asset in need of protection. Risk transfer policies for communities in areas of flooding risk or natural assets at risk of degradation are not likely to become available without further pilot projects co-designed by the state and insurance experts to test proof of concepts and determine costs and benefits.

Recommendation: The Insurance Commissioner should convene local government and community organizations, insurers and reinsurers, and co-develop at least four nature-

based solution risk transfer concepts. The focus of the convening should be to identify the asset, mitigator, level of damage, and threat for each innovative pilot project. The concept of these pilot projects would be to make an investment in natural infrastructure so that risks are reduced over time, and concurrently the community pays for insurance to maintain some financial protection (*Figure 5*).

Each pilot project would have three core elements:

1) blend risk mitigation and risk transfer,
2) serve as a template for further policy development, and
3) incorporate hydrologic modeling and scientific monitoring to measure the results of the specific projects.

Under this approach, public or private structures within a community would be the most likely insured assets. The project would identify a location where: 1) a determination is made that a wetland restoration project would reduce the threat of flooding, and 2) flooding maps exist to support the planning. After such a location is identified, a Public-Private Partnership with insurers and reinsurers that incorporates the benefits of risk mitigation from the wetland restoration project would be developed. The state should further allocate an amount equal to the risk premium reduction from the above project towards the next project, and provide the framework for insurance companies writing in that area and local businesses to contribute.

