Overwhelming Risk

Rethinking Flood Insurance in a World of Rising Seas

Union of Concerned Scientists

STORMS STRIKE THE U.S. COAST EACH YEAR, sometimes with devastating force. Both the risks and the costs of flooding and wind damage to seaside coastal communities are growing.[1] Rising population and increasing development along scenic coastlines are putting more people and more valuable property in harm's way. Accelerating sea level rise, which puts higher water levels in the path of coastal storms, is a growing threat, especially along the East and Gulf Coasts of the United States, which have seen much higher and faster rates of sea level rise than the global average.[2] Global warming has resulted in stronger and more destructive hurricanes in the North Atlantic, and more frequent heavy rain events. Together, those socioeconomic and climate-related trends are driving increased property damage and loss along our coasts—costs that are projected only to grow in a warming world.

In the face of increasingly unmanageable risks, many private insurers have left the coastal insurance market. The National Flood Insurance Program (NFIP) is now practically the sole provider of flood insurance for home owners and small businesses nationwide. To ensure widespread coverage against flooding and storm damages at an affordable cost, the federal government and many state governments have established taxpayer-backed subsidized insurance options. However, the artificially low insurance rates that result, and other aspects of these subsidized programs, have instead allowed—indeed, reinforced—risky patterns of land development. They have also created perverse incentives for repetitive insurance claims and an unsustainable level of financial exposure for all taxpayers, who ultimately help pay for insurance claims and disaster relief in the event of a major storm.

With sea levels projected to rise globally between at least eight inches and more than six and a half feet above 1992 levels by the end of this century, and at a substantially faster rate than at present along densely populated parts of the East Coast, our risk of physical and financial harm is rising rapidly, too. We urgently need to reform our insurance system so that it can help us manage these risks effectively, even as we invest in measures to slow global warming and sea level rise and prepare for their impacts.

Introduction

On Aug 29, 2005, Hurricane Katrina made landfall near Buras, Louisiana, causing storm surge flooding of 10 to 28 feet above normal tide levels along portions of the Alabama, Louisiana, and Mississippi coasts (NOAA 2011).[3] The surging waters destroyed many homes and structures, with the damage extending several miles inland. They overtopped and breached levees in and around New Orleans, inundating much of the city to depths of up to 20 feet (NOAA 2011). When the wind and water finally retreated, they left behind 1,200 dead, billions of dollars in damage, and thousands of home owners trying to pick up the pieces of their lives (NOAA 2011). In a world of rising seas, flooding from storm surge is projected to happen ever more frequently along our coasts, requiring that we face hard questions: How can we better prepare for, respond to, and recover from such damaging events? Why are coastal communities increasingly at risk? The focus of this report is how we can more effectively harness insurance as a tool to help manage our risks.

Homes and businesses along the coasts of the Pacific and Atlantic Oceans and the Gulf of Mexico face unique risks of loss and damage because of their proximity to the sea. A primary threat is sea level rise, which magnifies coastal storm surges, flooding, inundation, and erosion, as well as damage from high winds.[4,5] Yet the cost of coastal property insurance, often subsidized by taxpayers in every part of the country, does not adequately reflect the true risks faced by coastal property owners. Moreover, many home owners—even those along seaboard coastlines—do not carry adequate, or any, insurance. And communities are often unaware of their real risks until a major coastal storm hits.

Historically, private insurance for flooding and windstorms in high-risk coastal areas has been very expensive or too scarce to procure (Huber 2012; Michel-Kerjan 2010; Grace and Klein 2009; Kunreuther 1996). Federal and state subsidized insurance programs have stepped in to fill the gap; however, the providing of affordable insurance has had the perverse result of reinforcing risky choices of where and how to build. In addition, such public subsidy programs expose all taxpayers to large costs in the event of a disaster.

Barrier Islands Hit by Storm Surge

Homes and businesses along the U.S. coast, like these in Mantoloking, New Jersey, face unique risks of loss and damage. A primary threat to coastal communities is sea level rise, which magnifies coastal storm surges, flooding, inundation, and erosion. Storm waves and surge from Hurricane Sandy cut across this barrier island at Mantoloking, eroding a beach and washing away homes, roads, and bridges.

Furthermore, both the risks and the costs of flooding to seaside coastal communities are growing. Rising population and increasing development along scenic coastlines are putting more people and more valuable property in harm's way. Accelerating sea level rise is a growing threat, especially along the East and Gulf Coasts of the United States, which have seen much higher and faster rates of sea level rise than the global average (Boon 2012; NOAA 2012a; NOAA 2012b).[6] Global warming is also making it more likely for hurricanes, when they do form, to become stronger and more destructive, leading to greater damage costs (Mendelsohn et al. 2012; Knutson et al. 2010).[7,8,9] Global warming is also contributing to heavier rain events occurring more often (NCDC 2012; Karl, Melillo, and Peterson 2009). Together, those socioeconomic and climate-related trends are already driving increased property damage and loss along our coasts—costs that are projected to grow in a warming world (AECOM 2013).

Reforming our insurance system to reflect this growing exposure can help communicate the true risks to coastal communities so they are motivated to take protective steps. It can also help stem the heavy flow of taxpayer dollars spent on insurance claims and disaster relief.[10] Scientific projections of sea level rise and its impacts, including coastal erosion and magnification of flooding risks from higher high tides and storm surges, must be incorporated into local flood zone maps used to set insurance rates and guide building codes and floodplain development decisions. In combination with insurance reform, other actions to help build the resilience of coastal communities are needed. And paramount to the long-term future of our coasts, we as a society must invest in measures to reduce our carbon emissions to help slow global warming and the rate of sea level rise.[11]

The cost of coastal property insurance, often subsidized by taxpayers across the country, does not adequately reflect the true risks faced by coastal property owners.

Putting Ourselves in Harm's Way

More coastal development and rising sea levels are among the main reasons the risks of costly flooding are increasing along our coasts. A recent report commissioned by the Federal Emergency Management Agency (FEMA)[12] shows that rising seas and increasingly severe weather are expected to expand the areas of the coastal United States at high risk of floods[13] more than half again (55 percent) by 2100;[14] specifically, the floodplain area is generally expected to more than double for portions of the Gulf and Atlantic Coasts and increase by less than 50 percent along the Pacific Coast (AECOM 2013).[15] Meanwhile, the population in high-risk coastal flood zones is expected to increase 140 percent by the end of this century. On a national basis, 30 percent of the increased risk from flooding in 2100 can be attributed to population growth, while 70 percent is due to sea level rise from climate change and its associated risks (AECOM 2013).[16]

Castles Made on Sand

Many of the United States' most densely populated areas are situated along the coasts of the Pacific and Atlantic Oceans and the Gulf of Mexico. Those populations, and their property, risk being impacted by storm surge and coastal flooding—a risk rapidly increasing in a future where sea level is rising.

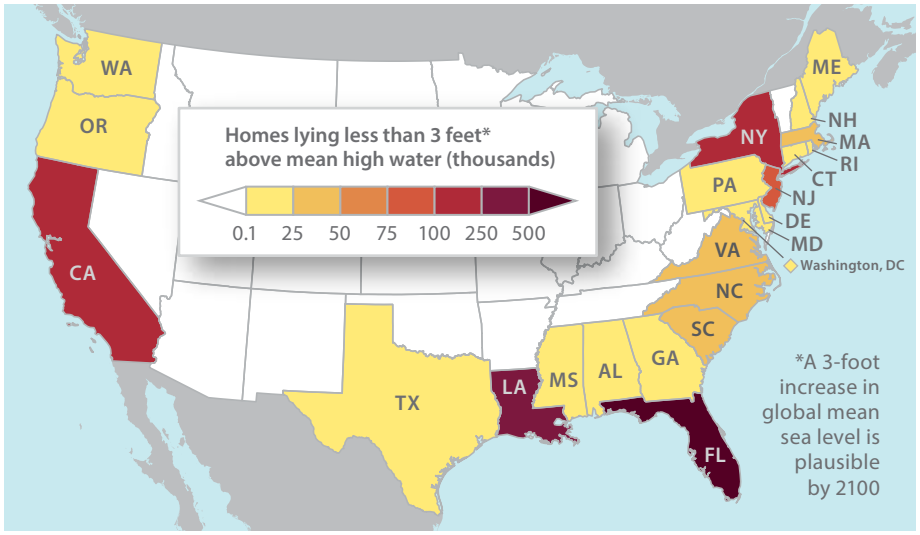

FIGURE 1. Growing Risks to Homes from Sea Level Rise and Storms

In recent years, properties in low-lying coastal states have experienced increasing damage from storms and severe flooding. Almost three million people—and their homes—reside within three feet of mean high water. With rising seas projected to exceed the three-foot mark within this century, a great many homes are clearly at risk (NOAA 2012a).

