

BRIEFING PAPER
CLIMATE



Safety First

Improving hazard resilience in
the Bay Area

MARCH 2020

This report is a component of the SPUR Regional Strategy, a vision for the future of the San Francisco Bay Area

spur.org/regionalstrategy

The SPUR Executive Board adopted this paper as official SPUR policy on December 3, 2019.

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Thank you to the funders of the SPUR Regional Strategy:

- Chan Zuckerberg Initiative
Clarence E. Heller Charitable Foundation
Curtis Infrastructure Initiative
Dignity Health
Facebook
Genentech
John S. and James L. Knight Foundation
Marin Community Foundation
George Miller
Sage Foundation
Silicon Valley Community Foundation
Stanford University

Additional funding provided by AECOM, Fund for the Environment and Urban Life, Hellman Foundation, Microsoft, the Seed Fund and Stripe.

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Executive Summary

We all want and deserve to be safe in our homes and communities. Yet for those of us who live and work in the San Francisco Bay Area, our home is a paradox. The Bay Area is both a treasured place and a hazardous environment where flooding, wildfires and earthquakes are common today. These hazards are likely to become more frequent, larger and more damaging in the future as climate change puts the region's people, built environment and natural habitats at risk. Without mitigation, the impact of these hazards will only increase as the region grows. This impact could disproportionately affect those who are more exposed and vulnerable to various risks — and who may have fewer resources to help them cope.

This report builds on SPUR's work in earthquake and climate resilience over the last 10 years and supports the SPUR Regional Strategy, a 50-year vision for how the Bay Area of 2070 can be more equitable, sustainable and resilient. The recommendations in this report address two key questions:

1. How can we mitigate risk from hazards and secure safety as the Bay Area adds people, jobs and housing over the next 50 years?
2. As a region exposed to multiple natural hazards, what can we do together to improve community resilience that we cannot achieve as individual cities and counties acting alone?

This report characterizes the Bay Area's changing risks from floods, fires and earthquakes and describes the potential equity impacts of worsening hazards. It also looks at how the region manages hazards today. SPUR found that most of the policy tools the region has to manage hazards and assure safety are not designed for changing risks or for a growing urban and interdependent region. One community's actions to increase resilience — or its failure to act — can affect its neighbors and the region as a whole. How one community prepares for wildfire affects the fire safety of all adjacent communities. What one community chooses to do about earthquake-vulnerable buildings and infrastructure affects surrounding neighborhoods and the economy. How one community alters its shoreline to manage sea level rise affects flooding for its neighbors. Failing to plan regionally means that resilience investments might not have the expected payoff or safety benefits, or they might not improve conditions for the community at large.

SPUR makes 12 policy recommendations for how the Bay Area can improve data and information gathering, codes and standards, community planning and funding for multi-hazard resilience. Each recommendation includes a longer discussion about why it's necessary, how it might be implemented and who is responsible for doing so.



Policy Recommendations:

1. Develop dynamic, web-based maps that reflect current and potential future property risk across multiple hazards.
2. Adopt a statewide functional recovery building standard so that more buildings will be usable and easily repaired after a disaster.
3. Require cities and counties to inventory and screen buildings for vulnerability to wildfires, flooding and earthquakes in areas of known risk. Make certain retrofits mandatory within 20 years.
4. Create a regional lifelines council to identify interdependencies between utility systems, assess their vulnerability to hazards, set regionwide mitigation priorities and identify ways to fund critical upgrades within the next 10 years.
5. Consolidate certain single-purpose special districts (such as fire or flood prevention) into multi-hazard resilience districts and expand their geography as needed.
6. Develop local disaster recovery frameworks in every city and county to help ensure that local jurisdictions are ready to manage recovery following a major disaster.
7. Change zoning codes to prevent further development in high-hazard areas that are significantly vulnerable to fire, liquefaction and sea level rise, with priority consideration in those areas where multiple hazards overlap. Ensure no net loss of planned housing by accommodating new development in low-hazard existing urbanized areas.
8. Acquire undeveloped hazard-prone lands for public ownership and use.
9. Develop a regional or state buyout program for properties repeatedly damaged by wildfire, flooding or other climate impacts.
10. Ensure that insurance for fire, earthquake and flood hazards remains available and affordable for residents and businesses. Ensure that state insurance regulations encourage and appropriately price resilient land use, new construction and retrofit practices.
11. Establish a regionwide geologic hazard abatement district, or a series of countywide districts, to pool resources to fund regional resilience projects.
12. Establish a regional resilience trust fund for future climate adaptation and hazard management needs.

The recommendations are directed at state, regional and local agencies because better hazard resilience is a function across all scales of governance. We conclude with a call to action at all of these scales to invest in better understanding, planning and implementation to create a safer Bay Area for everyone who is already here and everyone who is yet to come.

Introduction

We all want and deserve to live in a safe place. Safety underpins all human needs and ambitions: raising families, going to work and school, running businesses, having fun with friends, sleeping soundly at night. Safety from natural and unnatural disasters is often not at the forefront of our minds as we conduct our daily lives. But when safety fails, it pulls what’s important into sharp focus: Without safety, we can’t go about our normal activities — sometimes for a very long time. Collectively, we need safety for strong communities, physical and mental health, economic security and prosperity, and a smoothly functioning society.

The Bay Area’s mild climate and signature geographical features — wide river valleys, coastal bluffs and beaches, a shallow bay, steep and forested hillsides — make this area ecologically rich and, for many of us, an extremely desirable place to live. But these features also indicate great dynamism, where things are in motion and the landscape can change quickly.

And it does change. The Bay Area is exposed to natural and human-driven hazards, including flooding, wildfire, earthquakes, tsunamis, landslides, extreme heat, poor air quality and sea level rise. Flooding and wildfire occur periodically today, but as the climate changes, they will become more frequent, more severe and longer in duration. Sea level rise threatens our long coastline with permanent flooding. Small and moderate earthquakes occur sporadically today, but larger, much more serious earthquakes have a high likelihood of happening in our lifetimes. Our region’s built and natural environments — and our safety — are at risk from these growing threats. Without mitigation, the impact of these hazards will only increase as the Bay Area adds more people, housing and jobs.

Some of these problems are worse today because of choices made in the past. For example, cities once used the Bay as a landfill site and a place to build, because the region didn’t have a better system for managing waste or for protecting the Bay. Now, many neighborhoods built on low-lying land near the Bay shore are only a few feet above high tide, where they are vulnerable to sea level rise, rising groundwater and the liquefaction caused by earthquakes. Filling the Bay also reduced ecological richness and diminished the free natural flood protection provided by the wetlands and marshes that once lay between tidal areas and higher ground. Our earthquake risk is largely a function of now-obsolete technologies used in our buildings and infrastructure. While these structures were built with the accepted practices of their time, many of those practices are now widely recognized as risky, and we have been slow about addressing them. In another example of how human decision-making has increased risk, local governments have allowed development to progress into the region’s forested areas, which are prone to wildfires. Many of these communities have few evacuation routes. And of course, global climate change — a force multiplier — is caused by people and worsens every day with inaction. Our world’s inability or unwillingness to act quickly to reduce emissions will continue to worsen climate-related hazards, and thus the risks of living in the Bay Area.

We can do something about this. While we cannot prevent certain hazards, we don’t have to accept worsening damages, community disruption, injuries and deaths as the price of living here. We can correct mistakes made in the past. It is the job of government to protect people to the extent that science and tools such as land use planning, building codes and emergency response allow; government has a special obligation to address issues that require collective action, ones that individuals cannot address themselves. Preparing for climate change, correcting past development practices and other risk mitigation will not come cheap or easy



— but inaction will be far more costly. The full cost of disasters is much more expensive than investing in prevention and mitigation.¹

This report builds on SPUR’s work in earthquake and climate resilience over the last 10 years and supports the SPUR Regional Strategy, a 50-year vision for how the Bay Area of 2070 can be more equitable, sustainable and resilient. The recommendations in this report answer two key questions:

1. How can we mitigate risk from hazards and secure safety as the Bay Area adds people, jobs and housing over the next 50 years?
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¹ The National Institute of Building Sciences’ 2017 study found that every \$1 spent on hazard mitigation saved on average \$6 in future disaster costs: <https://www.nibs.org/page/mitigationsaves>

1. Hazards and Vulnerability

Here is a brief overview of the region's risks and hazards today and how they might change in the future.

Wildfire

Wildfires have always been a part of California's landscape, but as global temperatures climb and hydrological patterns change, we can expect to have longer fire seasons, larger and more destructive fires and more "fire weather" conditions, leading to the potential for multiple simultaneous blazes that overwhelm firefighting response.

The Bay Area has experienced the dramatic effects of large wildfires in recent years, including the devastation of three simultaneous North Bay fires (Tubbs, Nunn and Atlas) in October 2017, over a week of hazardous air quality caused by the fast-burning and deadly Camp Fire in Butte County in November 2018, and the region's largest-ever fire (Kincadee) in October 2019. Six of California's 10 worst wildfires have occurred in the last three years. And six of California's 20 most destructive wildfires (in terms of buildings lost) have occurred in the Bay Area.² In October 1991, the Tunnel Fire, also known as the Oakland Hills Fire, killed 25 people and injured 150 others over five days. The 1,520 acres destroyed included 2,843 single-family dwellings and 437 apartment and condominium units. The economic loss from the fire was estimated at \$1.5 billion in 1991 dollars.

There are many reasons why fires have gotten worse and more destructive in recent years. One of these is fire suppression policy (on both state and federal levels),³ which derived from the dual goals of protecting timber resources and keeping fire away from people and infrastructure. Evidence also shows that droughts — such as the extreme drought that California experienced between 2013 and 2018 — contribute to larger wildfires. The temperature increase from climate change has also simply dried out forests and left them more susceptible to burning. Across the southwestern United States, the area that burned between 1984 and 2015 was twice what it would have been in the absence of climate change.⁴ Finally, fire risk has increased as local governments have allowed housing and urban development to expand into the transitional zone between forested and developed areas, known as the wildland-urban interface (WUI), which is the fastest-growing land use type in the United States.⁵ The WUI is defined as the area where houses meet or intermingle with undeveloped wildland vegetation, with a minimum density of one unit per 40 acres.⁶

According to the 2018 National Climate Assessment produced by the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration, if greenhouse gas emissions are high, fire frequency in the southwestern United States (including California) could increase 25% by 2100, and the frequency of very large fires could triple.⁷ In the Bay Area, modeling indicates that fire risk might increase by up to 50% in parts

² D. Ackerly et al., *San Francisco Bay Area Summary Report*, California's Fourth Climate Change Assessment, University of California, Berkeley, 2018, p. 29, www.ClimateAssessment.ca.gov

³ Ibid., p. 28.

⁴ P. Gonzalez et al., "Chapter 25: Southwest," in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Volume II, U.S. Global Change Research Program, Washington, DC, pp. 1101-1184, Figure 25.4, doi: 10.7930/NCA4.2018.CH25, <https://nca2018.global-change.gov/chapter/25/>

⁵ V. Radeloff et al. "Rapid Growth of the U.S. Wildland-Urban Interface Increases Wildfire Risk," *Proceedings of the National Academy of Sciences*, March 27, 2018, 115 (13) 3314-3319, <https://doi.org/10.1073/pnas.1718850115>

⁶ V.C. Radeloff et al. "The Wildland-Urban Interface in the United States," *Ecological Applications*, 15 (3), 2005, pp. 799-805, https://www.fs.fed.us/pnw/pubs/journals/pnw_2005_radeloff001.pdf

⁷ Gonzales et al., Section 2.

of the Peninsula and the North Bay, due to more dense vegetation that will be drier than in the past.⁸ Studies show that in the future, fire activity might be worse in the WUI than in urbanized areas or in rural and open space areas, due to increased ignitions by humans.⁹ For the Bay Area, expanded development into the WUI is likely to increase both the probability of fire in the future and the exposure of more people and structures to its risks. The Tunnel Fire and the 2017 North Bay fires are all considered WUI fires.