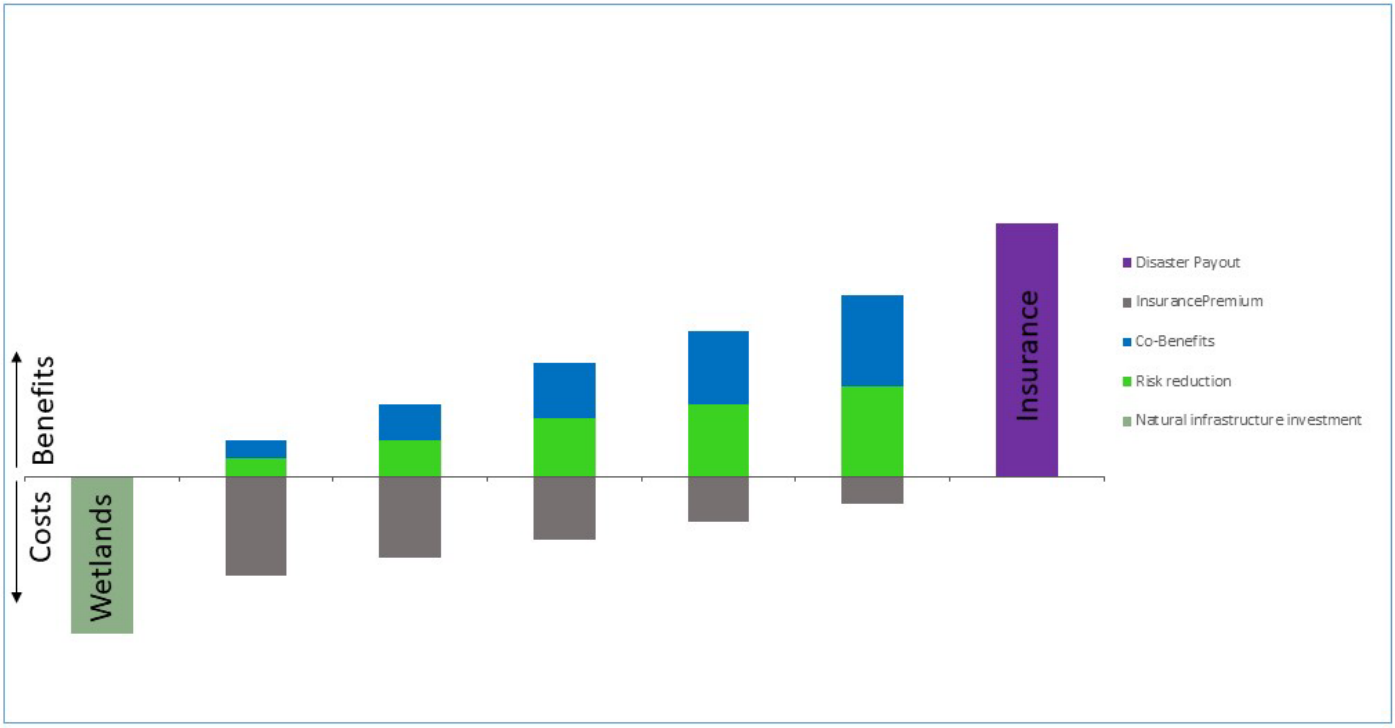

Figure 5. This figure demonstrates that a relatively small investment in a nature-based solution can have a significant multiplier effect by 1) protecting the specific asset in question; 2) lowering insurance premiums and providing savings that can help pay

for the desired green infrastructure; and 3) creating new value by protecting health and safety at a community-wide level, encouraging new opportunities for tourism and recreation, increasing biodiversity, protecting and enhancing habitat, enabling carbon sequestration, and providing resilience against climate change. Because the asset continues to be insured, the owner can still receive an insurance payout in the event of a natural disaster (See example, Reguero et al. 2019).

Box: Addressing equity issues related to improved flood mapping

Recently published and publicly accessible flooding maps are revealing further details that communities of color are located disproportionately in high-risk areas of flooding. Furthermore, more than 2/3 of the states in the US showed that communities of color were facing more undisclosed flood risk than the state average[89]. Further identification of flooding risk by better mapping and modeling is important because it makes risk information available to renters and homeowners that have not had access to such information before, providing some opportunities to prepare. Insurance companies already have private risk information that they use for underwriting, and additional information to the public could balance the information gap. However, such information could also be used to reduce access to funds or mortgages, and some economists argue that it could decrease property values in the short term or long term. Decreased property values could be beneficial to renters but detrimental to homeowners. Governments should consider how to incentivize risk reduction in high risk areas and should consider how to avoid further consequences where risk information exacerbates the legacy of redlining. Recent research points out that declining property investment in high risk areas would reduce the local tax base needed to pay for protective infrastructure upgrades. For pre-disaster risk mitigation to be successful, existing homes and businesses in high risk areas need options for reducing the risk and preparing for future storms, which necessitates funding or other policies alternatives.

CONCLUSION

This report describes the multiple accelerating climate impacts, existing insurance gaps, and the new steps on a pathway to inclusive resilience. Although the insurability of homes and businesses has waxed and waned over time, climate change poses a unique threat. Early action to increase resilience is socially, fiscally, and ecologically imperative for California. Successive climate-intensified catastrophes are likely to impact the most vulnerable communities, where insurance is currently uncommon, and will increase financial volatility, further complicating action on greenhouse gas emissions, and likely leaving jurisdictions strained by financial costs. Cities and local jurisdictions need to act now to protect their people, economies, and workers from the projected impacts, especially our most vulnerable communities and residents. Individuals will be reliant on the insurance that is available and affordable, and unmet costs will stress social safety nets.

The challenges from potentially overwhelming costs, vulnerable communities and infrastructure, and a multitude of risks can be met by stronger commitments from governments, communities, and the insurance and reinsurance sectors to accelerate investment in understanding, communicating, and planning for climate impacts. Climate risks will impact both the public and private sectors, creating opportunities for partnerships. The insurance industry needs to strengthen investments in risk reduction and find more innovative solutions. The state needs to prioritize and coordinate efforts to close the gaps identified in this report, including in risk assessment, risk communication, risk reduction, and risk transfer. In addition, existing tools such as hazard maps and models need to be expanded and improved.

This report includes forty recommendations that could be implemented over different time horizons. Some recommendations require the state to fund policy development through proof of concept projects; others require changes to state law or regulation. To prioritize next steps, this report concludes with short and long term bridges to a stronger, more resilient California.