Map based on data from Strauss et al. 2012.

Growing Risks from Sea Level Rise and Coastal Storms

Rising seas pose serious problems for coastal states for several reasons. Sea level rise contributes to shoreline erosion and degradation and raises flooding risks from extra-high tides. It amplifies storm surges because the surge rides on elevated sea levels, reaching further inland.[17] Rising seas can also inundate once-dry low-lying land. States with large areas of low-lying land (such as California, Florida, Louisiana, North Carolina, and South Carolina) or states with large populations living on low-lying land (such as California, Florida, Louisiana, and New York) are particularly vulnerable.[18] A rise of approximately two feet above today's sea level by 2100 would put more than $1 trillion of property and structures in the United States at risk of inundation, with roughly half of that value concentrated in Florida (Neumann et al. 2010).[19]

Global sea level has risen approximately eight inches since the Industrial Revolution, primarily driven by global warming. Human activities, such as the combustion of fossil fuels (coal, petroleum) and the cutting down of tropical forests, release heat-trapping carbon emissions into the atmosphere.[20] Because of additional local factors,[21] the East and Gulf Coasts of the United States have experienced higher than average rates of sea level rise. Tide gauges, land benchmarks, and other methods can be consulted in specific coastal areas to determine how much sea level rise at a given location differs from the global average rate. Projections show a 90 percent certainty of future global sea level rise ranging from an additional eight inches to 6.6 feet above 1992 levels by 2100 (NOAA 2012a).[22]

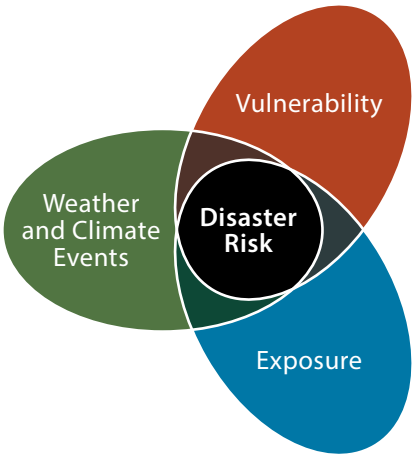

FIGURE 2. Recipe for Disaster

Densely populated and highly developed U.S. coastlines mean that the nation is greatly exposed to potential damages from coastal storms. The vulnerability of many communities, determined by such factors as people's access to essential services and the resilience of critical infrastructure, is often high as well. As climate change drives rising sea levels, intensifying storms, and more frequent heavy rain events, the ingredients for future disasters are disconcertingly aligned. Fortunately, we can make choices to help lower our physical and financial risks by investing in measures to increase coastal resilience and cut the carbon emissions that fuel accelerating sea level rise.

Based on a figure from IPCC 2012.

Across many parts of the country, including some coastal areas, climate change is also contributing to a trend of heavier rainfall events occurring more often, which may increase the risk of flooding.[23] Data reveal that from 1958 to 2011, there has been an increase in the amount of precipitation falling in very heavy events[24] everywhere in the United States. Over those 53 years, the Northeast saw an increase of 74 percent and the Southeast saw a 26 percent increase in the amount of rain falling in very heavy events. Projections show that this nationwide trend toward more heavy rainfall events will continue with warming temperatures (NCDC 2012; Karl, Melillo, and Peterson 2009) and, similarly, that rainfall rates associated with tropical cyclones are also likely to increase (Knutson et al. 2010).[25,26]

Global warming may also be increasing the risks of more destructive winds for coastal communities. Warming oceans—especially increasing sea surface temperatures—can make hurricanes stronger,[27] although there are other factors[28] that could break up hurricanes as they are forming. Indeed, many future projections show a decrease in the frequency of all hurricanes globally, but a higher chance of intense hurricanes forming when they do occur (Knutson et al. 2010).

Growing Coastal Population and Development

The growing pace of coastal development puts more people and property in the path of coastal storms, flooding, inundation, and erosion. Rising property values in many places along ocean coastlines also mean that, in the event of devastating storms, damage costs are growing.

According to data from the U.S. Census Bureau, the population in counties along the Atlantic, Pacific, and Gulf Coasts grew from 47 million in 1960 to 87 million in 2008,[29] with a consistent addition of between 5 and 10 million people each decade. Excluding Alaska, the average population density for these coastal counties also increased significantly, doubling from roughly 250 people per square mile in 1960 to nearly 500 in 2008. Four Northeast states—Massachusetts, New Jersey, New York, and Rhode Island—had coastline population densities above 1,000 people per square mile (Wilson and Fischetti 2010).

Alongside those population trends, the number of housing units along the coast more than doubled from 16.1 million in 1960 to 36.3 million in 2008 (Wilson and Fischetti 2010). In 2012, the insured value of residential and commercial property in the coastal counties of 18 Atlantic and Gulf Coast states was $10.6 trillion, with New York and Florida topping the list at approximately $2.9 trillion apiece. In Connecticut, Florida, Maine, Massachusetts, and New York, the insured value of coastal property exceeded 50 percent of the state's total insured property value (AIR Worldwide 2013, see Figure 3). Such large monetary values reflect the huge premium U.S. society places on coastal lifestyles.

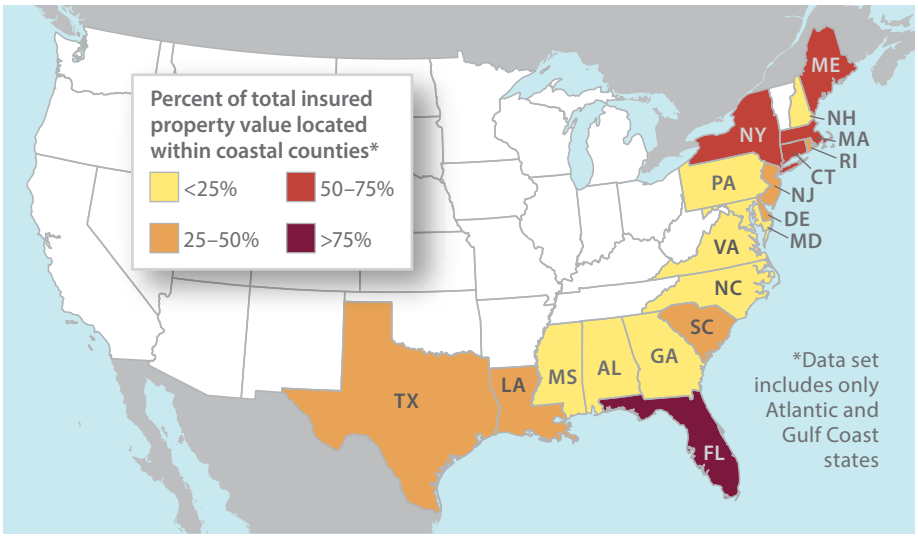

FIGURE 3. Insured Value of Coastal Property in 2012

In 2012, the insured value of residential and commercial property in the coastal counties of 18 Atlantic and Gulf Coast states was $10.6 trillion, with New York and Florida topping the list at approximately $2.9 trillion apiece. In many states, a large percentage of total insured property lies within coastal communities. Not surprisingly, Florida leads in this category with 79 percent of insured property in coastal areas; in four northeastern states (Connecticut, Maine, Massachusetts, and New York) more than 50 percent of insured property values is in the coastal zone.