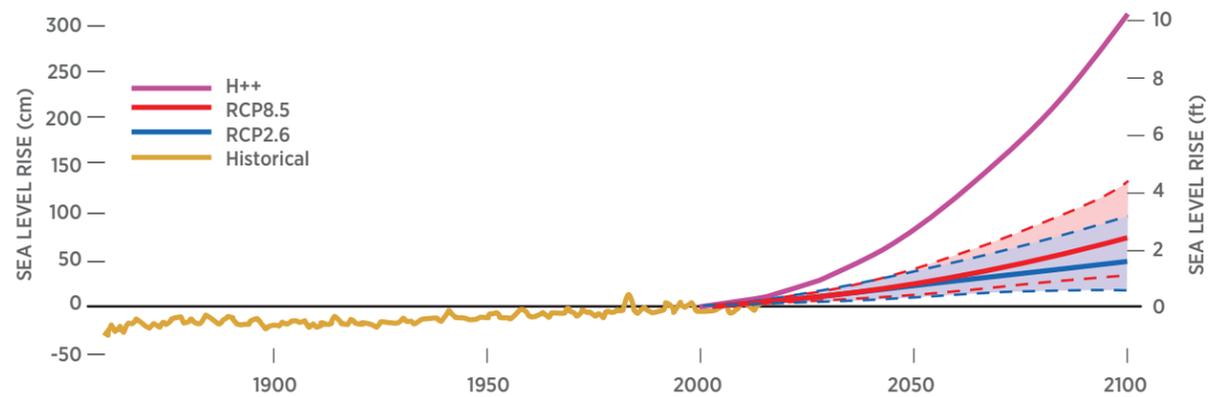
Flooding

Flood risk in the Bay Area also exists today and can come from multiple sources: rainfall, creek overflows, storm surges, combined flooding (riverine plus tidal flooding), sea level rise and rising groundwater.

California experiences some of the most episodic rainfall in the nation, with several large storms each year responsible for supplying much of the state's drinking water, most of which is stored in the snowpack (the layers of snow that accumulate at high elevations) in the Sierra Nevada mountains.¹⁰ The largest storms, called atmospheric rivers, generally occur in the winter and can bring extreme and heavy rainfall that causes flooding. Winter storms are frequently accompanied by storm surges and wave action that cause coastal flood damage. Climate change is likely to impact precipitation by making some winter storms bigger and more extreme and by making multiyear droughts longer and more severe. There is uncertainty around how the total amount of precipitation will change, but the form and frequency of that precipitation will be more damaging, especially if more of it falls as rain instead of snow. Extreme rainfall, coupled with fire-scarred land, can also trigger landslides.

FIGURE 1
Projected Sea Level Rise for San Francisco

The colored lines represent likely rates of sea level rise under different world greenhouse gas emission scenarios. The yellow line shows the historic rate of rise. Blue and red lines indicate two well-known emissions models, RCP 8.5 and RCP 2.6. The purple line, H++, is an extreme but possible scenario that includes the contribution of significant ice melt from Antarctica and Greenland on top of sea level rise from warming oceans.



8 Association of Bay Area Governments (ABAG) and Metropolitan Transportation Commission (MTC), *Bay Area Wildland-Urban Interface: Review of Risks, Plans, and Strategies*, 2018, p. 7, <http://resilience.abag.ca.gov/wp-content/uploads/Fire-Study-FINAL.pdf>

9 Ackerly et al., p. 29.

10 Ackerly et al., p. 17.

Source: Resources Agency and California Ocean Protection Council, 2017, <http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf>

Data Sources: Association of Bay Area Governments (<http://resilience.abag.ca.gov/open-data>); California's Fourth Climate Change Assessment (2018) (<https://cal-adapt.org/tools/slr-califlood-3d/>); CAL FIRE, Fire Hazard Severity Zones (FHSZ) (<http://frap.cdf.ca.gov/projects/hazard/hazard.htm>); FEMA via ABAG (NFIP Attributes A, AE, AH) (https://www.fema.gov/pdf/floodplan/is_9_complete.pdf)

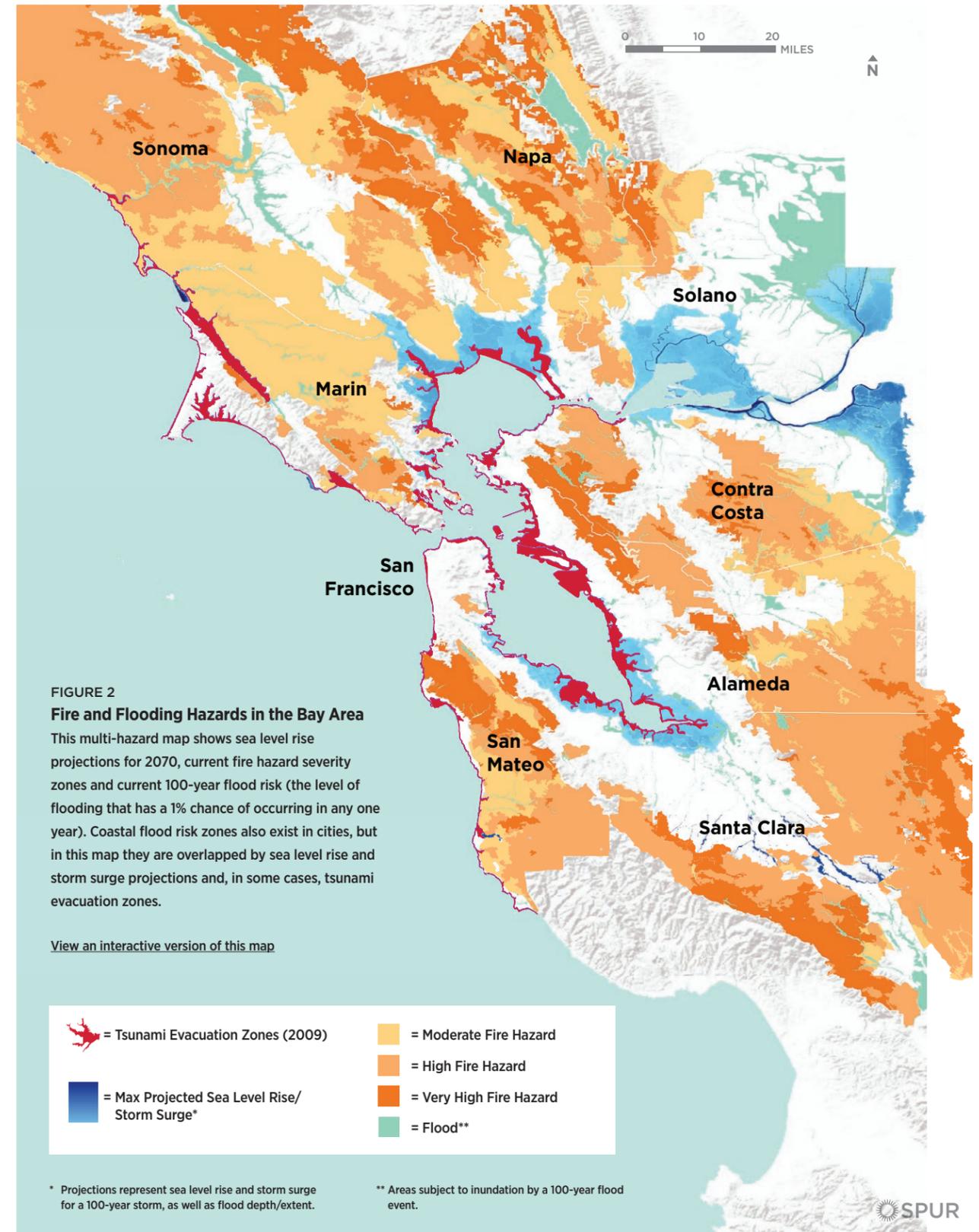


FIGURE 2
Fire and Flooding Hazards in the Bay Area
This multi-hazard map shows sea level rise projections for 2070, current fire hazard severity zones and current 100-year flood risk (the level of flooding that has a 1% chance of occurring in any one year). Coastal flood risk zones also exist in cities, but in this map they are overlapped by sea level rise and storm surge projections and, in some cases, tsunami evacuation zones.

[View an interactive version of this map](#)

- = Tsunami Evacuation Zones (2009)
- = Max Projected Sea Level Rise/Storm Surge*
- = Moderate Fire Hazard
- = High Fire Hazard
- = Very High Fire Hazard
- = Flood**

* Projections represent sea level rise and storm surge for a 100-year storm, as well as flood depth/extent.

** Areas subject to inundation by a 100-year flood event.

Accelerating sea level rise will also worsen the risk of coastal flooding. The rate of sea level rise over the next 20 years and beyond depends on the trajectory that world greenhouse gas emissions take in the future.¹¹ The California Ocean Protection Council has developed estimates for sea level rise at various places along the California coast based on various scenarios of emissions control. For the San Francisco Bay, there is a 50% probability of at least 1 foot of sea level rise by 2050 (see Figure 1). By 2100, sea levels are likely to rise between 1 foot and 3.5 feet, with a one in 200 chance of sea levels rising 6 to 8 feet above present-day levels; an extreme scenario of rise (known as H++) indicates 10 feet of sea level rise by 2100 and 22 feet by 2150.¹²

The risk of flooding increases along creeks and rivers when storm events combine with higher water levels caused by sea level rise.¹³ During storm events, the head of tide will move further inland, up the creeks and rivers, reducing their capacity and increasing the risk of flooding. As sea level rises, the water table will rise and could eventually break out above the land surface in low-lying areas, reducing natural drainage, saturating the soil and inundating the land, depending on local topography.¹⁴ In many areas near the Bay shoreline, groundwater depth today is less than 6 feet.

Earthquake

There is a 72% probability of at least one earthquake of magnitude 6.7 or greater striking somewhere in the San Francisco Bay region before 2043.¹⁵ And there's a 51% probability of at least one earthquake larger than magnitude 7.0 by that time. Earthquakes cause a multitude of other hazards beyond ground shaking, including liquefaction (when shaking causes soils to behave like liquid), landslides and tsunamis. Following a major earthquake, additional hazards include aftershocks and fires that may erupt from broken electrical and gas lines.

Seven major active earthquake faults cross the Bay Area (see Figure 3), but the one most likely to generate a major earthquake in the next few decades is the Hayward Fault, which underlies the East Bay from San Jose to San Pablo Bay. A recent major study — the HayWired scenario, led by USGS — evaluated the consequences of a simulated 7.0-magnitude rupture of this fault.¹⁶ The study found widespread impacts, including thousands of deaths and injuries from building and structural damage, business disruption, loss of water for drinking and firefighting, and major population displacement from damaged residential buildings. The 1989 magnitude-6.9 Loma Prieta Earthquake caused damage over a region nearly 100 miles long. Susceptibility to earthquake damage is a function of local geological and soil conditions, as well as the quality of building and infrastructure construction.