***Box**: Actions to take within the first year*:

The Insurance Commissioner should

- Implement tools to expand public access to risk information for all perils.
- Convene stakeholders to enhance communication of the risks of heat waves and the range of possible responses.
- Encourage pilots for intervention before and during a heat wave to reduce the impact of heat events on population health.
- Encourage flood insurance uptake through pilot projects and risk communication.
- Consider the advantages and disadvantages of the use of catastrophe models in insurance premiums and rates.

The Insurance Sector should

- Develop innovative insurance products and risk transfer policies to reduce the protection gaps related to climate risk impacts.
- Support the development and wide application of resilient building codes.
- Collect data to inform risk-focused models, retrofit opportunities, and future building codes.
- Consider investments in resilience bonds to reduce future losses.
- Develop insurance solutions for natural infrastructure that reduces the impact of wildfire, extreme heat, and flooding.
- Engage with scientists and researchers to measure risk reduction benefits of home and community actions

The State of California, through legislation or Executive Branch actions, should:

- Accelerate development of hazard maps for wildfire and flood.
- Incentivize risk mitigation through grants and loans.
- Provide matching funding for local government risk transfer pilot projects.
- Adopt land-use restrictions or requirements to enable local governments to understand the accelerating climate risks to new and existing developments.
- Consider establishing a state-wide risk transfer facility to support the long-term escalation in risks carried by the state and local governments.

Box: Actions to start immediately and supplement in the future:

Multiple recommendations require pilot programs that will inform future work, including the establishment of incentives for investment in natural infrastructure, developing nature-based solution pilot projects, and building more resiliently. These recommendations require sustained commitment, funding for policy development, and evaluation of performance. The recommendations need immediate attention to initiate the necessary pilot projects and concept development, but they also require long-term resolve to create lasting collaborations and sustained funding streams.

The combination of solutions fundamentally benefits from promoting a feedback loop where clear understanding of risks promotes risk reduction actions and risk transfer decisions that ultimately lead to reducing future risks. The challenges of insurance availability and affordability present difficult tradeoffs, exacerbated by the global risks we face today. At its core, the future insurability of homes, businesses, farms, ranches, and natural infrastructure depends on levels of risk. Aligning diffuse incentives to achieve these goals will enhance climate resiliency.

Among the several dozen recommendations in this report, a notable common thread is that each peril is interwoven into the same basic themes: accessible risk information, policies to promote insurance availability and equity to reduce the protection gap, resilient building codes, resilient land use, and insurance approaches related to innovation, risk reduction, and nature-based solutions. This common theme enables state and local governments, private companies, and non-governmental organizations to set cross-cutting benchmarks and timelines. Because this report is one of few--if not the first--report of this kind, the working group hopes that the cross-cutting themes lay the groundwork for future efforts on additional perils or in additional jurisdictions, and bring new ideas into the field.

APPENDICES

Appendix 1. Senate Bill No. 30, Chapter 614, Statutes of 2018, State of California.

An act to add Section 12922.5 to the Insurance Code, relating to insurance.

SECTION 1. The Legislature finds and declares all of the following:

(a) Much of California may have increasing exposure to climate-related events.

(b) California has environmental features that can mitigate damage from climate-related events.

(c) Innovative insurance and reinsurance businesses may provide opportunities to reduce the exposure of local communities and homeowners to these events.

(d) Reinsurance companies are already doing risk assessments and designing risk transfer products that incentivize investment in natural resources to mitigate against climate risks.

SEC. 2. Section 12922.5 is added to the Insurance Code, to read:

(a) The commissioner shall convene a working group to identify, assess, and recommend risk transfer market mechanisms that promote investment in natural infrastructure to reduce the risks of climate change related to catastrophic events and that:

(1) Create incentives for investment in natural infrastructure to reduce risks to communities.