Map based on data from AIR Worldwide 2013.

OUR COASTAL COMMUNITIES AT RISK

Florida: On the Front Lines of Sea Level Rise

Florida has long been on the front line of dealing with the risks and costs of coastal storms, flooding, and high winds. Hurricane Andrew, which hit the state in August 1992, remains one of the costliest natural disasters ever experienced in the United States.[30] Florida has the second-longest coastline in the United States at 1,350 miles[31] (NOAA 1975). The insured value of property in the coastal counties of Florida is $2.9 trillion—approximately 80 percent of the state's total insured value of property (AIR Worldwide 2013).

Much of the Florida coast has already experienced local sea level rise of eight inches since 1900,[32] worsening the state's risk of flooding from coastal storm surge—or even from routine high tides in some places (NOAA 2012b). About 2.4 million Floridians (more than 12 percent of the population) live within four feet of the local high tide line—and global sea level rise projections show it is plausible that there will be an increase of four feet by the end of this century (NOAA 2012b). Moreover, the state has seven of the 10 U.S. cities most at risk from sea level rise (Climate Central n.d.). With approximately 80 percent of the state's 19 million residents living or conducting business near its coastline, and its coastal-tourism-dependent economy, the state has much at stake as it prepares for the impacts of sea level rise (Florida Division of Emergency Management 2013).

The insurance market in Florida is extremely challenged by the state's exposure to risks. The state has the largest number of policies under the federally backed National Flood Insurance Program (NFIP)—amounting to 37 percent of NFIP policies issued nationwide (FEMA 2013a). Most of those policies are concentrated in the 100-year floodplain (Michel-Kerjan and Kousky 2010).[33] Moreover, Florida ranks fifth in insurance payouts since 1978[34] (FEMA 2013a). Yet, despite these sobering numbers, only 47 percent[35] of communities participate in the Community Rating System (CRS) program, a program that can help lower NFIP insurance rates through investments in measures that reduce flood risks, and many of them are not taking advantage of all possible measures (FEMA 2012b).

After Hurricane Andrew, the state created the Florida Hurricane Catastrophe Fund (FHCF) to help insurance companies cope with high payouts, in return for keeping their wind insurance rates low.

About 2.4 million Floridians live within four feet of the local high tide line. The state has seven of the 10 U.S. cities most at risk from sea level rise, including Miami, shown here (Climate Central n.d.). Hurricane Andrew, which hit the state in August 1992, remains one of the costliest natural disasters ever experienced in the United States.

Parts of Florida, including Fort Lauderdale (above), regularly face flooding during high tides.

Additionally, in 2002 the Citizens Property Insurance Corporation (Florida Citizens) was created to help provide affordable multi-peril and wind-only insurance for high-risk buyers who could not find such insurance on the open market. Florida Citizens is now the largest insurance carrier in the state, insuring 22 percent of the personal property market and 62 percent of the market for condominiums, apartment buildings, and other commercial multi-unit dwellings (Betz et al. 2011).[36] Total exposure to loss covered under Florida Citizens has grown from about $155 billion to almost $500 billion over the last 10 years (Hartwig and Wilkinson 2012).[37] Recently the Florida legislature enacted a bill, which the governor signed into law, to address the growing liabilities of the insurance program—however, the law does not require increases in rates to reflect risk, which leaves the state treasury greatly exposed to losses should a major hurricane hit (State of Florida 2013).[38]

Some areas in Florida are taking steps to address climate change. For example, the Southeast Florida Climate Compact was formed by the four coastal counties of Broward, Miami-Dade, Monroe, and Palm Beach in January 2010 to coordinate adaptation activities and actions to reduce carbon emissions across county lines. The four-county compact has recently released a multi-faceted climate action plan that includes plans to develop sea level rise maps for regional planning and development purposes, help reduce carbon emissions from transportation, and assess climate impacts on water supplies and infrastructure related to handling storm water and wastewater (Southeast Florida Regional Climate Change Compact 2012).

Managing (and Mismanaging) Our Risk

How Insurance Typically Works

Insurance is a tool to help manage the risk of potentially costly damages in an uncertain world. A typical insurance contract involves a relatively modest premium collected by an insurance company on a regular basis, with the guarantee that it would pay out a predetermined sum of money in the event of damages caused by a named peril (an insured event). For example, home owner's insurance protects homes from the cost of fire or theft; automobile insurance provides coverage in the event of an accident that hurts someone or damages a vehicle or property; life insurance helps provide for loved ones in case of a policyholder's death.

In a well-functioning insurance market, companies have a good sense of the frequency of particular types of events occurring, how severe they may be, and the factors that contribute to risk, all based on detailed historical data and computational modeling. They also have a reasonable confidence that the events won't happen simultaneously in many areas where they operate.[39] For example, in the case of life insurance: based on a person's age, gender, and basic medical information, insurers can ascertain the risk of that person dying in a given period of time. This information helps insurance companies set premiums at a rate that would guarantee that they could cover all their insurance payouts in a given year with a margin left over for profit. Of course, there is always a risk that the modeled outcome may not match reality in a particular instance, but the insurance industry works to fine-tune their models so that, on average over a large number of policies, such risk (called actuarial risk) is minimized.

Another important feature of a well-functioning insurance market is that those who are insured (policyholders) are aware, or should be made aware, of key factors that contribute to their risk. They may then take some protective actions to lower it, often being offered an incentive such as getting a discount on their insurance premium in return. For example, installing smoke alarms in a home can help lower a home owner's insurance premium, having a clean driving record can help lower automobile insurance rates, and exercising and not smoking can help lower life insurance rates. Incentives like this improve the efficiency of the market because the overall risks of damages are lowered in a cost-effective way.

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The Unique Challenges of Coastal Flood and Wind Insurance

Coastal property insurance markets in many parts of the country are considered high-risk because of their highly uncertain historical and ongoing exposure to damage from coastal storms, flooding, and high winds. For a variety of reasons, described below, private insurers consider those risks essentially uninsurable and have been unwilling or unable to provide affordable, widely available flood and wind insurance in many of these areas (Huber 2012).[40]

Unlike the risks of relatively frequent events such as fires, where there is a much more robust data record and sophisticated statistical modeling to draw on, the risks of low-probability/high-loss events such as hurricanes and flooding are difficult to ascertain (Kunreuther 1996). To an insurer, the prospect of very high payouts in the event of a large disaster, such as a major hurricane, is daunting. Such risks would require insurers to keep large reserves of capital on hand to remain solvent and could make profits very volatile from year to year. Moreover, the factors that raise the risk of big insurance payouts, such as large storm systems or the impacts of sea level rise, tend to affect large swaths of land, sometimes

Insurance is a tool to help manage the risk of potentially costly damages in an uncertain world.

How Risk Builds

Artificially low flood insurance rates and other aspects of subsidized coastal insurance programs have allowed, even reinforced, risky patterns of land development, such as homes built in Duck, along the Outer Banks of North Carolina. This beachfront home has been badly damaged due to erosion of sand dunes following a nor'easter in 2012. Federal and state-backed insurance programs have also created an unsustainable level of financial exposure for all taxpayers, who ultimately help pay for insurance claims and disaster relief in the event of a major storm.

entire states or regions. Thus, compared with what is standard in home owner's or automobile insurance, insurers are limited in their ability to diversify their risk by pooling risks across policyholders as a way to maintain balance and remain profitable. Additionally, property owners with the more expensive and higher-risk properties tend to be the ones who actually buy insurance, whereas less-well-off people with fewer assets might choose not to or may not be able to afford to—a problem economists call "adverse selection" (CBO 2007).[41] That skewed distribution is partly built into the design of the National Flood Insurance Program (or NFIP, see section on NFIP below), which requires a home owner to purchase flood insurance only in high-risk flood zones (and there too enforcement is spotty), leaving it optional in other places with a lower but still non-negligible risk of flooding. Insuring only the highest-risk houses is akin to having a health insurance plan that only the sickest people purchase. The inability to balance payout costs with premiums from lower-risk policyholders would make such an insurance plan unsustainable over the long term.