11 G. Griggs et al. *Rising Seas in California: An Update on Sea-Level Rise Science*. California Ocean Science Trust, April 2017, <http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf>

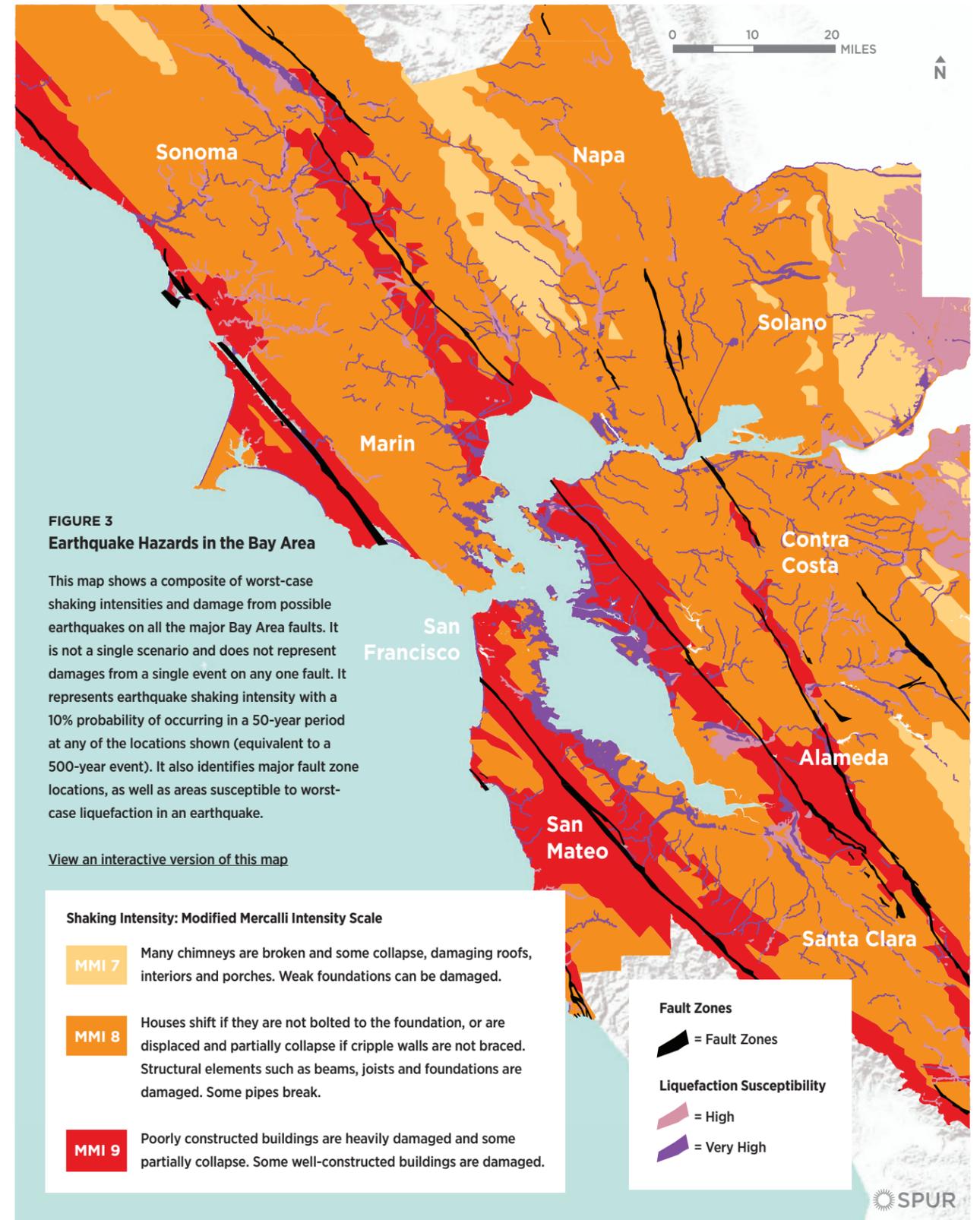
12 Griggs et al., p. 26.

13 San Francisco Estuary Institute and SPUR, *San Francisco Bay Shoreline Adaptation Atlas*, 2019, p. 53, <https://www.sfei.org/adaptationatlas>

14 E. Plane, K. Hill and K. May, *Minimum Depth to Groundwater for the Coastal San Francisco Bay Area*, UC Berkeley, 2017.

15 USGS, *Earthquake Outlook for the San Francisco Bay Region, 2014–2043*, 2016, <https://pubs.usgs.gov/fs/2016/3020/fs20163020.pdf>

16 USGS, *HayWired Scenario*, https://www.usgs.gov/natural-hazards/science-application-risk-reduction/science/haywired-scenario?qt-science_center_objects=0#qt-science_center_objects



Data Sources: Association of Bay Area Governments (<http://resilience.abag.ca.gov/open-data>); USGS & ABAG - The Modified Mercalli Intensity (MMI) Scale (<http://resilience.abag.ca.gov/shaking/mmiipopup/>)

The Resilient City

In 2009, SPUR launched the Resilient City, an initiative to address the challenge of seismic safety in San Francisco.¹⁷ The resulting series of nine policy reports addressed the potential for a major earthquake and what to do about it in three sequenced parts: Before the Disaster, Emergency Response and After the Disaster. The comprehensive suite of policy ideas in these reports included defining resilience and seismic performance objectives for everything from homes to hospitals to power lines, addressing the dilemma of existing buildings and keeping them safe enough to live in after a major event, upgrading “lifeline” infrastructure such as power and water lines, preparing for community-based disaster response, and

rebuilding and recovery in the months and years after a major quake. SPUR’s recommendations for better seismic resilience went on to inform San Francisco’s Community Action Plan for Seismic Safety and the city’s 30-year Earthquake Safety Implementation Plan. They were also instrumental in prompting former Mayor Ed Lee to create and host the nation’s first-ever Lifelines Council, which is dedicated to improving the seismic performance of critical infrastructure and its interdependencies in an on-going way. Work to implement these recommendations is currently underway, led by the city’s Office of Resilience and Capital Planning.¹⁸

17 SPUR, *The Resilient City*, 2008–2013, <https://www.spur.org/featured-project/resilient-city>

18 For more information, visit www.onesanfrancisco.org

Hazard exposure and vulnerability

The presence of natural hazards is only one part of understanding risk. Risk is also a function of which people and places will be exposed to a hazard, how severe the impact will be on those people and places and how difficult it will be for them to recover.

Exposure identifies the communities that could experience the risk and the geographical extent of different hazards, such as fires, flooding and earthquakes. *Vulnerability* considers the degree to which structures and infrastructure are likely to be damaged or destroyed and how much people are likely to be impacted. *Vulnerability* also assesses which populations, structures and infrastructure may be least able to cope with a hazard or to recover quickly. To prioritize efforts to improve resilience, a city or other government agency must understand all of these variables.

The Bay Area’s exposure and vulnerability can be measured and understood in two ways. First, a survey of past damages allows us to understand the nature and cost of various types of events like flooding and wildfire, as well as the geographic extent of areas that might experience recurrent hazards. Figure 4 lists some of the major presidentially declared disasters that have affected the region in the last 50 years.



FIGURE 4
Major Presidential Declared Disasters Affecting the Bay Area in the Last 50 Years

California frequently experiences disasters that impact multiple counties and cause losses in the hundreds of millions to billions of dollars.

NAME OF DISASTER	EVENT CATEGORY	DATE	COUNTIES INVOLVED	LOSS IN U.S. DOLLARS (NOT INFLATION-ADJUSTED)	STRUCTURES LOST	DEATHS
Russian River Flood	Flood	Feb. 2019	Lake, Marin, Monterey, Napa, Sonoma, Yolo	\$155 million	1,900	1
Tubbs, Nunn, Atlas and Wine Country Fires	Fire	Oct. 2017	Napa, Solano, Sonoma	\$14.5 billion	8,900	44
South Napa Earthquake	Earthquake	Sep. 2014	Napa, Solano	\$300 million	2,000	2
Severe Storms, Flooding, Landslides and Mudslides	Flood	Dec. 2005–April 2006	Alameda, Contra Costa, Lake, Marin, Napa, Santa Cruz, Solano, Sonoma, Yolo	\$300 million	1,000	
Severe Storms, Flooding, Landslides and Mudslides	Flood	Jan.–April 1995	Statewide	\$1.8 billion	10,300	28
Oakland Hills Fire	Fire	Oct. 1991	Alameda	\$1.5 billion	3,000	25
Loma Prieta Earthquake	Earthquake	Oct. 1989	Alameda, Monterey, San Benito, San Mateo, Santa Clara, Santa Cruz	\$6.9 billion	12,000	63
Northern California Flood	Flood	Jan. 1982	Contra Costa, Santa Cruz, Sonoma	\$280 million		25–32
El Niño	Flood	1982–83	40 coastal counties	\$800 million	7,800	33

Sources: Multiple sources including FEMA (<https://www.fema.gov/disasters>) and ABAG (“Disasters Affecting the San Francisco Bay Area, 1950–2009,” <http://resilience.abag.ca.gov/wp-content/documents/ThePlan-D-2011.pdf>)

Second, scenario planning can forecast the potential damage from simulated future events. For example, USGS’s HayWired earthquake scenario examined at length the cascading consequences of a scientifically realistic 7.0-magnitude earthquake on the Hayward Fault.¹⁹ The potential hazard impacts include strong ground shaking, landslides, liquefaction, aftershocks and multiple fires following the earthquake, including the loss of firefighting water due to broken and depressurized pipes. Estimates of property damage and losses from business disruption come to \$82 billion, with 77,000 households displaced. If other factors (such as utility outages) are included, more than 152,000 households, or 411,000 people, could be displaced by the shaking-related damages. Other loss estimates include 800 people killed, 18,000 nonfatal injuries and over 22,000 people requiring rescue from collapsed buildings and stalled elevators. While the USGS and its partners in the scenario study acknowledged that as much as \$50 billion has been invested into seismic safety of infrastructure in the Bay Area in the 30 years since the Loma Prieta Earthquake, there is still a lot more to be done to reduce impacts to vulnerable people, buildings and lifeline infrastructure.

19 USGS, *The Haywired Earthquake Scenario: We Can Outsmart Disaster*, April 2018, <https://pubs.usgs.gov/fs/2018/3016/fs20183016.pdf>

Equity and vulnerability

Earthquakes and climate hazards affect everyone, but some social groups are more vulnerable than others, including people with low incomes, immigrants, communities of color, elders and young children. The poor air quality resulting from higher temperatures and heat waves will disproportionately affect these groups, along with those who have certain preexisting health conditions. Those with low incomes and those who don't speak English are less able to access emergency resources like evacuation information, emergency housing and transportation. People who are more vulnerable often do not have sufficient insurance or the financial reserves necessary to recover from a disaster. They are more likely to occupy housing that is made with less resistant materials or that has not been retrofitted for earthquakes, wildfires or flooding. They're also at greater risk of long-term displacement in the event of a major disaster. Figure 5, adapted from the report *Stronger Housing, Safer Communities* by the Association of Bay Area Governments (ABAG),²⁰ describes factors that contribute to a community's disaster vulnerability and to its ability to recover.

FIGURE 5
Considerations for Community Vulnerability

Many community members have limited access to resources

Many Bay Area residents are resource-constrained. This includes households with low or very low incomes, households of all income levels that spend a high percentage of their earnings on housing and transportation, and households that depend on transit because they don't have a car. Resource-limited households are less able to prepare for natural disasters and, if displaced from damaged homes, will likely struggle to find housing that is affordable and near to the jobs, schools, medical facilities and other services they rely on.

Housing affordability is an existing challenge that is aggravated by climate risk and could hinder recovery

Many of the region's residents are already cost-burdened with regard to housing, meaning that they spend more than 30% of their income on housing. After a disaster, if many housing units are too damaged to live in, a constrained market could drive up the cost of housing even further and aggravate the existing lack of affordable housing. This will likely increase the number of people who leave the Bay Area because they can't find housing they can afford.

²⁰ ABAG, *Stronger Housing, Safer Communities: Strategies for Seismic and Flood Risks*, 2015, http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/

Source: ABAG, *Stronger Housing, Safer Communities: Strategies for Seismic and Flood Risks*, 2015, http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/

Renters have limited ability to improve their housing resilience

Renters typically can't control how their buildings are designed, operated or retrofitted for disaster. Neither are they likely to have hazard insurance to protect themselves and their belongings in case of a disaster. During a disaster, communities with a large number of renters, and in particular resource-limited renters, will need to provide these residents with emergency shelter facilities. After a disaster, resource-limited renters will need help finding interim affordable housing to avoid being permanently displaced from communities due to damaged housing.

Many community members have limited or inadequate information about hazards

Access to timely, accurate and meaningful information both before and after a natural disaster can be challenging in all communities and can be particularly hard to find in communities with a large number of non-English-speaking households.

Information on elders and very young community members is limited

Up-to-date and easily accessible information about the number of elders and young children living in a community can be challenging to find, particularly during a disaster. It can be difficult to evacuate these community members, especially if they need specialized equipment or supervision. Emergency shelter facilities need to be prepared to house them safely and to maintain communication with concerned family members.

Figure 6 shows the number and magnitude of earthquake, fire and flooding risks in various areas, overlaid with the location of Communities of Concern, as identified by the Metropolitan Transportation Commission and the Association of Bay Area Governments (MTC-ABAG). These are census tracts with concentrations of disadvantaged groups such as minority, low-income, senior and disabled populations; people with limited English proficiency; zero-vehicle and rent-burdened households; and single-parent families.²¹ While this map shows that every part of the Bay Area is exposed to one or more hazards, it also identifies those communities that may be less able to cope with exposure and may need extra support to prepare for, respond to and recover from a disaster.