(2) Provide mitigation incentives for private investment in natural lands to lessen exposure and reduce climate risks to public safety, property, utilities, and infrastructure.

(b) To the extent that the working group recommends risk transfer market mechanisms that would be provided by insurance and reinsurance companies, the working group shall recommend mechanisms that:

(1) Are profitable to insurance and reinsurance companies.

(2) If appropriate, apply to communities or regions, rather than individual land parcels.

(c) The policies recommended pursuant to subdivisions (a) and (b) shall include all of the following questions:

(1) What are the California analogies to examples in other countries for creating incentives for investment in natural infrastructure as part of insurance policies that mitigate elemental risks?

(2) Can we use insurance to create incentives for wetland restoration to help defend the coast against storm surge?

(3) Can we create incentives for forests to be managed to reduce the risk of major fires?

(4) Can we reduce the exposure of insurance companies to climate change-related losses through innovative state policies or insurance pricing mechanisms that reward good behavior and charge premiums for actions that increase public safety risks or losses of property or environmental attributes?

(5) Can we develop rating systems based on community risk factors to climate events, and use insurance incentives to make a community more resilient?

Appendix 2. Climate Insurance Working Group Members and Subgroups

Appendix 3. Options for Innovative Extreme Heat Risk Transfer

Two options for a potential pilot project are described here:

Option 1: Parametric Coverage for uninsured patients
Vulnerable populations may delay or limit seeking care until after the early onset of health impacts, which compounds the personal and systemic cost of treatment. Hospitals serve as critical intervention points to not just catch the early onset of heat health symptoms, but also to provide comprehensive care to rejuvenate these individuals sufficiently to avoid repeat emergency room visits. This type of risk transfer could offer a hospital or city the following benefits:

- Offering necessary services to uninsured patients without further straining hospital budgets
- Paying for lost revenue and uninsured expenses incurred during an extreme heat event
- Offering necessary services to patients to limit long-term impacts or repeat visits

Option 2: Supplemental coverage for public hospitals serving underinsured populations
When extreme heat events occur, it is crucial for the hospital to treat patients as long as necessary and not curtail their length of stay based on the patients' (lack of) insurance coverage. Hospitals incur operational costs to handle surges in hospitalization rates and emergency room visits. Excess operational expenses, costs of underinsurance, and limitations of care posed through Medicaid can be insured. A local jurisdiction seeking to serve vulnerable populations in conjunction with the publicly-owned hospital can use such an insurance coverage. Such a coverage could provide the following benefits:

- Providing vulnerable populations with the care they need regardless of health insurance coverage
- Indemnifying hospitals for providing care and incurring expenses not covered within the patient's insurance coverage