Moreover, property owners are often not fully aware of their risks from floods and coastal storms, nor aware of important ways they can help lower their risk (e.g., through elevating homes, instituting other flood-proofing measures, or even relocating from a high-risk flood zone to a lower-risk area). Instead, people often view natural disasters as being "acts of God" that cannot be avoided.

To ensure widespread coverage against flooding at an affordable cost, the federal and state governments have intervened in the property insurance markets in significant ways, primarily through establishing taxpayer-backed subsidized insurance options. However, the artificially low insurance rates and other aspects of these subsidized programs have instead allowed—indeed, reinforced—risky patterns of land development. They have also created an unsustainable level of financial exposure for all taxpayers, who ultimately help pay for insurance claims and disaster relief in the event of a major storm.

The National Flood Insurance Program

A Rapidly Increasing Taxpayer Liability

NFIP was created by Congress in 1968,[42] partly in response to the devastating losses after Hurricane Betsy hit Louisiana in 1965 (Michel-Kerjan 2010). The program was designed to help deliver affordable, widely available insurance[43] against flood damage (both coastal and inland)—coverage that was increasingly hard to find in the private market—and to reduce the need for taxpayer-funded relief. NFIP was also intended to provide incentives for home owners and communities to take measures to reduce their risks of flooding, such as elevating structures above the base flood level, flood-proofing buildings, and investing in floodplain management.

Since NFIP is administered by a government agency, FEMA, it does not make any profit; moreover, if needed, it can borrow from the U.S. Treasury at low interest rates. Those facts are part of the reason the program can provide lower insurance rates. NFIP is now practically the sole provider of flood insurance for home owners and small businesses nationwide. At the end of 2012, NFIP provided more than 5.6 million insurance policies with approximately $3.6 billion in total premiums and $1.25 trillion in insured assets (FEMA 2013a). In 2011, taxpayers were responsible for $527 billion of insured assets in oceanside coastal floodplains alone (FEMA 2013a; NOAA 2012c).

FEMA assesses and communicates risks and helps set rates for NFIP across the country. The policies themselves are usually sold through private insurance companies.[44] Home owners with federally backed mortgages are required to carry flood insurance if they live in

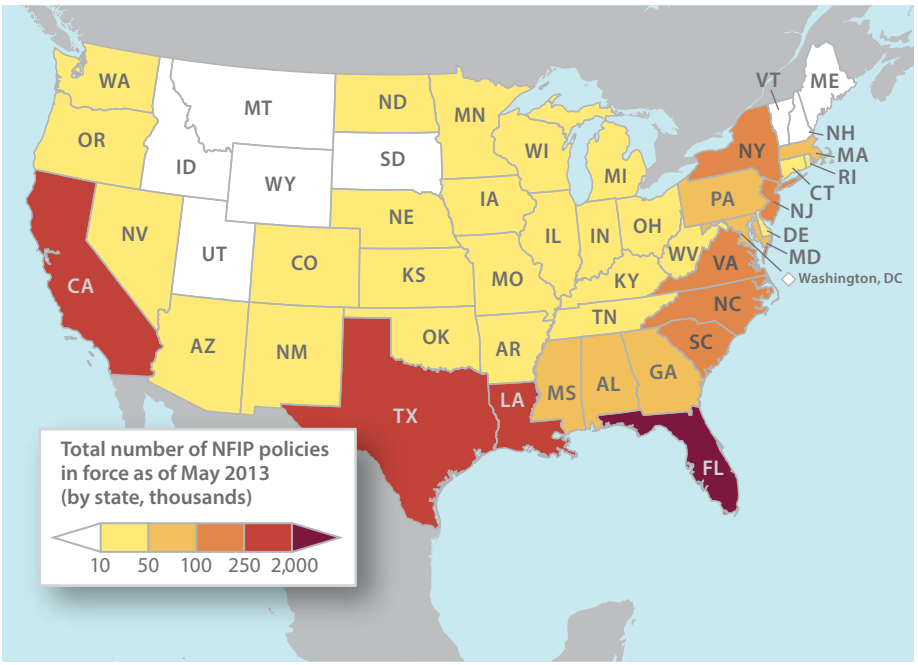

FIGURE 4. The Only Coastal Insurer Left Standing

The National Flood Insurance Program (NFIP) is practically the only source of flood insurance for homes and small businesses nationwide. At the end of 2012, NFIP provided more than 5.6 million insurance policies, insuring $1.25 trillion in assets but collecting only $3.6 billion in total premiums. Together, the top five states by number of policies—Florida, Texas, Louisiana, California, and New Jersey—accounted for approximately three-quarters of all coastal NFIP policies (see Table 1).[45] Map based on May 2013 FEMA data.

TABLE 1. National Flood Insurance Program (NFIP) Data for Top 10 States (by Number of Policies) along the U.S. Coasts

State	Number of NFIP Policies	Total Value of Premiums Paid ($)	Total Value of Insurance Coverage ($)
Florida	2,053,208	1,039,268,322	477,347,070,700
Texas	641,653	368,060,396	162,213,731,200
Louisiana	484,450	353,617,497	113,095,824,400
California	254,532	211,981,864	67,051,088,000
New Jersey	245,501	234,266,905	56,802,985,800
South Carolina	205,052	130,320,137	50,240,415,500
New York	186,071	184,363,135	46,727,308,500
North Carolina	138,916	104,339,428	32,641,296,900
Virginia	116,553	80,831,234	28,442,395,500
Georgia	96,951	69,948,619	23,647,137,900

Source: Based on May 2013 FEMA data.

areas with high flooding risk. However, enforcement is inadequate and, in practice, many home owners are not adequately insured, or insured at all.

NFIP's subsidized premium rates mean that property owners lack a direct, accurate market signal that communicates their true risks; therefore, they do not have appropriate incentives to protect themselves. When NFIP cannot cover payout costs for major storms through premiums collected, the program has to borrow from the U.S. Treasury, and taxpayers at large are exposed. A 2011 Government Accountability Office (GAO) report found that the future financial solvency of NFIP is in doubt without significant reforms (GAO 2011). Moreover, artificially low insurance rates encourage development in ecologically sensitive areas, such as wetlands and barrier islands, which can further erode natural defenses to flooding risks (Bagstad, Stapleton, and D'Agostino 2007).

Several key factors challenge NFIP's success—indeed its survival—as a solvent risk management system: artificially low premiums that do not reflect true risk, loopholes in the program that allow some properties to keep their rates low through grandfathering provisions, repeated payouts for losses to the same high-risk properties, and the failure to account for future sea level rise in flood risk maps that help determine insurance rates.