21 MTC-ABAG, *Plan Bay Area 2040: Final Equity Analysis Report*, July 2017, http://2040.planbayarea.org/sites/default/files/2017-07/Equity_Report_PBA%202040%20_7-2017.pdf

2. How California Manages and Governs Hazard Resilience

Today, disaster-related risks in the Bay Area are managed through a number of government programs and tools, many of them implemented at the state level.

Community land use, hazard mitigation and resilience planning

California leads the nation with its approach to managing the risks posed by earthquake and climate-related hazards. State law requires risk assessment and management as part of community-level planning. All cities and counties must adopt a general plan to guide future development, and all general plans must include a safety element to protect the community from risks such as earthquakes, fires and floods.

One of seven required general plan elements, the safety element directs all cities and counties to adopt a comprehensive plan that addresses seismic hazards, flooding, wildfire, liquefaction, other geological hazards, hazard mitigation strategies and climate adaptation. In the last 10 years, the state legislature has made changes to safety element requirements in response to new and increasing risks. Cities and counties are now required to address the risk of fire in very-high-wildfire hazard areas (2012 Senate Bill 1241) and to include climate change information and adaptation strategies (2015 Senate Bill 379) in their general plans. The Governor's Office of Planning and Research (OPR) provides general plan guidance to cities and counties on developing safety elements. Safety elements are not frequently updated by local governments, and they are not required to be updated except to comply with these recent changes to state law.

Another tool that cities and counties have is the local hazard mitigation plan (LHMP). These are not required by state law, but the Federal Emergency Management Agency (FEMA) does require them for governments to be eligible for federal hazard mitigation grants and post-disaster funding. In practice, many local jurisdictions adopt LHMPs and include that information in their safety element as well. (State law also encourages this.) The Federal Disaster Mitigation Act of 2000²² requires that states review LHMPs to gather hazard, vulnerability and mitigation information from the local level for use in state-level planning; to ensure that local jurisdictions are made aware of the hazards and vulnerabilities within their jurisdiction; and to develop strategies to reduce those vulnerabilities. The hazard mitigation planning staff at the state Office of Emergency Services (Cal OES) assists local governments in the development of LHMPs and provides limited technical assistance, training and outreach to local jurisdictions. Cal OES reviews all LHMPs and coordinates with local jurisdictions to ensure compliance with FEMA's Local Mitigation Plan Review Guide before final review and approval by FEMA. Most Bay Area cities have adopted LHMPs.

Other local government plans and policies that may include hazard information and resilience policies or programs include general plans, local coastal plans (required by the California Coastal Act), specific plans, climate action plans and resilience strategies.

²² For the text of the law, see: <https://www.caloes.ca.gov/HazardMitigationSite/Documents/Disaster Mitigation Act of 2000.pdf>

Building and lifeline codes and standards

In California, the design and construction of buildings must follow the California Building Code, which requires that all new buildings are designed to withstand flood and earthquake loads and limit the impacts of fires. Seismic provisions have been in place for many decades and have evolved considerably over time as research and real earthquakes have tested building performance. For the most part, current seismic provisions focus on protecting lives and avoiding life-threatening damage. They do not address the protection of building contents or set standards for maintaining the functionality of plumbing, electrical and other systems in the aftermath of a damaging earthquake. As a result, even a newly constructed building can incur costly repairs and be uninhabitable for weeks or months following an earthquake it was designed to withstand.

In 2005, California adopted the model building and fire codes of the National Fire Protection Association, which include special provisions for the construction of new buildings in state or local fire hazard areas. In Special Flood Hazard Areas designated by FEMA and the California Department of Water Resources, structures must be raised above the base flood elevation by a specified amount for the area, plus a margin of safety (called the “freeboard”).

There are many codes, standards, guidelines and manuals that govern the design, construction and performance of transportation and lifeline systems and system components.²³ Developed in a variety of ways, they vary considerably from system to system. Most tend to cover minimum levels of safety or performance for parts of their system (though not for systemwide performance), and most address day-to-day operations and not extreme, low-probability, high-consequence events like earthquakes, floods and wildfire. The processes by which lifeline codes, standards and guidelines are developed represent various levels of consensus, most typically among operators, regulators and engineering experts.

The California Public Utilities Commission regulates privately owned electric, natural gas, telecommunications, water and transportation companies. Public transportation and utilities, such as BART, Muni, AC Transit and many of the Bay Area’s water and wastewater providers, are overseen by locally appointed or elected boards and commissions. Most regulators adopt the latest codes and standards, and some even add more stringent requirements for both new and existing systems. However, even if codes and standards are adopted, their effectiveness might be jeopardized by poor enforcement during planning, design and construction of infrastructure components, or due to a lack of funding for resilience upgrades.

²³ Applied Technology Council, *Critical Assessment of Lifeline System Performance: Understanding Societal Needs in Disaster Recovery*, National Institute of Standards and Technology, April 2016, <http://dx.doi.org/10.6028/NIST.GCR.16-917-39>



Approaches to Risk: Avoid, Mitigate, Transfer, Retain

There are four basic options for controlling risks: avoidance, reduction or mitigation, sharing or transfer, and retention.²⁴ The challenge in risk decision-making is to find the best solution, not the only solution. The best solution depends on the circumstances, values and priorities of the decision-makers.

Risk avoidance means deciding not to pursue a project that would introduce new risks, such as building in a flood hazard zone. Risk avoidance tools include prohibiting development in certain areas, offering voluntary property buyouts, making zoning requirements more restrictive and forbidding the occupancy of hazardous or damage-prone buildings. Although avoidance is highly effective, it may be impractical, or it may need to be balanced with other considerations, such as a community’s need to build new housing. Some risks, such as damage from earthquakes, are not technically possible to eliminate at this time: We cannot stop earthquakes from occurring and cannot practically retrofit all structures to survive them undamaged. Once a risk is known, avoidance, if possible and affordable, may be the best course of action.

Risk reduction or mitigation strategies usually reduce the frequency or severity of the potential losses resulting from a risk. Risk reduction tools include passing stricter building codes, instituting hazard warning systems, creating redundant infrastructure, strengthening or retrofitting structures and infrastructure and establishing emergency facilities for vulnerable populations before and after a disaster.

Risk-sharing or transfer strategies shift the risk-bearing responsibility to another party, and that party then handles any losses. Insurance is a classic example of an economic risk transfer technique. Another example occurs during the land development process, when the streets, sidewalks and other infrastructure built as part of the project are deeded to local agencies. As part of this transfer, local agencies then assume the costs and associated risks of maintaining infrastructure and services. Other risk-sharing tools include real estate hazard disclosures, geologic hazard abatement districts, transfer of development rights and insurance pools.

Risk retention by public agencies occurs when they choose to fund potential losses, either wholly or partially, with their own resources. The most visible form of risk retention is self-insurance that communities accept knowingly. For example, electing not to insure city-owned buildings against potential damage from floods and earthquakes means that those risks are self-insured. More commonly, risk is retained unknowingly because governments, businesses and residents are unaware of the risk. In addition to self-insurance, risk retention tools include not taking action at all, using catastrophe bonds and establishing a line of credit for lost revenues or asset losses.

²⁴ L. Johnson, L. Dwelley Samant and S. Frew, *Planning for the Unexpected: Land Use Development and Risk*, American Planning Association, 2005, https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/PAS-Report-531.pdf

Insurance

Property insurance is a primary form of risk transfer and an important source of post-disaster financing. For residents and businesses, California is the nation's largest insurance market, with over 1,300 insurance companies collecting \$310 billion in premiums annually and holding \$5 trillion in assets under management.²⁵ Most local governments in the United States participate in risk pools, which effectively operate like insurance companies to share the risk across public buildings and infrastructure and to purchase reinsurance as a group.

Nationwide, about 95% of homeowners have basic residential insurance coverage.²⁶ In California, a standard homeowners insurance policy covers the risk of fire but excludes earthquake- and flood-related risks. The California Department of Insurance regularly conducts a data call to estimate the residential insurance coverage for fires and earthquakes across the state. Across the nine-county Bay Area, there are over 2.4 million residential fire insurance policies for homeowners, condominium unit owners, mobile homes and renters.²⁷ If residents and businesses are unable to obtain fire insurance coverage in the voluntary private insurance market, the California FAIR Plan Association exists as an insurer of last resort, providing basic fire insurance coverage for residential and commercial buildings, as well as personal property coverage for residential and business occupancies. The coverages offered on a FAIR Plan policy are much more limited than standard residential or commercial insurance policies.

The take-up of residential and commercial earthquake insurance is far lower than fire insurance, both because fire insurance is typically required by mortgage lenders and because earthquake insurance is very expensive. For example, only 11% of homeowners with a fire insurance policy in the nine-county Bay Area also have an earthquake policy.²⁸ About two-thirds of the residential earthquake insurance policies statewide are provided by the California Earthquake Authority (CEA), a not-for-profit, privately funded and publicly managed organization. Most of the commercial earthquake insurance in the state covers large commercial buildings.²⁹

The National Flood Insurance Program (NFIP) is a primary provider of basic residential and commercial flood insurance policies. Data from the NFIP indicate that there are even fewer properties with flood insurance than with earthquake insurance in the nine-county Bay Area.³⁰ High-hazard flood zones are smaller than the areas exposed to strong ground shaking and other earthquake hazards, but flood risk exists outside the official flood zones mapped by FEMA and is likely to be much more variable with climate change. Note that the NFIP is not the only provider of flood insurance; many residential and commercial properties with NFIP policies also buy an excess flood insurance policy to extend their coverage.

25 E. Mills et al., *Trial by Fire: Managing Climate Risks Facing Insurers in the Golden State*, California Department of Insurance, September 2018, <https://www.law.berkeley.edu/wp-content/uploads/2018/09/Trial-by-Fire-September-2018.pdf>

26 C. Wilkinson, "How Many Homes Are Insured? How Many Are Uninsured?," The Triple-I Blog, Insurance Information Institute, January 26, 2016, <http://www.iii.org/insuranceindustryblog/how-many-homes-are-insured-how-many-are-uninsured>

27 California Department of Insurance, "Fire and Earthquake Policy Count per County as of December 31, 2017," http://www.insurance.ca.gov/0400-news/0200-studies-reports/0250-homeowners-study/upload/C-Policy-Count-by-County-2_v1.pdf

28 Ibid.

29 California Department of Insurance, *California Earthquake Zoning and Probable Maximum Loss Evaluation Program: An Analysis of Potential Insured Earthquake Losses from Questionnaires Submitted to the California Department of Insurance by Licensed Property/Casualty Insurers in California for: 2002-2010*, 2012, https://www.insurance.ca.gov/0400-news/0200-studies-reports/upload/EQ_PML_RPT_2002_2010.pdf

30 FEMA, "National Flood Insurance Program Policy Information by State and Community, as of June 30, 2019," <https://www.fema.gov/policy-claim-statistics-flood-insurance>



Not only are there differences in the insurance take-up rates for fire, earthquake and flood hazards, but there are also important differences in the policy coverages.³¹ For example, under a standard homeowners fire policy, there are coverages for the dwelling itself and attached structures, other structures (i.e., detached garage and sheds), personal property and loss of use. The maximum value for dwelling coverage for both a standard homeowners fire policy and the CEA homeowners earthquake policy is the estimated cost to rebuild the dwelling and attached structures. The California FAIR Plan homeowners fire policy sets a maximum value for all coverages at \$1.5 million, and the NFIP residential flood policy sets a maximum value of \$250,000 for dwelling-related losses. Neither the CEA earthquake nor NFIP flood policies cover losses to other structures, and the NFIP also does not cover loss of use.

Of the already-small portion of residents and businesses who are insured for earthquakes and floods, many are underinsured, with a gap between the actual cost of repairing or replacing damaged property and the payout received from a claim. Post-disaster surveys consistently find that more than half of homeowners do not have adequate coverage to replace or rebuild their homes after disaster strikes.³² Underinsurance can be caused by insurance limits that are too low, gaps in coverage due to policy exclusions and high deductibles. Underinsurance delays or hinders rebuilding, compounds the trauma of loss and weakens communities' ability to rebound from devastating events.