[1] Pew Charitable Trusts. 2017. It Pays to Prepare for Natural Disasters. (https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2017/05/it-pays-to-prepare-for-natural-disasters)
[2] Madrigano, J., Ito, K., Johnson, S., Kinney, P.L., and T.A. Matte. 2015. A Case-Only Study of Vulnerability to Heat Wave–Related Mortality in New York City (2000–2011). Environmental Health Perspectives 123: 672–678.
[3] https://www.epa.gov/heat-islands/heat-islands-and-equity
[4] https://www.scientificamerican.com/article/flooding-disproportionately-harms-black-neighborhoods/
[5] Peacock, W.G., and C. Girar. 1997. Ethnic and racial inequalities in hurricane damage and insurance. In Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters, ed. W.G. Peacock, B.H. Morrow, H. Gladwin, pp. 171-90. Oxon, UK: Routledge.
[6] Meyer, R. and H. Kunreather. 2017. The Ostrich Paradox. Wharton Digital Press. Philadelphia, PA.
[7] Deutz, A., Heal, G. M., Niu, R., Swanson, E., Townshend, T., Zhu, L., Delmar, A., Meghji, A., Sethi, S. A., and Tobin-de la Puente, J. 2020. Financing Nature: Closing the global biodiversity financing gap. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability. (https://www.paulsoninstitute.org/wp-content/uploads/2020/09/High-level-summary-of-exec-summary-Final-9.13.20.pdf)
[8] Deutz, A., Heal, G. M., Niu, R., Swanson, E., Townshend, T., Zhu, L., Delmar, A., Meghji, A., Sethi, S. A., and Tobin-de la Puente, J. 2020. Financing Nature: Closing the global biodiversity financing gap. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability. (https://www.paulsoninstitute.org/wp-content/uploads/2020/10/Updated-10.23.20-FINANCING-NATURE_Exec.-Summary_Final-with-endorsements_101420.pdf)
[9] Narayan, S., Beck, M.W., Wilson, P., Thomas, C.J., Guerrero, A., Shepard, C.C., Reguero, B.G., Franco, G. Ingram, J.C., and D. Trespalacios. 2017. The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. *Sci Rep* **7**, 9463. https://doi.org/10.1038/s41598-017-09269-z
[10] Kousky, C. (2019). "The Role of Natural Disaster Insurance in Recovery and Risk Reduction" *Annual Review of Resource Economics* 11(3).
[11] Cambridge Centre for Risk Studies and AXA XL, 2020. Optimising Disaster Recovery: The Role of Insurance Capital in Improving Economic Resilience. Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School (https://axaxl.com/-/media/axaxl/files/optimizing-disaster-recovery.pdf)
[12] Sengupta, R. and C. Kousky (2020). Parametric Insurance for Disasters. Wharton Risk Center, September. (https://riskcenter.wharton.upenn.edu/wp-content/uploads/2020/09/Parametric-Insurance-for-Disasters_Sep-2020.pdf)
[13] Bernhardt, A., C. Kousky, A. Read, and C. Sykes (2021). Community-Based Catastrophe Insurance: A Model for Closing the Disaster Protection Gap. Marsh & McLennan Companies and the Wharton Risk Management and Decision Processes Center.

[14] Klinenberg, Eric. 2002. Heat Wave: A Social Autopsy of Disaster in Chicago. University of Chicago Press, Chicago, IL.
[15] https://www.npr.org/2018/07/10/627687639/estimated-70-deaths-linked-to-canadas-heat-wave; CIUSSS, "Canicule: Juuillet 2018 – Montreal Bilan Preliminaire" (Montreal, Canada: CIUSSS du Centre-Sud-de-I'LLe-de-Montreal Direction Regionale de Sante Publique, 2018)
[16] Peacock, W.G. Girard, C. Book Title: Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters. Routledge Publishing, New York, New York.
[17] California State Senate. Senate Bill 30, 2018, Chapter 614, Statutes of 2018
[18] California Department of Insurance Website (https://www.insurance.ca.gov/01-consumers/180-climate-change/index.cfm)
[19] Global Commissioner on Adaptation. 2019. (https://gca.org/global-commission-on-adaptation/report)
[20] California Public Resources Code 71340 (d); Defining Vulnerable Communities in the Context of Climate Adaptation, July 2018
[21] Cambridge Centre for Risk Studies and AXA XL, 2020. Optimising Disaster Recovery: The Role of Insurance Capital in Improving Economic Resilience. Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School (https://axaxl.com/-/media/axaxl/files/optimizing-disaster-recovery.pdf)
[22] W. E. Rice. 1996. Race, Gender, "Redlining," and the Discriminatory Access to Loans, Credit, and Insurance: An Historical and Empirical Analysis of Consumers Who Sued Lenders and Insurers in Federal and State Courts, 1950-1995, 33 San Diego L. Rev. 583.
[23] Kousky, C. 2019. The Role of Natural Disaster Insurance in Recovery and Risk Reduction. Annual Review of Resource Economics 11(3).
[24] Cambridge Centre for Risk Studies and AXA XL, 2020. Optimising Disaster Recovery: The Role of Insurance Capital in Improving Economic Resilience. Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School (https://axaxl.com/-/media/axaxl/files/optimizing-disaster-recovery.pdf)
[25] https://www.federalreserve.gov/publications/2020-economic-well-being-of-us-households-in-2019-dealing-with-unexpected-expenses.htm
[26] City of Colorado Springs, Colorado. Wildfire Risk Assessment Site. https://gis.coloradosprings.gov/Html5Viewer/?viewer=wildfiremitigation
[27] http://www.insurance.ca.gov/0250-insurers/0500-legal-info/0300-workshop-insurers/upload/Invitation-to-Virtual-Meeting-Regarding-Home-Hardening-Standards-and-Wildfire-Catastrophe-Modeling-in-Ratemaking.pdf
[28] Pinellas County, Florida. Flood information. https://floodmaps.pinellascounty.org/pages/flood-information-introduction
[29] Pinellas County, Florida. Flood information. http://www.pinellascounty.org/flooding/real_estate_disclosure.htm
[30] Mawhorter, S., D. Garcia, and H. Raetz. 2018, March. It All Adds Up: The Cost of Development Fees in Seven California Cities. Final Report, Terner Center for Housing and Innovation. University of California, Berkeley. http://ternercenter.berkeley.edu/uploads/Development_Fees_Report_Final_2.pdf
[31] Coburn, A.S. and J.C. Whitehead. 2019. An analysis of federal expenditures related to the Coastal Barrier resource Act (CBRA) of 1982. Journal of Coastal Research.