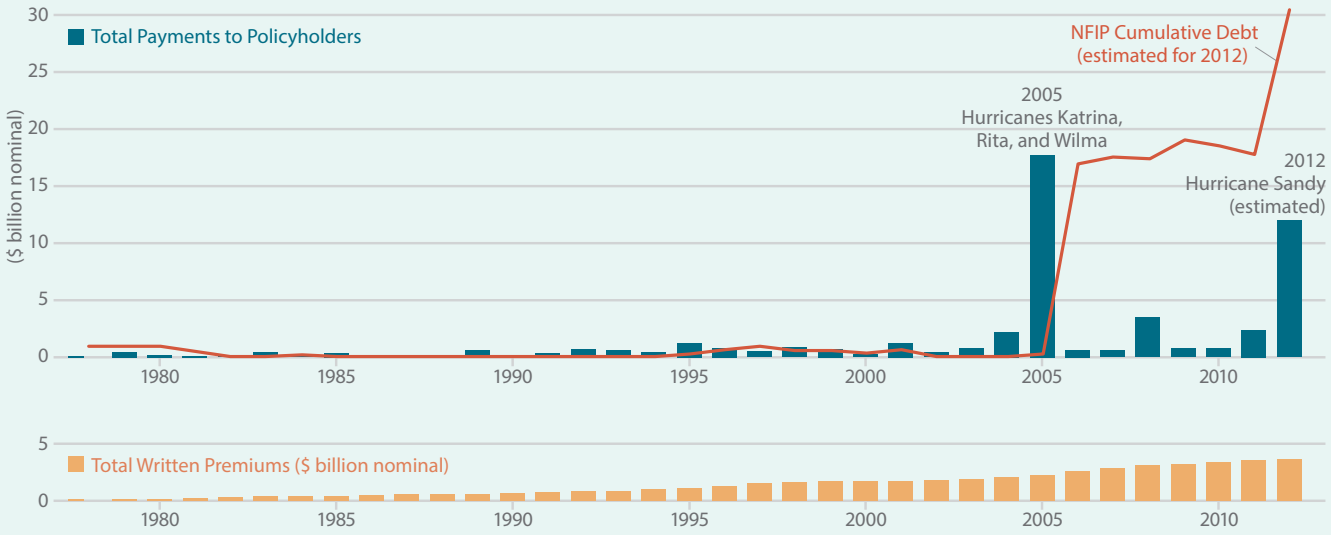

FIGURE 5. National Flood Insurance Program Debt Grows

The National Flood Insurance Program has fallen deeper in debt since the payouts after Hurricane Katrina and most recently the costs of Hurricane Sandy. As of November 2012, the program was more than $20 billion in debt to the U.S. Treasury (GAO 2013), and that figure is likely to rise once all the Sandy claims are settled.

Sources: FEMA 2013a; estimate for 2012 NFIP payments for Hurricane Sandy from King 2013; estimate for 2012 NFIP debt based on its borrowing limit of $30.4 billion set by the Hurricane Sandy Relief Act.

NFIP is one of the largest financial obligations of the U.S. government.

Low Insurance Rates and Growing NFIP Debt

A series of recent storms has made clear that NFIP's rates are too low to cover its costs, especially during years with exceptionally high damages—a state of affairs that has resulted in the program running at a loss. The 2005 hurricane season, with devastating hurricanes Katrina, Rita, and Wilma making landfall, precipitated a crisis in NFIP's financial situation. The program was forced to borrow $21 billion from the U.S. Treasury to pay for claims and has struggled with paying off those loans.[46]

Hurricane Sandy added further pressure to NFIP's finances. As of January 2013, NFIP insurance claims from Hurricane Sandy are estimated to be between $12 billion and $15 billion. As part of the Sandy Relief Act passed in January 2013, Congress temporarily increased NFIP's authority to borrow funds from the Treasury by $9.7 billion, from $20.7 billion to $30.4 billion, to help address these claims (King 2013).

NFIP is one of the largest financial obligations of the U.S. government.[47] In 2011, taxpayers had shouldered the responsibility for covering $1.25 trillion of insured assets overall, with $527 billion of that risk in the coastal floodplain (FEMA 2013a; NOAA 2012c). With interest payments alone on the debt to the U.S. Treasury being very high, it is looking increasingly unlikely that NFIP will ever be able to pay off its debt entirely, let alone build up a reserve in anticipation of future damaging floods.[48]

Repetitive-loss properties represent 1.3 percent of all policies but are expected to account for 15 to 20 percent of future losses.

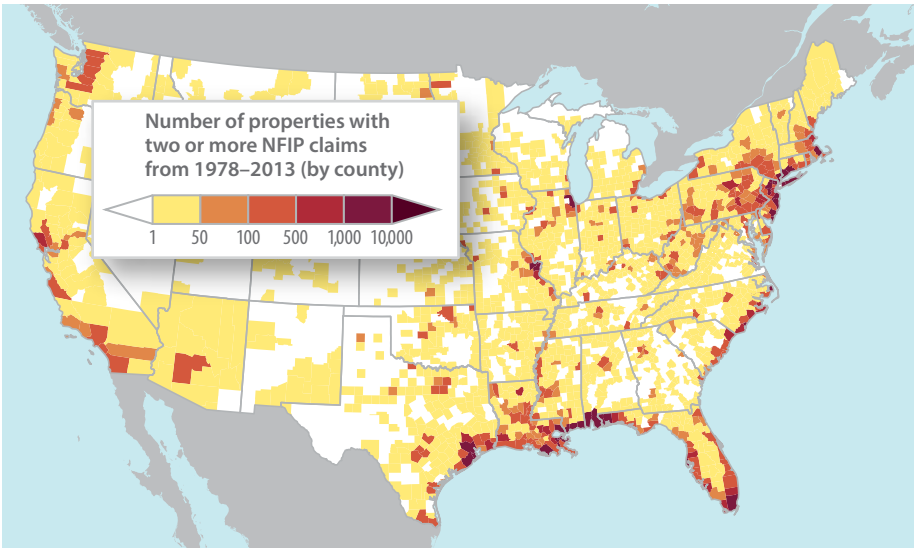

FIGURE 6. Repetitive-Loss Properties by U.S. County

Insurance claims on properties that are repeatedly damaged by flooding, or "repetitive losses," are of particular concern to the National Flood Insurance Program (NFIP). NFIP has paid out almost $9 billion in claims to repetitive-loss properties, which amounts to about a quarter of all payments since 1978. Repetitive-loss properties, shown here, account for just 1.3 percent of all policies but are responsible for fully 25 percent of all NFIP claim payments since 1978. The darker colors show counties particularly prone to repetitive losses.

Map based on May 2013 FEMA data.

Repetitive Losses

Insurance claims on properties that are repeatedly damaged by flooding, or "repetitive losses,"[49] are of particular concern to NFIP because of the disproportionate financial drain they represent. NFIP has paid out almost $9 billion in claims to repetitive-loss properties, which amounts to about a quarter of all NFIP payments since 1978 (see Figure 6). Currently, repetitive-loss properties represent 1.3 percent of all policies but they are expected to account for 15 to 20 percent of future losses (NFIP 2011).[50] Furthermore, NFIP does not increase rates on properties that have had repeated claims, although such rate increases are a common practice in other private insurance markets.

Low Rates of Purchase of Insurance Coverage

In the wake of Sandy, it was estimated that only 15 to 25 percent of at-risk properties in Special Flood Hazard Areas (SFHAs) in the Northeast were insured for flood losses (King 2013). Many coastal property owners do not carry adequate insurance or are simply not insured at all. It is estimated that, nationally, only 18 percent of households in flood zone areas, which include inland (lakeside and riverside) and coastal areas, have flood insurance. While flood insurance is supposed to be mandatory in all SFHAs, it is not required outside those high-risk zones, despite flood risks. Studies also show that some home owners may buy insurance initially but then let it lapse, especially if a few years go by without a major storm.[51] The main reason for inadequate insurance coverage seems to be that people systematically underestimate the risks of these types of events (Kunreuther 1996). Another likely reason is a lack of awareness that ordinary home owner's insurance does not cover flood damages. Even so, were another large storm like Sandy to occur, the damage costs for those who are uninsured would likely be at least partially reimbursed through federal disaster relief (i.e., paid for by the American taxpayer).

After the Storm, a Federal Program Awash in Claims

National Flood Insurance Program claims from Hurricane Sandy were estimated in early 2013 to be between $12 billion and $15 billion (King 2013). Some homes, such as this one in Camp Osborn, New Jersey, are a total loss. Taxpayers also paid for more than $50 billion in disaster relief through the Hurricane Sandy Relief Act.