Voluntary programs

In addition to required local plans, voluntary programs offer ways to improve community resilience at the local scale and often are aimed at reducing insurance costs for property owners. For example, FEMA's Community Rating System is a voluntary program that provides reduced flood insurance premiums for property owners in communities that participate in the National Flood Insurance Program but proactively manage floodplains in ways that go beyond the program's minimum requirements. Fire safe councils are community-led organizations that educate homeowners about wildfire preparedness and sometimes develop community wildfire protection plans. These plans provide a framework for federal forest management and fuel reduction activities near communities, and they recommend local actions for improving the fire safety of structures in the WUI.

31 California Department of Insurance, *Residential Insurance: Homeowners and Renters*, Revised May 2018, <http://www.insurance.ca.gov/01-consumers/105-type/95-guides/03-res/res-ins-guide.cfm#coveragea>; California Earthquake Authority, "CEA Homeowners Policy Coverages & Deductibles," 2019, <https://www.earthquakeauthority.com/California-Earthquake-Insurance-Policies/Homeowners/Coverages-and-Deductibles>; California FAIR Plan Property Insurance, "Dwelling Policy," 2019, <https://www.cfpnet.com/index.php/consumers/dwelling-policy/>

32 United Policyholders, "Underinsurance Help: Were You Lulled into a False Sense of Security, or Did You Intentionally Underinsure Your Biggest Asset?," <https://www.uphelp.org/guide/underinsurance-help-were-you-lulled-false-sense-security-or-did-you-intentionally-underinsure>

Summary

It is worth noting that most existing tools are not designed to be cross-jurisdictional or applied at the regional scale. Even the plans that are multi-jurisdictional recommend actions that are mostly local. This limits the effectiveness of resilience planning. One community's actions to increase resilience — or its failure to act — can affect its neighbors and the region as a whole. A county-by-county or city-by-city approach, combined with voluntary efforts, may adequately recognize differences in goals, values and the hazards to be addressed, but it's not enough to secure regional resilience in cases where communities are adjoining and interdependent. What one community in the WUI chooses to do affects the fire safety of all adjacent communities. What one community chooses to do about earthquake-vulnerable buildings and infrastructure affects surrounding neighborhoods and the economy. What one community chooses to do on its shoreline to manage sea level rise affects flooding for its neighbors. When development occurs upstream in a watershed, it can affect flooding downstream by increasing the speed, volume and water quality of runoff. Failing to plan regionally means that resilience investments might not have the expected payoff or safety benefits, or they might not improve conditions for the community at large. Of course, proactive cities and counties can go above and beyond expectations, innovating new standards that can be broadly applied and adopted. This kind of leadership benefits those communities and increases regional resilience, though it is no substitute for a shared baseline of safety.





As the Bay Area grows, our exposure and potential vulnerability to hazards will increase unless we do further planning for risk and prioritize a variety of strategies to reduce risk. Meanwhile, there is better information than ever before about what future hazards and impacts might look like. SPUR sees a need and an opportunity at the regional scale to address the vulnerabilities of the region’s interconnected, interdependent infrastructure systems and communities — and at the local scale within the region, because of its multi-hazard exposure. In some cases, to create a level playing field and provide better information, SPUR suggests strategies at the state level. This report makes 12 recommendations in four categories, covering how we can improve data and information gathering, codes and standards, community planning, and funding for multi-hazard resilience in the Bay Area.

3. Policy Recommendations and Discussion

FIGURE 7
Recommendations Summary

CATEGORY	SCALE	RECOMMENDATIONS
Data and information	State	1. Develop dynamic, web-based maps that reflect current and potential future property risk across multiple hazards.
	State	2. Adopt a statewide functional recovery building standard so that more buildings will be usable and easily repaired after a disaster.
Building and lifeline codes and standards	State, regional and local	3. Require cities and counties to inventory and screen buildings for vulnerability to wildfires, flooding and earthquakes in areas of known risk. Make certain retrofits mandatory within 20 years.
	Regional	4. Create a regional lifelines council to identify interdependencies between utility systems, assess their vulnerability to hazards, set regionwide mitigation priorities and identify ways to fund critical upgrades within the next 10 years.
	Local	5. Consolidate certain single-purpose special districts (such as fire or flood prevention) into multi-hazard resilience districts and expand their geography as needed.
	Local	6. Develop local disaster recovery frameworks in every city and county to help ensure that local jurisdictions are ready to manage recovery following a major disaster.
Community planning	Local	7. Change zoning codes to prevent further development in high-hazard areas that are significantly vulnerable to fire, liquefaction and sea level rise, with priority consideration in those areas where multiple hazards overlap. Ensure no net loss of planned housing by accommodating new development in low-hazard existing urbanized areas.
	Local	8. Acquire undeveloped hazard-prone lands for public ownership and use.
Funding	State or regional	9. Develop a regional or state buyout program for properties repeatedly damaged by wildfire, flooding or other climate impacts.
	State	10. Ensure that insurance for fire, earthquake and flood hazards remains available and affordable for residents and businesses. Ensure that state insurance regulations encourage and appropriately price resilient land use, new construction and retrofit practices.
	Regional	11. Establish a regionwide geologic hazard abatement district, or a series of countywide districts, to pool resources to fund regional resilience projects.
	Regional	12. Establish a regional resilience trust fund for future climate adaptation and hazard management needs.

RECOMMENDATION 1

Develop dynamic, web-based maps that reflect current and potential future property risk across multiple hazards.

Who: California Office of Emergency Services (Cal OES) with California Geological Survey (CGS), California Department of Forestry and Fire Protection (Cal Fire), California Department of Water Resources, Governor's Office of Planning and Research (OPR) and FEMA

Today, the maps that government agencies use to identify hazardous areas are incomplete and do not respond to changing conditions. For example, FEMA flood insurance rate maps are based on flood recurrence intervals derived from historical hydrology records (for river and creek flooding) and tidal records (for coastal flooding). They do not include projections for the impact of climate change on nearby urban development, nor do they factor sea level rise into the risk of coastal flooding. Today, many people who own property in a Special Flood Hazard Area and are required to purchase flood insurance do not frequently experience flooding. At the same time, many people who live outside of FEMA's designated flood zones and are not covered by private insurance will experience flooding in the future. There are virtually no state-adopted maps that indicate the hazards of rising groundwater and increasing liquefaction risk as water tables rise due to sea level rise, one of the factors behind the phenomenon of "sunny day flooding."

Many of the areas that burned in the 2017 Wine Country fires were not designated as hazardous areas on Cal Fire's maps.³³ Outside of Cal Fire's responsibility areas (generally wilderness areas) — in places where cities are responsible for firefighting, zoning, building inspections and other controls — only "very high" fire hazard areas are typically mapped, not "high" or "moderate" hazard areas. In all cases, fire maps do not take extreme weather conditions into account.

The 1972 Alquist-Priolo Earthquake Fault Zoning Act requires the California Geological Survey (CGS) to establish earthquake fault zones and issue appropriate maps of these fault zones. The 1990 Seismic Hazard Mapping Act requires the state geologist and CGS to prepare maps of seismic hazard zones, identifying the areas that are susceptible to strong ground shaking, earthquake-induced landslides, liquefaction or other ground failures. The act also requires that the areas susceptible to tsunamis and seiches (standing waves in a semi-enclosed water body, usually triggered by earthquakes) be included in these maps when appropriate hazard information and funding are available to complete this work. While earthquake fault mapping has been completed in all Bay Area counties, there are gaps in the mapping of liquefaction and earthquake-induced landslide hazards. Hazard zone maps for tsunamis are now in development. The state's current tsunami inundation zone maps are mainly intended for use in evacuation planning, but future maps could be sufficiently detailed to use in land use planning.

In order to make good land use planning, zoning and building code decisions, the Bay Area needs maps that represent the hazards of the future, not just those of the past. Cal OES, working with OPR, Cal Fire, FEMA, the California Department of Water Resources and CGS, should integrate data from multiple agencies and sources to develop regularly updated web-based maps that fully cover the hazards in all nine counties and

³³ L. Sommer, "See If You Live in a High-Risk Fire Zone and What That Means," KQED, October 31, 2017, <https://www.kqed.org/science/1917374/map-see-if-you-live-in-a-high-risk-fire-zone-and-what-that-means>



reflect the latest available information. These agencies should map hazards to reflect risk as consistently and accurately as possible throughout all cities and counties in California — regardless of who is responsible for managing the hazard. Once this process is complete, Cal OES should update the maps on its MyHazards web-site — a tool for the general public to look up hazards in their area — to help inform property owners, prospective owners, tenants, local governments, insurers and others.

Funding for this mapping must be consistent and not dependent — as CGS funding currently is — on building permit application fees collected by cities and counties, a funding stream that fluctuates with the boom-and-bust cycle of California's building industry. The California State Legislature appropriates the funds in the Hazards Mapping Fund and should allocate enough funding to expand and improve the mapping program to address all the hazard mapping needs for the next five years.

RECOMMENDATION 2

Adopt a statewide functional recovery building standard so that more buildings will be usable and easily repaired after a disaster.

Who: California Building Standards Commission; city and county building departments to adopt and enforce

Over the last few years, policymakers and advocates have begun calling for "better than code" design for earthquake resilience that would achieve not only safety but also acceptable recovery times.³⁴ A functional recovery standard aims to ensure that buildings and infrastructure can sufficiently maintain or restore pre-earthquake functionality following an earthquake. For essential facilities like hospitals and fire stations, the code requires that these buildings be in shape to be occupied and functional immediately, so we already know that better performance is possible. For housing or commercial properties, which wouldn't entail as many requirements as essential facilities, the price to achieve the functional standard would be lower. In fact, a growing number of projects voluntarily designed for predictable and fast recovery are showing that this better performance is possible for very little to no additional cost. Two examples in San Francisco are 181 Fremont Street and Casa Adelante, a 100% affordable senior housing development.

In the 2009 report *Defining Resilience*, SPUR proposed having different post-earthquake recovery times for different building uses and lifelines.³⁵ The City and County of San Francisco has expanded on that work by developing recovery targets for different building types and uses, in consultation with a stakeholder working group. The city is also working with the Lifelines Council to develop desired targets for system recoveries following a magnitude-7.2 earthquake and to evaluate the current state of performance for systems in that earthquake.³⁶

³⁴ Earthquake Engineering Research Institute, *Functional Recovery: A Conceptual Framework with Policy Options*, December 6, 2019, <https://www.eeri.org/wp-content/uploads/EERI-Functional-Recovery-Conceptual-Framework-White-Paper-201907.pdf>

³⁵ C. Poland, *Defining Resilience: What San Francisco needs from its seismic mitigation policies*, SPUR, 2009, <https://www.spur.org/publications/spur-report/2009-02-01/defining-resilience>

³⁶ City and County of San Francisco, Office of Resilience and Capital Planning, "Recovery Plan," ONESF, <https://onesanfrancisco.org/recovery-plan>

Cities can reasonably justify local building performance standards that are higher than required by state law. San Francisco already anticipates that it will have to increase its standards to improve the city's earthquake resilience. Bay Area cities are subject to higher seismic risk than some other parts of California and should adopt functional recovery standards that restore a building's pre-earthquake use within an acceptable time, which could vary for different uses or occupancies.

Assembly Bill 393, passed by the California Assembly in 2019 and still under consideration by the State Senate as of February 2020, directs the State Building Standards Commission to assemble a functional recovery working group made up of appropriate public and private sector entities to consider whether a functional recovery standard is warranted for all or some building uses. This could result in either a mandatory or voluntary set of building regulations that provide specific design and construction requirements for residential and non-residential buildings.

RECOMMENDATION 3

Require cities and counties to inventory and screen buildings for vulnerability to wildfires, flooding and earthquakes in areas of known risk. Make certain retrofits mandatory within 20 years.