[32] National Institute for Standards and Technology. US Department of Commerce. January 2021. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2135.pdf
[33] https://natcatservice.munich.munichre.com/
[34] Beck, et al., 2019; Reguero, B.G., Beck, M.W., Schmid, D. , Stadtmuller, D.J., Raepple, J., Schussele, S. and K. Pfliegner. 2019. Financing coastal resilience by combining nature-based risk reduction with insurance. Ecological Economics 169:1-10.
[35] The World Bank. Integrated Disaster Risk Management and Resilience Program. https://projects.worldbank.org/en/projects-operations/project-detail/P144539?lang=en
[36] World Bank. Upgrading Morocco's Disaster Risk Management Strategy. https://www.worldbank.org/en/news/press-release/2019/12/11/upgrading-moroccos-disaster-risk-management-strategy; World Bank. Appraisal Program Information Document: Morocco Disaster Risk Management Development Policy Loan with a Catastrophe Deferred Drawdown Option. http://documents1.worldbank.org/curated/es/853061555762567306/pdf/Appraisal-Program-Information-Document-PID-Morocco-Disaster-Risk-Management-Development-Policy-Loan-with-a-Catastrophe-Deferred-Drawdown-Option-P168580.pdf
[37] Atlas Magazine. Natural Catastrophes Cover: Adoption of the draft decree. https://www.atlas-mag.net/en/article/natural-catastrophes-cover-adoption-of-the-draft-decree#:~:text=Jobs-,Natural%20catastrophes%20cover%3A%20Adoption%20of%20the%20draft%20decree,the%2021st%20of%20March%202019.
[38] World Bank. 2012. FONDEN : Mexico's Natural Disaster Fund--A Review. World Bank, Washington, DC
[39] Geologic Hazard Abatement District. http://ghad.org/about-ghads/
[40] National Fire Protection Association. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA
[41] Talberth, J., Selman, M., Walker, S., and E. Gray. 2013. Pay for performance: Optimizing public investments in agricultural best management practices in the Chesapeake Bay Watershed. Ecological Economics 118:252-261.
[42] Environmental and Energy Study Institute
[43] Aerts, Jeroen et al., *Pathways to resilience: adapting to sea level rise in Los Angeles*, Annals of the New York Academy of Sciences (vol. 1427: issue 1), 19 September 2018, https://doi.org/10.111/nyas.13917
[44] Governor's Office of Planning and Research. California. 2021. https://resilientca.org/
[45] Government Code Section 51178; Public Resources Code Section 4204
[46] Kasler, D. and R. Sabalow. 2019, November 15. Burned-out California town ignores stricter building codes, even with wildfire threat. Sacramento Bee. https://www.sacbee.com/news/california/fires/article236909028.html
[47] Building a wildfire-resistant home: codes and costs. Headwaters Economics. 2018, November (https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf)
[48] Klein, K.S. 2018. Minding the protection gap: Resolving unintended, pervasive, profound homeowner underinsurance. Connecticut Insurance Law Journal 25(1):35-