NFIP's "Grandfathering" Clause

Another significant challenge is the system of "grandfathering" that exempts properties from complying with protective requirements if they were built before FEMA flood maps were created for the local community. Similarly, if a property is continuously insured, it can avoid paying higher insurance premiums if the area in which it is located is rezoned with a higher flood risk (FEMA 2010). The grandfathering provisions of NFIP are effectively a large subsidy to qualifying property owners, and perversely reinforce decisions to remain located in high-risk floodplains.[52]

Climate Risks

Climate change and resulting rising sea levels are significantly raising the risks of seacoast flooding. A 2013 GAO study of high-risk areas found that, "The federal government is not well positioned to address the fiscal exposure presented by climate change," citing its exposure to climate risks through NFIP and federal disaster declarations as major examples (GAO 2013).[53] A recent report commissioned by FEMA points out that the number of NFIP policies could grow 130 percent by 2100 as a result of a greater number of areas being designated high-risk flood zones as a result of sea level rise (AECOM 2013). While such risks cannot be completely eliminated, as a society we can try to ensure that market signals, land use planning decisions, and investments in protective measures are aligned to help reduce the risks as much as possible.

The National Flood Insurance Program, now practically the sole provider of flood insurance for home owners and small businesses, is more than $20 billion in debt to the U.S. Treasury.

OUR COASTAL COMMUNITIES AT RISK

New Jersey: A Densely Populated Coastline at Risk

In October 2012 Hurricane Sandy made landfall, becoming the deadliest and most costly storm in New Jersey history, with 38 deaths and more than $37 billion in damages (NJDEP 2013). While coastal areas were the most severely affected physically and financially, high winds and subsequent damage were experienced throughout the state.

Storm-related flooding is considered the greatest natural disaster hazard within the state of New Jersey as a result of its natural exposure[54] and the fact that approximately 45 percent of the state's 8.4 million residents live within flood hazard areas (NJDEP 2013). New Jersey's shore is a vital portion of the state's economy. Coastal tourism contributes roughly $38 billion of the state's GDP and provides approximately a quarter of private-sector employment (NJDCA 2013).

New Jersey ranks fifth in the nation for the number of policies in force under the federally backed National Flood Insurance Program (NFIP),[55] and third-highest in terms of NFIP payouts[56] (FEMA 2013a). Currently only 11 percent[57] of communities participate in the Community Rating System (CRS) program, a program that can help lower NFIP insurance rates through investments in measures that reduce flood risks[58] (FEMA 2012b).

As New Jersey moves forward from the devastation of Sandy, communities are drawing on information from new draft flood maps released by FEMA. However, these maps still do not include projections of future sea level rise. Governor Chris Christie has directed rebuilding efforts to add an additional buffer of one foot above FEMA's recommended elevation to create a margin of safety, in accordance with prior state law (State of New Jersey Office of the Governor 2013a). The New Jersey Department of Community Affairs' Disaster Recovery Action Plan outlines efforts to rebuild housing as well as repairs and improvements to infrastructure[59] (NJDCA 2013). Throughout the summer of 2013, the U.S. Army Corps of Engineers (USACE) will continue restoration and improvements to Jersey Shore beaches (USACE n.d.). Efforts are also under way to repair and rebuild boardwalks to make them stronger and more resilient. For example, the Seaside Heights boardwalk has been raised 16 feet, to place it two feet above FEMA's recommended elevation to help reduce flood risk. Additionally, while the boardwalk has been rebuilt with wood instead of longer-lasting synthetic materials, its 25-foot pilings will be secured into the ground 10 feet below sea level (Van Embden 2013).[60] Governor Christie's "reNew" Jersey Initiative is intended to encourage resettlement and rebuilding to stronger standards along coastal New Jersey.[61]

Since 2011, the New Jersey Climate Adaptation Alliance (NJCAA) has been working to promote climate awareness, identify scientific research and data needs, and collaborate with policy makers to develop state and local actions. The alliance is focused on climate change preparedness in several key sectors, including public health, watersheds, river and coastal communities, built infrastructure, agriculture, and natural resources (Rutgers 2012).

In contrast to some of these efforts and accomplishments, the New Jersey legislature recently passed a bill (State of New Jersey 2013) that, if signed into law by Governor Christie, would allow new buildings and coastal development in many high-hazard coastal zones, and possibly jeopardize the state's eligibility with NFIP.[62] Coastal residents and businesses should weigh their long-term choices in light of the true risks they will face rather than follow such shortsighted policies.

The New Jersey coastline was hard hit by flooding from storm surge driven by Hurricane Sandy in October 2012. Sea level rise means that storm surges are riding on higher water levels and thus have the potential to reach higher and further inland, causing greater damage. Aerial views reveal the breadth of flooding caused by Sandy along the New Jersey coast.

The Federal Emergency Management Agency

Mapping Coastal Flood Risks

FEMA plays a critical role in assessing a coastal community's risk of flooding by developing flood maps, based on modeling the dynamics of coastal waves and storm surges. The flood maps also help communities plan evacuation routes and plan emergency management (ASFPM 2013b). The flood maps are developed using a variety of data including historic flooding, hydrologic and meteorological considerations, protective measures installed, and type of land use. FEMA's flood insurance rate maps (FIRMs) assign zones to coastal communities depending on their risks.[63] This zoning then becomes the basis for setting insurance rates for coastal properties.

In practice, information about local flood risks is often not clear to home buyers. There are no uniform disclosure requirements at the time of purchase of a property. Knowing a property's flood risks provides a strong incentive to purchase insurance, although it may cause a small decline in property value.[64] Studies show that homes located in a high-risk flood zone or SFHA, especially those that are under mortgage, are the most likely to have insurance (Petrolia, Landry, and Coble 2013).

Updating and Improving FEMA's Flood Maps

Because of a lack of funding from Congress, FEMA's flood maps[65] are only now being updated in some parts of the country for the first time since the 1980s.[66] The agency has assigned high priority to releasing maps of the coastal areas of New York and New Jersey that were hard hit by Sandy and are now in the process of making critical decisions about rebuilding.[67] Maps for other high-risk areas such as the Greater New Orleans area in Louisiana and some coastal counties in Florida have also been released.[68] The revised maps reveal that, in many states, areas much further inland are subject to significant flooding risks, and that the flood risk for many coastal areas has increased substantially since they were last mapped.

The new draft maps can help inform, even enforce in some cases,[69] better decision making. But they do not fully reflect the risks of sea level rise in the coming decades and are thus an inadequate basis for long-lived decisions, such as where to build homes. For example, in the near term, impacts of sea level rise such as increased coastal erosion, steepening of the coastal profile, and potential for waves and storm surge to reach further inland due to elevated sea levels can have a significant effect on flooding and inundation risks to coastal communities. Congress has not given FEMA the mandate to account for long-term erosion when it updates its flood maps (GAO 2013), nor does FEMA currently account for ongoing sea level rise, which could, in the coming decades, cause low-lying coastal areas to become regularly flooded or permanently inundated. Thus, despite significant time and investment, the new maps still do not reflect the true risks of coastal flooding.[70] In recognition of this, the state of New Jersey, post-Sandy, has recommended that communities elevate structures a foot above the level recommended by FEMA.[71] That approach is popular within communities that are part of NFIP's Community Rating System (see next section) as a way to help lower both flooding risks and insurance rates (Batten et al. 2008). The Association of State Floodplain Managers further recommends that the FIRMs be kept updated: "The federal government's investment in the development of flood hazard data is considerable and must not be allowed to decay as happened in the mid-1980s and 1990s" (ASFPM 2013b).

FEMA's flood risk maps do not currently reflect projections of sea level rise and are thus an inadequate basis for long-lived decisions, such as where to build homes.