Who: California State Legislature, city councils and county boards of supervisors to legislate; regional government and local building departments and officials to implement

There are two ways to improve existing building safety and performance and to make policy-supported changes to the existing building stock. One way requires upgrades to be made at "trigger points," when they're easier to do, such as during a major renovation, expansion or sale of the building. This approach has worked well for improving the environmental performance of buildings and is part of local building codes including San Francisco's Green Building Ordinance. Another example is San Francisco's Retrofit on Resale plumbing ordinance, which required all buildings to be fitted with high-efficiency water fixtures, either at the point of sale or by the end of 2017, whichever came first (an approach now copied by state law). The downside is that this approach does not catch all buildings and can take considerable time to implement. Furthermore, the California Building Code exempts much existing housing from triggered hazard upgrades.

The second way to improve the building stock is through mandatory screening and upgrades. This approach is especially warranted when public safety, especially human life, is at risk; when systematic damage to certain types of buildings poses challenges to community resilience, including the risk of large-scale population displacement; or when a building can affect the safety of adjacent buildings in a disaster. An example of this approach is San Francisco's 2013 Soft-Story Retrofit Ordinance, which required seismic safety retrofits for older apartment buildings with large openings for garages or storefront windows on their ground floors. The ordinance required the building inspector to send a screening form to all buildings with soft-story conditions; building owners could use the form to declare an exemption or to demonstrate that seismic upgrades had already been performed. Those who were not able to certify their building's compliance (as determined by an architect or engineer) were required to perform building upgrades within about three years. The screening

Source: San Francisco Department of Building Inspection, <https://sfdbi.org/received-violation>

phase of the program has achieved a 99% compliance rate, and over 3,700 buildings have been retrofitted or have upgrades underway (76% compliance rate).³⁷ The high compliance rate may be due to the very effective notices of violation that the Department of Building Inspection developed, combined with public buy-in and a strong rental and housing market that provided owners with the capital to make the improvements.

The cities of San Francisco, Alameda, Berkeley, Fremont, Oakland, San Leandro and Sebastopol, as well as Santa Clara County, have all developed inventories of seismically vulnerable soft-story buildings,³⁸ but only Berkeley, Fremont, Oakland and San Francisco have mandated retrofits. In addition to soft-story buildings, there are many other types of seismically vulnerable buildings in the Bay Area that are not as well understood. ABAG's Resilience Program has developed an Earthquake Home Safety Quiz that helps residents and homeowners identify vulnerable housing types and learn about resources for making the structures and occupants safer.³⁹

A major issue in the Bay Area is that we simply do not know which buildings are vulnerable to which hazards. Each jurisdiction has a different mix of building sizes, ages, uses and vulnerabilities. A thoughtful regionwide, multi-hazard building inventory rooted in concepts of community resilience is needed in order to prioritize retrofit programs. A resilience-based inventory should not simply pick a damage-prone building type and start making a list of addresses. Instead, it should identify buildings that serve communitywide functions — housing, jobs, industry, etc. — and then take stock of each group, estimating the percentage of these buildings that have known vulnerabilities. For earthquakes, we know that vulnerable structure types include unreinforced masonry, wood soft story, tilt-up and non-ductile concrete. For wildfire, the vulnerabilities could include buildings with certain roof types or those lacking defensible space. For flood, they could include buildings without adequate elevation in certain flood-prone areas.

With a resilience-based inventory, cities and counties would be able to identify groups of buildings with

37 City and County of San Francisco, Department of Building Inspection, *Updated Soft Story Report*, October 16, 2019.

38 ABAG Resilience Program, Table 1.1., "Prevalence of Particular Best Practices in 'Soft Story Leadership Communities (as of March, 2016)';" http://resilience.abag.ca.gov/projects/soft_story_2016/

39 See: www.homequakequiz.org



The City of San Francisco developed highly effective notices to encourage property owners to bring their buildings into compliance with mandatory earthquake retrofit requirements.

critical combinations of use and vulnerability. Where both use and vulnerability are high, so is the retrofit priority. Special priority and urgency could be given to building groups that are most vulnerable to damage from one or more hazards; however, different communities could reasonably set their own priorities and target different hazards and different building groups. For buildings vulnerable to wildfire, flooding, sea level rise and earthquakes, different standards would apply depending on risks and building types. For example, buildings in the WUI built prior to the California WUI fire code (adopted in 2005) should be required to improve their wild-fire resilience in order to enhance both their own safety and communitywide resilience. These improvements should include creating defensible space, using better roofing materials, ventilating attics, enclosing rain gutters, covering vents to prevent embers entering the structure, installing dual-paned glass windows and more.⁴⁰ Buildings in floodplains should be dry-floodproofed (designed to keep water out all the time), wet-floodproofed (capable of handling occasional ground-floor inundation) or elevated. After Hurricane Sandy, the New York City Planning Department developed an illustrated guide to flood-retrofitting different types of buildings and building conditions, from single-story housing to very large mixed-use buildings. The guide also describes which types of upgrades would reduce NFIP premiums.⁴¹

Local retrofit programs should include both mandatory screenings — where property owners are notified of potential risk and must verify their compliance with mitigation standards — and retrofit standards that comprehensively address all risks (e.g., “Do not elevate buildings onto piles in areas of liquefaction”). Also, local retrofit programs need to balance the benefits and costs for the affected owners, tenants and, ideally, for the implementing jurisdiction itself. For example, among Bay Area soft-story retrofit programs, each city has had to grapple with the critical question of how to distribute retrofit costs between owners and tenants, given local rent stabilization rules and housing affordability concerns. Just as building stocks and priorities vary from city to city, so does the political feasibility of solutions to this problem.

The California Revenue and Tax Code exempts seismic retrofit improvements from triggering property tax reassessment. This state policy should be expanded to include risk reduction measures for wind, wildfire, flood and other natural hazards. State-level funding for inventory development and for guidance on best practices for retrofit programs is also needed. Cal OES could make resilience-based inventories part of its recommended or required practice for updating local hazard mitigation plans.

40 “Hardening Your Home Against Wildfire,” FireSafe Marin, <https://www.firesafemarin.org/home-hardening>

41 New York City Department of Planning, *Retrofitting Buildings for Flood Risk*, October 2014, www.nyc.gov/retrofitting



RECOMMENDATION 4

Create a regional lifelines council to identify interdependencies between utility systems, assess their vulnerability to hazards, set regionwide mitigation priorities and identify ways to fund critical upgrades within the next 10 years.

Who: MTC-ABAG to convene public and private utility operators

Lifelines are the utility systems that deliver water, wastewater, electricity, natural gas and telecommunications, as well as the transportation systems that allow us to get around, including public transit, ports, airports and road infrastructure.⁴² Like buildings, lifelines are critical to our ability to recover from a disaster. Lifelines are also interdependent — for example, the communications network depends on the power system, and restoring the power system following a disaster might be dependent on the condition of highways and rail lines.⁴³

As SPUR discussed in the 2009 report *Lifelines*,⁴⁴ hazard performance standards and regulatory requirements for lifelines vary across different infrastructure owners and operators, many of which are private entities. Many of these utilities have made major seismic upgrades to their systems in recent years. For example, the San Francisco Public Utilities Commission and the East Bay Municipal Utility District have invested billions of dollars into improving the expected seismic performance of water transmission systems (including by interconnecting with each other’s systems), and PG&E has made many improvements to its natural gas distribution system. However, gaps remain. For example, USGS’s HayWired earthquake scenario study projected that in the East Bay, the fire following an earthquake would be much more damaging and deadly than the earthquake itself and would be compounded by a broken water distribution system that limits firefighting capability.⁴⁵

Substantial resilience benefits would be gained if the region’s governmental and utility agencies took a more systematic and regional approach to setting lifeline infrastructure performance objectives and then used those objectives to prioritize and finance upgrades to the region’s most seismically vulnerable lifeline infrastructure. Since the 1989 Loma Prieta Earthquake, up to \$33 billion has been invested in the Bay Area to improve the resilience of regional utility and transportation infrastructure.⁴⁶ That investment has not been consistent across different utility sectors, and seismically vulnerable systems continue to threaten regional disaster resilience.⁴⁷

42 C. Barkley, *Lifelines: Upgrading Infrastructure to Enhance San Francisco’s Earthquake Resilience*, SPUR, 2009, <https://www.spur.org/publications/spur-report/2009-02-01/lifelines>

43 *Ibid.*, p. 5.

44 *Ibid.*

45 USGS, *The Haywired Earthquake Scenario: We Can Outsmart Disaster*, April 2018, https://pubs.usgs.gov/fs/2018/3016/fs20183016_.pdf

46 T.M. Brocher, K. Gefeke, J. Boatwright and K.L. Knudsen, *Reported Investments in Earthquake Mitigation Top \$73 to \$80 Billion in the San Francisco Bay Area, California, Since the 1989 Loma Prieta Earthquake*, USGS, 2018, <http://doi.org/10.3133/ofr20181168>

47 ABAG, 2014, http://resilience.abag.ca.gov/projects/transportation_utilities_2014/

The Bay Area needs to conduct a study of lifeline interdependencies and establish a regional lifelines council to identify critical resilience priorities, figure out how to fund mitigation work (possibly borrowing from the resilience trust fund or geologic hazard abatement district; see Recommendations 11 and 12) and be ready to coordinate disaster recovery. San Francisco offers a model to follow. The San Francisco Lifelines Council conducted an interdependency study in 2014 that identified vulnerabilities and made recommendations based on the scenario of a major San Andreas Fault earthquake. For example, one critical interdependency the study identified was that if damage and debris caused city streets to close, operators would not be able to manually manage valves for the water supply and natural gas systems.⁴⁸ The study's recommendations were translated into a five-year work program that the council is continuing to make progress on today.

Other disaster scenarios — such as multiple major wildfires burning at the same time or a major earthquake on a different fault — could inform a regional study and regional action. The regional lifelines council could identify “choke points” — critical geographic areas of utility interdependency — that need further study and should be prioritized for improvements.

RECOMMENDATION 5

Consolidate certain single-purpose special districts (such as fire or flood prevention) into multi-hazard resilience districts and expand their geography as needed.

Who: County local agency formation commissions

In many counties, particularly in unincorporated areas, firefighting, flood control, water supply and other public services may be provided by special districts that have independent, elected governing boards and the power to raise revenue through fees for service or by issuing bonds. In California, the specific geographies of these special districts are governed by local agency formation commissions (LAFCOs). Special districts typically focus on providing a narrow suite of services to a relatively small number of stakeholders at the county scale.

However, climate change will push and shift the geographic boundaries of the hazards we currently experience. Flooding, sea level rise and wildfire are all expected to affect areas that were long considered safe and were therefore excluded from special districts dedicated to addressing these issues. To manage these changing risks, existing special districts such as fire and flood control agencies should consolidate into larger, multi-hazard districts that can raise dedicated revenue over a larger geography and invest in mitigation and emergency response for multiple types of disasters.

A special district focused on resilience of all kinds could offer, and expand on, the suite of services provided by today's flood control and fire districts. Extending the boundaries of such a district would also increase the pool of potential resources to pay for it by including more property owners subject to fees or special taxes. There are pros and cons to creating geographically larger districts for the purpose of levying special taxes,

⁴⁸ City and County of San Francisco Lifelines Council, *Lifelines Interdependency Study*, April 17, 2014, p. v., <https://sfgov.org/orr/sites/default/files/documents/Lifelines%20Council%20Interdependency%20Study.pdf>



as they require a two-thirds majority vote to pass. Meanwhile, a benefit assessment district, which may only extend services like fire or flood control to specific enrolled properties, can be established with only a simple majority of property owners.

Two examples of resilience districts are instructive. First, the Gentilly Resilience District, a special district within the City of New Orleans, implements water and land management solutions in service of a healthier, safer neighborhood. The district was awarded over \$141 million by the Department of Housing and Urban Development's National Disaster Resilience Competition to support hurricane recovery and to reduce flood risk. The district's current projects include stormwater detention facilities, green infrastructure and drainage improvements at schools and playgrounds, homeowner education programs, public art and energy resilience projects. Second, San Mateo County recently formed the San Mateo Flood and Sea Level Rise Resiliency Agency, an effort to expand the county's narrow and dispersed flood control district into a larger agency that can help the county adapt to sea level rise in a coordinated manner across 20 cities and numerous special districts. While the new district has just been formed, it has the support of all 20 cities in San Mateo County. Given its larger geographic area, the district now has better potential to harness technical assistance, avoid duplication of effort and provide a comprehensive countywide approach to dealing with increased flood hazards.