116. https://cilj.law.uconn.edu/wp-content/uploads/sites/2520/2019/06/Vol25.1-art2.pdf

[49] Klein, K.S. 2018. Minding the protection gap: Resolving unintended, pervasive, profound homeowner underinsurance. Connecticut Insurance Law Journal 25(1):35-116. (https://cilj.law.uconn.edu/wp-content/uploads/sites/2520/2019/06/Vol25.1-art2.pdf)

[50]

[51] Hoffman J.S., Shandas V., and N. Pendleton. 2020. The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. *Climate* 8(1):12. (https://doi.org/10.3390/cli8010012)

[52] Schmeltz, M.T., Petkova, E.P., J.T. Gamble. 2016. Economic Burden of Hospitalizations for Heat-Related Illnesses in the United States, 2001-2010. International Journal Environmental Research on Public Health 13(9):894.

[53] Schmeltz, M.T., Petkova, E.P., and J.L. Gamble. 2016. Economic Burden of Hospitalizations for Heat-Related Illnesses in the United States, 2001-2010. International journal of environmental research and public health, 13(9), 894.

[54] Natural Resources Defense Council. November 2011. Health and Climate Change: Accounting for the Costs. https://www.nrdc.org/sites/default/files/accountingcosts.pdf

[55] Drugmand, D. Costs of extreme heat are huge , but hard to quantify. 2018, August. (https://www.climateliabilitynews.org/2018/08/09/extreme-heat-climate-costs-liability/)

[56] Limaye, V.S., Max, W., Constible, J., and K. Knowlton. 2019. Estimating the health-related costs of 10 climate-sensitive U.S. events during 2012. GeoHealth, 3:245-265. https:// doi.org/10.1029/2019GH000202

[57] Knowlton, K., Rotkin-Ellman, M., King, G., Margolis, H.G., Smith, D., Solomon, G., Trent, R., and P. English. 2009. The 2006 California Heat Wave: Impacts on hospitalizations and emergency room visits. Environmental Health Perspectives 117 (1): 61-67.

[58] Deryugina, T. and S.M. Hsiang. 2014. Does the environment still matter? Daily temperature and income in the United States. Working Paper 20750. National Bureau of Economic Research.
https://gspp.berkeley.edu/assets/uploads/research/pdf/Does_the_Environment_Still_Matter.pdf

[59] Government Accountability Office. 2017. Climate Change, Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure.
https://www.gao.gov/assets/690/687466.pdf

[60] Deryugina, T. and S.M. Hsiang. 2014. Does the environment still matter? Daily temperature and income in the United States. Working Paper 20750. National Bureau of Economic Research.
https://gspp.berkeley.edu/assets/uploads/research/pdf/Does_the_Environment_Still_Matter.pdf

[61] https://www.nasa.gov/feature/nasa-helps-new-yorkers-cope-with-summer-swelter

[62] https://www.gov.ca.gov/wp-content/uploads/2020/08/8.16.20-Extreme-Heat-Event-proclamation-text.pdf