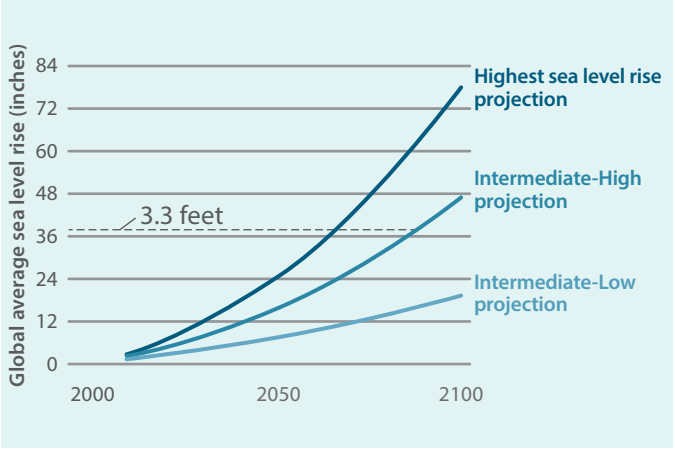

FIGURE 7. Global Average Sea Level Rise Projections through the End of the Century

Scientists have developed a range of scenarios for future sea level rise based on estimates of growth in heat-trapping emissions and the potential responses of oceans and ice. Here we show three of the more plausible scenarios, with a range of 1.6 to 6.6 feet of sea level rise by 2100,[72] and at least 3.3 feet of increase likely in this time period (NOAA 2012a). Large stretches of the East Coast are expected to see sea levels rise significantly faster than the global average rate (Sallenger et al. 2012). Yet the flood risks from these sea level rise projections are not captured in FEMA's current flood risk maps, which influence long-term building and rebuilding decisions along the coast.

Figure based on projections from NOAA 2012a.

The Community Rating System (CRS): Investments in Reducing Flood Risks

The CRS is a voluntary program administered by FEMA that provides incentives for communities and individual home owners to go beyond the minimum requirements of NFIP and invest in further floodplain management measures, elevation of structures or other flood-proofing measures in return for discounted insurance rates. Depending on the measures implemented, communities are classified from Class 1 (the best category, which gets a 45 percent discount on NFIP premiums) to Class 10 (the lowest category, which gets no discount) (FEMA 2006).[73]

As a risk reduction tool, the CRS has strong potential, but is underutilized. Participation in the CRS is very uneven across coastal states, ranging from 47 percent of communities in Florida to 11 percent in New Jersey, and often depends on the interest and awareness of local officials. Nationwide, only approximately 6 percent of communities with NFIP policies participate in the CRS; however, those same communities account for 70 percent of the total insurance in force under NFIP (FEMA 2012a). Communities that do participate often do not take advantage of all the opportunities available to reduce flood risks and damage costs.[74] Improving CRS participation rates and community ratings can be an important tool for building resilience in coastal areas. In addition, the CRS program itself could be improved so that it targets recommendations to lower risk in a way that is more location-specific and less generic. The highest discounts could then be provided for the activities that actually lower a particular community's risk the most.

The Biggert-Waters Flood Insurance Reform Act of 2012

The Biggert-Waters Flood Insurance Reform Act of 2012 takes some substantial steps to address shortcomings in the National Flood Insurance Program (NFIP). The act reauthorizes NFIP for five years, through September 30, 2017, and includes provisions to reform insurance rates, phase out some subsidies, set up a reserve fund, establish a plan to repay the U.S. Treasury, and update flood maps.

Starting in 2013, NFIP insurance rates are set to increase quite significantly in several coastal areas to bring them in line with true flood risks,[75] with annual rate increases capped at 20 percent.[76] The act will also attempt to phase out other forms of subsidy, such as those for severe repetitive-loss properties, grandfathered properties, and second homes.[77] One of the most important provisions of the act is the establishment of a Technical Mapping Advisory Council that will provide recommendations to the Federal Emergency Management Agency (FEMA) about how to consider the impacts of sea level rise and coastal development in flood insurance rate maps (FIRMs). FEMA has been authorized to update FIRMs to include any relevant information and data "relating to the best available science regarding future changes in sea levels, precipitation, and intensity of hurricanes," and information from the storm surge modeling of the National Oceanic and Atmospheric Administration (NOAA), among other things (Biggert-Waters Act of 2012 [H.R. 4348]; Grannis 2012). It is unclear, however, how and when new maps will be drawn up and from where the funding for that will come.[78] Nor does it specify any new mandatory actions coastal communities might have to take based on these maps.

The insurance rate increases triggered by this act are understandably unpopular. Many coastal communities are unhappy with the changes; there are even attempts in Congress to delay or rescind the increases.[79,80] However, given years of mismanagement of our coastal risks and the prospect of increasing risks from sea level rise, the changes in the act are overdue and are badly needed. It will be important to address equity concerns as the changes go into effect, for example through providing rebates or vouchers for low-income property owners (see box, p. 16). The Biggert-Waters Act represents the most significant overhaul of NFIP to date and received broad support from stakeholders ranging from free-market proponents who would like to see insurance rates more in line with market rates, to environmental groups who would like to see incentives for reducing development in high-risk floodplains, to taxpayer advocacy groups who would like to reduce taxpayers' exposure to bearing the brunt of insurance bailouts (Lehrer 2013).

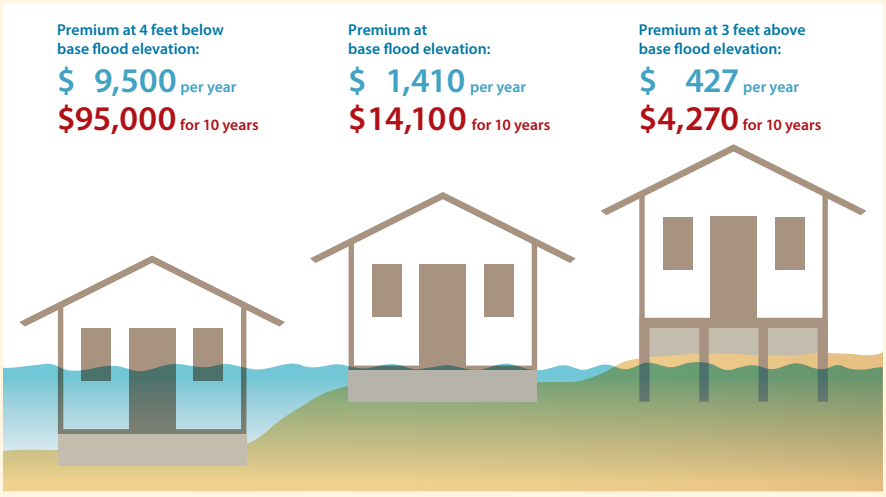

FIGURE 8. Savings on Insurance Bills Can Multiply Quickly

The insurance advantages of elevating a home in a flood zone can be significant. This figure shows current insurance costs for structure coverage on a $250,000 single-family, one-story home without a basement. Over a decade, the potential premium savings associated with elevation can exceed $90,000, which could help offset a significant portion of investments in elevation or other flood-proofing measures.

Source: Based on data and a graphic from FEMA.

State-Subsidized Insurance Markets

Insuring against Windstorm Damage

When storms strike coastlines, severe damage is often caused by high winds. Wind-related coastal storm damage from hurricanes, nor'easters, and other ferocious storms is increasingly being covered through "residual property insurance markets" that provide subsidized special-purpose insurance through state or private companies. Fair Access to Insurance Requirements (FAIR) Plans and Beach and Windstorm Plans are available in many states, although their specific terms of coverage and the way they are organized and run differ from state to state.[81,82]

Rate-setting for residual plans is usually a highly regulated activity, controlled by the office of the state insurance commissioner or other similar agencies. The policies are sold through private insurance companies that typically pool risks, losses, and profits across all policies in a state (or even across state lines for national companies) and provide subsidized coverage, often backed by state guarantees in the event of a major catastrophe. Such a structure allows companies to offer a cheaper rate than would ordinarily be available on the open market and also allows insurers to pass through some of their downside risk to state taxpayers.