RECOMMENDATION 6

Develop local disaster recovery frameworks in every city and county to help ensure that local jurisdictions are ready to manage recovery following a major disaster.

Who: Cities and counties with support from the Bay Area Urban Areas Security Initiative and MTC-ABAG

All cities and counties should develop local disaster recovery frameworks so that they have a plan in place to manage the long arc of recovery and rebuilding after a disaster. A local disaster recovery framework is a vision for rebuilding that assigns roles and responsibilities and improves the coordination of different agencies' responses within a community that has experienced a disaster. Disasters disrupt the economy, the housing system, social services, health care, infrastructure, natural and cultural resources and more. In the aftermath of a disaster, local, state, tribal and federal agencies may be involved in providing money, technical assistance, permits, community outreach, and support for recovery and rebuilding — support functions that might need to remain in place for months or years. This can require changes to the levels of service that these agencies previously provided, which a local disaster recovery framework would address. It could also specify how the community should rebuild in a way that improves future hazard resilience and safety.

The National Disaster Recovery Framework (NDRF) was published by FEMA in 2011.⁴⁹ It describes critical response and recovery tasks, including community planning and stabilization, public information and warnings, operational coordination, economic impact and recovery, supporting temporary and permanent housing, restoring infrastructure, and providing health and social services for affected populations. The NDRF outlines

⁴⁹ FEMA, *National Disaster Recovery Framework*, Second Edition, January 2017, <https://www.fema.gov/media-library/assets/documents/117794>

federal roles and provides a framework for organizing state and local recovery plans. Cal OES published the California Disaster Recovery Framework in 2019, establishing a recovery coordination structure consistent with the federal NDRF to facilitate the delivery of state and federal disaster assistance to impacted communities.⁵⁰ Both the state and federal frameworks outline guiding principles for recovery; roles and responsibilities of government, individuals and the private sector; and functional areas to focus on during recovery, such as housing, infrastructure, the economy, social and health services, natural and cultural resources, and community planning and capacity building.

Cities and counties are not currently required to develop local disaster recovery frameworks in the same way that they must develop local hazard mitigation plans to obtain mitigation grant funding from FEMA or include climate resilience and vulnerability information into general plan safety elements. Nonetheless, Bay Area cities, including San Francisco and Oakland, are developing local disaster recovery frameworks in advance of disasters.

Recovery planning that specifies roles, leadership and more will be critical to rebuilding after a major disaster in order to protecting people and the economy and prevent depopulation of the region. SPUR's 2013 report *On Solid Ground* made recommendations on how local governments could execute recovery planning, including improving the financing process, streamlining regulations, making decisions about rebuilding vs. replanning, addressing nonconforming uses (when a building predates zoning changes and does not conform to the zoning code) and preserving historic structures.⁵¹ SPUR also recommended that recovery plans include a streamlined procedure for modifying general plans and zoning ordinances, as well as any other local authorizations needed for the activities referenced in the recovery plan. The Bay Area Urban Areas Security Initiative has provided funding for recovery planning and developed a template that local governments can use to create their own recovery frameworks.⁵² MTC-ABAG could also develop a regional recovery framework to specify how counties could work together following a major multi-county disaster and to consolidate information about financing options, technical information on rebuilding and more.

50 California Governor's Office of Emergency Services, California Disaster Recovery Framework, 2019, <https://www.caloes.ca.gov/RecoverySite/Documents/2019-California-Disaster-Recovery-Framework.pdf>

51 SPUR, *On Solid Ground*, February 2013, https://www.spur.org/sites/default/files/publications_pdfs/SPUR_On_Solid_Ground.pdf

52 FEMA and Bay Area Urban Areas Security Initiative, *Templates: Disaster Recovery Framework & Recovery Support Function Guide*, April 2015, <http://www.bayareauasi.org/sites/default/files/resources/FINAL%20Local%20Government%20DRF%20and%20RSF%20Guide%20Templates%20April%202015.pdf>



RECOMMENDATION 7

Change zoning codes to prevent further development in high-hazard areas that are significantly vulnerable to fire, liquefaction and sea level rise, with priority consideration in those areas where multiple hazards overlap. Ensure no net loss of planned housing by accommodating new development in low-hazard existing urbanized areas.

Who: City and county planning departments

Expanding development into areas that are increasingly vulnerable, especially to multiple hazards, will likely increase the probability of risk and the exposure of more people and structures to risk. Building structures in high-risk or very-high-risk wildfire hazard areas, or near the Bay where permanent inundation from sea level rise is all but certain, should be avoided in favor of putting new people, housing and jobs in safer, more insurable locations. Good land use planning is a more effective tool than building codes to reduce future exposure to wildfire, flooding and earthquake hazards.⁵³ Cities and counties that have high and very high wildfire risks should change the zoning to prevent development in areas where adding new buildings might increase the vulnerability of future residents to wildfire. In particular, they should put a stop to sprawling single-family development in hillside areas that are both hard to defend and hard to evacuate people from. Cities and counties should prioritize these prohibitions in areas that have overlapping hazards, such as areas subject to both wildfire and landslides, or areas prone to sea level rise and liquefaction.

Senate Bill 379 (2015) requires general plan safety elements to be updated with climate change information so that cities and counties can better understand their vulnerabilities to worsening threats. Senate Bill 1035 (2018) adds to this by requiring cities to review and revise their general plan safety elements at least every eight years, upon each revision of the housing element or local hazard mitigation plan, to identify new information relating to flood, fire or other climate hazards. Yet many local safety elements are not consistently translated into land use elements, nor are they consistent with zoning, meaning that community safety policy does not necessarily inform changes in land use. SPUR recommends that cities and counties work through the process of taking safety element and local hazard mitigation plan information and translating it into effective land use policy. Such a process is especially critical in very-high-hazard areas that are difficult to protect through building codes, that may not have safe evacuation routes during a major disaster, that pose a danger to human life or that face recurrent threats, where buildings will likely have to be rebuilt repeatedly.

53 American Planning Association, *Planning for Post-Disaster Recovery Briefing Papers*, 2014, <https://planning-org-uploaded-media.s3.amazonaws.com/document/post-disaster-paper-11-hazard-mitigation.pdf>

Cities and counties should ensure that hazard mitigation is not used as a tool for excluding needed housing from their jurisdictions. For any potential housing lost through a review of hazards and subsequent re-zoning, cities and counties should accommodate that growth instead in existing urbanized areas, ideally near transit and other services. Transfer of development rights (TDR) is a tool that could be used to facilitate exchanges. In a TDR scheme, land uses or developable building square footage are relocated to different areas, sometimes allowing additional density and/or taller building heights to incentivize the exchange.

RECOMMENDATION 8

Acquire undeveloped hazard-prone lands for public ownership and use.

Who: Land trusts, county open space agencies, California Coastal Conservancy and other public agencies

This recommendation calls for using market-based tools to keep some land undeveloped and open to the public without having to make a regulatory change or adjustment of zoning. Typically, open space conservation organizations and public agencies acquire lands based on their habitat and recreational value. But these groups could also purchase areas subject to liquefaction, wildfire, landslides, flooding and other hazards. These areas and parcels might not have high recreational value and might not be contiguous, but keeping them from being developed could reduce communitywide risk and lower the cost of future protection. This tool might be especially valuable in places that are highly vulnerable to worsening risk, such as areas very likely to be subjected to future sea level rise. For example, the *San Francisco Bay Shoreline Adaptation Atlas*, a report by SPUR and the San Francisco Estuary Institute (SFEI), identified undeveloped wetland migration areas that could benefit future restoration and would have public and ecological benefits if left undeveloped.⁵⁴

Outright purchase may be prohibitively expensive in the Bay Area, but strategies such as conservation and agricultural easements offer a less expensive way to remove development potential. Conservation easements are voluntary agreements not to develop on a property to preserve it for habitat, open space, recreation or farmland in exchange for compensation or tax benefits. Easements may include terms that specify allowable types of hazard mitigation, such as erosion control or other activities. In California, only certain nonprofit and governmental organizations are permitted to acquire and hold conservation easements.

⁵⁴ SFEI and SPUR, *San Francisco Bay Shoreline Adaptation Atlas*, 2019, <https://www.spur.org/publications/spur-report/2019-05-02/san-francisco-bay-shoreline-adaptation-atlas>



RECOMMENDATION 9

Develop a regional or state buyout program for properties repeatedly damaged by wildfire, flooding or other climate impacts.

Who: California Coastal Conservancy, FEMA, local land trusts and county open space agencies

As SFEI and SPUR wrote about in the *San Francisco Bay Shoreline Adaptation Atlas*, voluntary buyout programs use public funds to remove buildings from repeat-hazard areas, reducing future property damage and promoting public safety. They may be most suitable for high-hazard areas and can be a practical approach for property owners who no longer want to live in these areas, allowing them to move somewhere safer. Buyouts can be used at a variety of scales, from individual buildings to whole neighborhoods. For example, buyouts were used in the New York–New Jersey region after Hurricanes Sandy and Irene and in New Orleans, North Dakota, Florida and many other states following major storms and flooding. If buyouts are implemented voluntarily and not everyone participates, they could create a “checkerboard effect,” causing blight, increasing the cost of utility and community services for those remaining in such areas and making complete retreat difficult. This may also limit the reuse of the land for other resilience strategies such as floodplain buffers.

Buyout programs have been supported by federal hazard mitigation grant programs; these federal programs typically require a local match, with the source of local funding usually being taxes, fees or bonds. A fiscal challenge of buyouts is that they may potentially reduce the local government’s tax base. Land purchase programs are also likely to be very costly in the Bay Area. Mandatory buyouts, or eminent domain, might be used to prevent immediate health, safety and life risks, but they are typically not eligible for cost-sharing by the federal government, so they are much more expensive and difficult. Leasebacks are buyout programs in which properties are leased to their current owners for a specified period so that they can continue to use them without economic loss.

The Blue Acres program in New Jersey provides an interesting buyout model for the Bay Area.⁵⁵ The program uses federal and state money to buy out homeowners in coastal areas that have repeatedly flooded. Homeowners can recoup their home’s pre-storm value, on a voluntary basis. The funding comes from FEMA, the Department of Housing and Urban Development, the Department of Agriculture and the State of New Jersey. The program prioritizes neighborhoods where multiple claims have been filed under the National Flood Insurance Program and where the local government is supportive. Funding for the program was substantially expanded and applied after Hurricane Sandy. After transactions are complete, the state demolishes the homes and the land is preserved as accessible open space for recreation and conservation and as a natural buffer zone for future storms.

In areas that are prone to long-term sea level rise, some communities and local governments may opt for managed retreat, the process of intentionally removing not just buildings but roads, flood protection such as seawalls and other infrastructure. To establish a regional approach to defining buyout areas, the Bay Area can look to the State of Louisiana, which recently produced a statewide strategy for retreat. The plan divides the flood-prone areas of Louisiana into areas of low, medium and high risk, helps identify the safer areas where

⁵⁵ New Jersey Department of Environmental Protection, “Superstorm Sandy Blue Acres Buyout Program FAQ,” <https://www.nj.gov/dep/greenacres/pdf/faqs-blueacres.pdf>

people could move and describes preparation strategies both for managing the retreat areas and for readying receiving areas for a population influx.

Buyouts could be offered differently in pre-disaster and post-disaster situations. In areas with high-hazard exposure, or for repeat-disaster properties, buyouts could be offered prior to a disaster at fair market value on a voluntary basis. In post-disaster situations, buyouts could be offered to properties that are substantially damaged, such as those that trigger FEMA's Substantial Damages and Substantial Improvements Rule in flood-plain areas. This rule states that flood-damaged buildings can only be rebuilt in compliance with local flood-plain regulations through elevation or floodproofing.

After a disaster, property owners might prefer to relocate rather than repair, even if insurance might cover part of the repair and upgrade cost. A regional buyout program could offer people buyouts immediately, enabling them to move right away rather than having to wait months for FEMA funds. The regional program could then be reimbursed by FEMA sometime later, similar to the way that New Jersey's Blue Acres program secured \$350 million in FEMA funding in 2013, after Hurricane Sandy.