[63] UCLA Heat and Health study

[64] California Natural Resources Agency. Fourth Climate Assessment. https://cal-heat.org/
[65] Global Commissioner on Adaptation. 2019. (https://gca.org/global-commission-on-adaptation/report)
[66] Global Commissioner on Adaptation. 2019. (https://gca.org/global-commission-on-adaptation/report)
[67] Natural Resources Defense Council. 2016, October. (https://www.nrdc.org/experts/alisa-valderrama/pay-performance-meets-green-infrastructure)
[68] African Risk Capacity. (https://www.africanriskcapacity.org/about/how-arc-works/)
[69] The Caribbean Catastrophe Risk Insurance Facility. (https://www.ccrif.org/)
[70] Global Facility for Disaster Reduction and Recovery. (https://www.gfdrr.org/sites/gfdrr/files/publication/FONDEN_paper_M4.pdf)
[71] California Environmental Protection Agency. (https://calepa.ca.gov/climate/urban-heat-island-index-for-california/)
[72] State of California Sea-Level Rise Guidance Document, California Ocean Protection Council, 2018
[73] Griggs, G., Árvai, J, Cayan, D, DeConto, R, Fox, J, Fricker, H.A., Kopp, R.E., Tebaldi, C, and E.A. Whiteman. 2017. Rising Seas in California: An Update on Sea-Level Rise Science
[74] *Ibid.*
[75] State of California Sea-Level Rise Guidance Document, *supra*.
[76] Rising Seas report, *supra*.
[77] California Department of Water Resources. 2017. Central Valley Floodplain Protection Plan 2017 Update, at iii, (https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Flood-Management/Flood-Planning-and-Studies/Central-Valley-Flood-Protection-Plan/Files/2017-CVFPP-Update-FINAL_a_y19.pdf?la=en&hash=BCross-cuttingCF94FABFBEF7AC0B7B9A9195F0148EBBAD20C)
[78] California Water Resilience Portfolio. 2020, at XXX. Available at https://waterresilience.ca.gov/wp-content/uploads/2020/07/Final_California-Water-Resilience-Portfolio-2020_ADA3_v2_ay11-opt.pdf
[79] *See*, *e.g.*, Yolo Bypass (https://wildlife.ca.gov/lands/places-to-visit/yolo-bypass-wa) Sutter Bypass (https://www.spk.usace.army.mil/Portals/12/documents/civil_works/Sutter/Final_Report/SutterPilotFeasibilityReport_FEIR-SEIS.pdf)
[80] Opperman et al. describes a study comparing flood damages in adjacent areas in Ontario and Michigan during floods in 1986: floods in Ontario had a greater magnitude, but property damages totaled approximately $500,000 while damage in Michigan were approximately $500,000 million because Ontario maintained regulatory policies to discovery development in the floodplain. Id. At 125 (citing Brown et al. 1997)
[81] Opperman at al., at 124-125.
[82] Kousky, C. 2010. Using Natural Capital to Reduce Disaster Risk. Journal of Natural Resources Policy Research 2(4): 343-356.
[83] Ibid. (citing to Opperman et al. 2009, 2010)

[84] Meyer, R. and H. Kunreuther. 2017. The Ostrich Paradox, Why we underprepare for disasters. The Wharton School, University of Pennsylvania, Philadelphia, PA.
[85] McDow, W. Environment Defense Fund. 2020, June. North Carolina's Legislature moves toward greater flood protection and climate resilience. (http://blogs.edf.org/growingreturns/2020/06/25/north-carolina-flood-protection-resilience-hb1087/)
[86] Sources: First Street Foundation, PPIC (https://www.ppic.org/blog/high-and-rising-flood-risk-in-california-grows/) and https://advances.sciencemag.org/content/6/29/eaba1323
[87] Reguero, B.G., Beck, M.W., Schmid, D. , Stadtmuller, D.J., Raepple, J., Schussele, S. and K. Pfliegner. 2019. Financing coastal resilience by combining nature-based risk reduction with insurance. Ecological Economics 169:1-10.
[88] California Water Quality Monitoring Council. California Wetlands. https://mywaterquality.ca.gov/eco_health/wetlands/#
[89] https://qz.com/1876202/new-flood-risk-maps-could-undermine-marginalized-neighborhoods/:;