RECOMMENDATION 10

Ensure that insurance for fire, earthquake and flood hazards remains available and affordable for residents and businesses. Ensure that state insurance regulations encourage and appropriately price resilient land use, new construction and retrofit practices.

Who: State insurance commissioner

The Bay Area's hazard exposure is likely to worsen with time, and the region has some of the oldest building stock west of the Mississippi. As a result, the cost of hazard-related insurance for Bay Area residents and businesses is likely to increase, while the availability of insurance products will likely decrease without regulatory intervention.

Private insurers doing business in California have developed some products and services aimed at reducing climate risks. For example, eight companies offer mileage-based auto insurance products in California that reward reduced driving with lower premiums, consistent with the reduced roadway risks that these drivers incur.⁵⁶

The Insurance Institute for Business and Home Safety has developed a set of standards that go beyond typical building codes to support better building performance during severe weather such as hurricanes, strong thunderstorms and lower-level tornadoes. The FORTIFIED Home Standards rate both new residential construction and existing homes with three designations: bronze, silver and gold. Home certifications are di-

⁵⁶ California Department of Insurance, *Trial By Fire: Managing Climate Risks Facing Insurers in the Golden State*, September 2018, <http://www.insurance.ca.gov/0400-news/0100-press-releases/2018/upload/nr106TrialbyFire090618.pdf>



rectly linked to insurance rates from participating insurance companies.

The California Earthquake Authority (CEA) offers up to a 25% discount on earthquake policy premiums for older, seismically vulnerable homes that have been properly retrofitted. In 2011, the CEA also joined with Cal OES to create the Earthquake Brace and Bolt Program to incentivize seismic retrofits.⁵⁷ The program offers up to \$3,000 toward a code-compliant seismic retrofit for certain kinds of homes built before 1979 in certain zip codes. Owners need not purchase insurance to participate. As of September 2019, the CEA had supported nearly 3,000 retrofits across the nine-county region, and the program was available in more than 126 zip codes in the region.⁵⁸ The CEA and Cal OES hope that the program will eventually be available for more housing types in all areas with high seismic hazards in the state.

RECOMMENDATION 11

Establish a regionwide geologic hazard abatement district, or a series of countywide districts, to pool resources to fund regional resilience projects.

Who: Property owners to petition; MTC or county supervisors to approve

As described in the *San Francisco Bay Shoreline Adaptation Atlas*, a geologic hazard abatement district (GHAD) is an independent governmental district that can assess and tax properties within a defined area and dedicate the revenue to abating or controlling hazards such as landslides, earthquakes and erosion.

Establishing a Bay Area-wide GHAD could provide a way to identify, monitor, address and mitigate hazards across the region through districtwide or individual property improvements. GHADs offer long-term security for property values and a form of insurance for probable geologic issues. The money can be used to construct coastal resilience measures, pay for seismic upgrades, build green infrastructure and more. To establish a GHAD, 10% of property owners within the proposed district must petition for its creation. Typically, tax assessments must then be adopted by the city council or board of supervisors.⁵⁹ The GHAD is governed by a plan of control and a board of directors, often an existing legislative body or people appointed by one. GHADs can own and acquire land and do preventive work. There are over 30 GHADs in California, including in Contra Costa, Alameda and Santa Cruz counties. In the City of Malibu, a GHAD formed to restore and nourish an eroding beach and dune system, thus protecting coastal properties. There is no precedent for a large, multi-county or regional GHAD in California today, so this strategy would require working out certain governance mechanisms, such as who would petition for its creation and who would serve on the board of directors.

GHADs could also be established at the county level to simplify their creation, operation and administration. The county scale might be more politically feasible to implement, because resilience priorities vary from place to place and there's a general desire for local control of property tax resources. If a series of county GHADs are developed in lieu of a bigger regional one, it would be important for state or regional resources to

⁵⁷ For more information, see: <https://www.earthquakebracebolt.com/>

⁵⁸ Steven Martinez, California Earthquake Authority, written communication, September 2019.

⁵⁹ California Association of Geologic Hazard Abatement Districts, "Geologic Hazard Abatement Districts (GHADs)," <http://ghad.org/wp-content/uploads/2019/01/GHAD-document-for-CA-Assoc.-of-GHADs-website.pdf>

support all nine counties in developing GHADs so that those counties that lack institutional capacity to plan ahead for resilience would not be disproportionately underfunded to address their needs.

As with other types of tax assessments, GHADs can pool resources that would otherwise not be deployed in a coordinated fashion. But they can also be regressive, as they typically take the form of a property tax, which some owners can more readily afford than others. The funds raised should ideally be put toward an adaptation strategy or vision that has broad public and governmental support, or else they could result in payment for short-term solutions at the expense of a more holistic and resilient approach.

RECOMMENDATION 12

Establish a regional resilience trust fund for future climate adaptation and hazard management needs.

Who: MTC-ABAG with support from the Bay Conservation and Development Commission (BCDC), the San Francisco Bay Regional Water Quality Control Board and the California Coastal Conservancy

A resilience trust fund is like a retirement savings account for future adaptation and hazard management needs. The New York Regional Plan Association recommends regional resilience trust funds in its Fourth Regional Plan for the New York metropolitan area.⁶⁰ This plan proposes establishing a four-state commission that would pool regional resources for coordinated, multi-jurisdictional climate change measures. Each state would have its own regional resilience trust fund funded by a surcharge on certain insurance products. The trust fund would take the legal form of a public benefit corporation and would fund a grant program and low-cost loans for resilience priority projects. The rate of capitalization and the terms of the surcharge (e.g., whether it would sunset after 10 years, after 20 years or never) would depend on the financial need of the resilience projects. The types of projects could range from community-based resilience planning processes to longer-term infrastructure investments.

In California, a regional resilience trust fund could be deployed against numerous resilience challenges, after estimating need and developing a prioritization framework across hazards. As has been proposed in the New York metro region, a new commission consisting of elected officials could be created to manage the funds, subject to a public process and accountability. Or, since the Bay Area already has several decision-making bodies consisting of locally elected officials — such as MTC-ABAG, BCDC and the Bay Restoration Authority — it's possible that the governance model for developing priorities and making funding decisions for a regional resilience trust fund already exists. If trust fund revenue is collected at the state level, the governing body would have to figure out how to effectively apportion resources at the regional scale in accordance with need.

⁶⁰ J.F. Keenan, *Regional Resilience Trust Funds: An Exploratory Analysis for the New York Metropolitan Region*, Regional Plan Association, 2017, <http://library.rpa.org/pdf/Keenan-Regional-Resilience-Trust-Funds-2017.pdf>

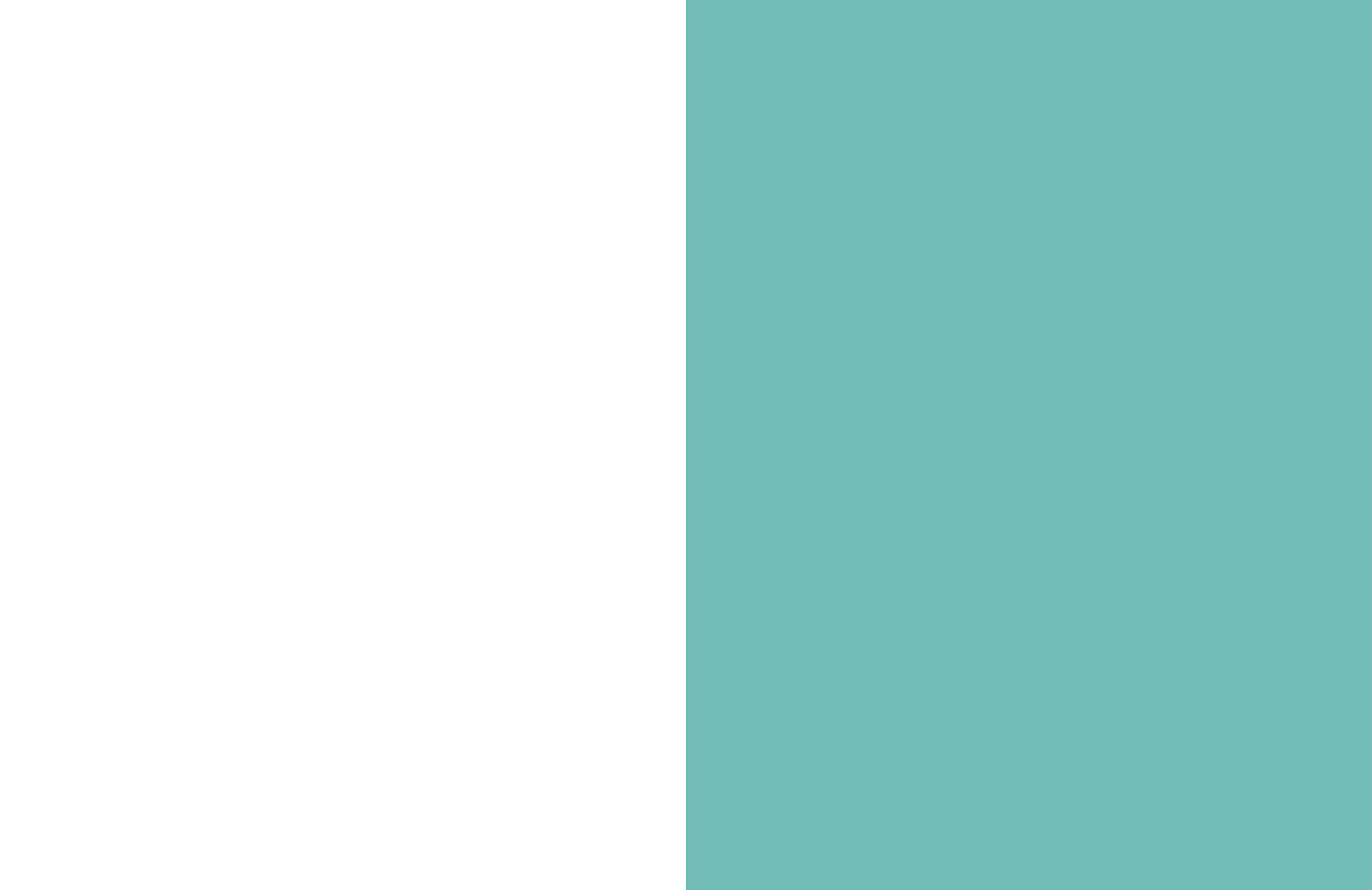


Conclusion

The Bay Area is both a special place and a hazardous place, but those of us who live and work here can make it more resilient to natural hazards through policy and thoughtful action. Events like fire-related heavy-smoke days, public safety power shutoffs, and weeks-long closures of State Route 37 due to flooding make it clear that we are entering a “new normal” as the climate changes. There will be some hazards we can't control, such as earthquakes and sea level changes, but there are ways we can respond effectively — and ways to make the next event calmer, safer and less disruptive.

We must begin with better information about the changing nature of our risks and their geographic extents. We can use this information to determine where to stop allowing new development — or to radically change how we build it — in areas of increasing flood and fire risk. Because we are in the middle of a housing crisis, this is not to say we should stop building housing. Rather, we should build much-needed new housing in existing urbanized areas that are walkable and served by transit, making sure every new building is built to high standards that will minimize potential damages, whether from flood, fire, earthquake or some combination. We will need to make an inventory of the vulnerabilities in all of our existing homes, workplaces and infrastructure so that we know the scale of our built environment's fragility. Then we can develop a plan to sequence retrofit requirements and prioritize funding for retrofits — especially in areas that are subject to worsening hazards and that may be home to sensitive communities. We will need to create larger pools of resources at the countywide or regional scale to pay for these retrofits, for select voluntary buyouts and for land acquisition for public enjoyment and environmental restoration. We will need to develop recovery plans for the inevitable disasters of the future so that we can minimize harm in the recovery process and build back quickly, avoiding or reducing displacement and economic losses.

We need to take action at all levels of government — local, regional and state — to secure a reliable, resilient future for the Bay Area. If we are successful, we will ensure a safer Bay Area for everyone who is already here — and everyone who is yet to come.





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