Nationwide, the number of residual policies more than tripled from roughly 1 million to more than 3 million between 1990 and 2011.[83] Simultaneously, because of increasing high-value development along the coast, the value of insurance coverage offered by these plans (also known as "exposure to loss") disproportionately increased more than 1,500 percent—that is, 16 times, growing from $55 billion in 1990 to $885 billion in 2011 (Hartwig and Wilkinson 2012). In the case of very damaging events, the losses are often passed through to the state taxpayers or to other property owners (including those located inland) in the form of policy surcharges or increased insurance rates on the residual plans. Florida, Massachusetts, Louisiana, Rhode Island, and Texas (listed in decreasing order of exposure) have the highest percentage of total insurance market premiums in such state-subsidized insurance pools (Hartwig and Wilkinson 2012).

A 2010 GAO report on state insurance programs for different types of natural catastrophes[84] showed that insurance programs in Florida, Texas, and Mississippi—all coastal hurricane-prone states—experienced the most growth in total exposure to loss since 2005, with increases of roughly 150 percent, 150 percent,

Harnessing Financial Markets

Both private and state-subsidized insurance plans are increasingly turning to the broader capital markets to find ways to spread their risks and remain solvent in the face of large or frequent disasters. The GAO has recommended that NFIP consider using such financial tools. Even so, risk-pooling techniques must recognize a new reality: global warming and continuing sea level rise will contribute to rising risks of losses along the nation's seacoasts, especially along the Gulf and East Coasts; moreover, those risks are correlated because long stretches of the coast may be affected by a single storm. Finding ways to diversify and transfer some of that risk to broader global capital markets—notably through the mechanisms of reinsurance or catastrophe bonds—will be critical. However, before going down that route, it will be essential to ensure that the effect of such changes is not to further encourage risky coastal development or large taxpayer bailouts.

Reinsurance. The most common way that insurance companies try to manage risks while ensuring competitive insurance rates is purchasing their own insurance against losses from reinsurance companies. Operating at global scale, reinsurance policies are able to spread local and regional risks across global markets where such risks are usually uncorrelated. Leading reinsurance companies, such as Swiss Re and Munich Re, are increasingly recognizing the risks posed by climate change to insurance markets and the broader economy. According to a recent report from Swiss Re, which assumes a 10-inch rise in sea levels by 2050, the frequency of mammoth losses due to powerful, widespread storms such as Sandy are likely to increase and should be expected about every five years when looking at the entire United States. (Swiss Re 2013).[85]

Catastrophe bonds. A relatively new tool for dealing with growing insurance risks is the catastrophe bond (or CAT bond). By selling bonds, an insurer is able to transfer some of its financial risk to the broader capital market. Investors buy the CAT bonds to help diversify their portfolios with an investment whose risks are not typically correlated with the broader economy (for example, the risks of an extreme coastal storm are not typically correlated with such economic metrics as GDP or employment). Florida's state-subsidized insurance plan (Florida Citizens) issued a record-setting $750 million in CAT bonds in 2012 and again issued $250 million in CAT bonds in 2013. Alabama and Massachusetts have also turned to the reinsurance and CAT bond markets for coverage for hurricanes and windstorms.[86]

Such sophisticated financial instruments will require considerable expertise and oversight to employ well. Issuing catastrophe bonds could make publicly subsidized insurance programs more financially balanced, but it will come at a cost. Transferring insurance risks to the financial markets will likely contribute to at least a small rise in insurance rates since the bond market will require a higher return on investment than the rate the U.S. Treasury charges on borrowing.[87]

Damaging Winds

Along with flood damages from storm surge, many coastal communities are also experiencing costs from severe windstorms. The value of insurance coverage in wind insurance plans (also known as "exposure to loss") increased 16-fold, from $54.7 billion in 1990 to a record high of $884.7 billion in 2011.

Source: PIPSO Insurance Information Institute.

and 500 percent, respectively. Florida's insurance and reinsurance programs had a combined total exposure of more than $2 trillion, far exceeding that of all other programs combined (GAO 2010). Such rapid growth in insurance coverage is creating an unsustainable exposure to risk for state budgets and taxpayers and might even become a burden for federal taxpayers if the state of Florida is unable to cover the costs of a major storm.

Implications for Coastal Communities

Perverse Incentives Create More Risk, Less Resilience

Subsidized insurance rates, the practice of passing through damage and loss costs to taxpayers, the lack of accurate information on flood risks—all these factors have distorted the coastal insurance market to create potentially disastrous outcomes.

Recent insurance industry estimates showed that NFIP was providing overall flood insurance at one-half the true risk cost; and in higher-risk areas, it was providing flood insurance at one-third the cost (PCI 2011). Such perverse incentives have ironically led to more coastal development, more exposure to climate and other coastal risks, less incentive to build the needed resilience to those risks, and increased taxpayer burden. Indeed, the GAO has rated NFIP a "high-risk" program since 2006, stating most recently in its 2013 report that, "The potential losses generated by NFIP create substantial financial exposure for the federal government and U.S. taxpayers" (GAO 2013). The Biggert-Waters Flood Insurance Reform Act of 2012 is aiming to change several of these problematic aspects (see box, p. 13).

Near-term interests, however, can often trump the need to build in a more sustainable way along our coasts. In the state of New Jersey, for example, local officials, real estate developers, and other business interests have long fought any coastal development restrictions despite serious beach erosion and threats of storm damage (Kirkham and Rudolf 2012). Yet, when Hurricane Sandy struck, many coastal New Jersey communities were among the hardest-hit. In Florida, legislators representing inland residents were instrumental in passing a recent bill aimed at reforming the state-backed wind insurance plan because of concerns that the high insurance rates their constituents pay are subsidizing coastal residents, and that inland residents would also be on the hook for damage costs when a major storm strikes (Cotterell 2013).

Insurance Reform

Recommendations to Reduce Our Risks

Reforming the coastal insurance system requires not simply ensuring that rates are set in a way that reflects risk. It also should create opportunities for home owners and communities to make choices that reduce their exposure to risk and increase their resilience to the ravages of major storms. A number of measures could help reduce some of the perverse incentives created by the current insurance system, improve the fiscal health of federal- and state-subsidized insurance programs, reduce taxpayer exposure to burgeoning liability, and allow coastal communities to protect themselves against growing risks, including climate-related risks. The Biggert-Waters Act will help address some of the perverse incentives—but it will be essential to ensure it is implemented well and in a timely fashion. Moreover, as a society we need to go even further.

Key recommendations include:

- **Ensure premiums reflect risk.** *NFIP should ensure that insurance premiums reflect true risks to coastal properties.* Increases in NFIP's insurance premiums are already set to take place through the Biggert-Waters Act, and efforts to delay those increases should be avoided. Additionally, state-subsidized wind insurance plans should also set rates commensurate with risk. Funding from community development block grants, administered by the U.S. Department of Housing and Urban Development (HUD), could be used to help residents buy insurance.[88] An income-based voucher or rebate program should be set up to help target assistance to lower-income home owners who struggle with higher insurance rates (see box below).

- **Include sea level rise projections in flood maps.** *FEMA should use the latest scientific projections of sea level rise and storm surge in maps used to determine ongoing and future flood risks and set rates (premiums and coverage) in both the private and government insurance programs.* Such scientific projections, plus other relevant contributing factors such as land subsidence (the sinking or settling of coastal land areas[89]), coastal topography, and erosion, should be incorporated in FEMA's flood maps. Congress should authorize sufficient resources for regular updates to maps as well. While more accurate maps are being drafted, one interim way communities could try to take additional risks into account would be to build even higher or farther inland than the minimum recommended by the current maps, thus creating an additional margin of safety.

The Burden Is Unequal

Low-income communities are often among the hardest-hit by major storms. Recent studies show that impacts of Hurricane Sandy were especially severe on low-income people, including communities of color, in New Jersey and New York. Forty-three percent of the 518,000 households requesting federal aid after Sandy reported annual incomes of less than $30,000 (Enterprise Community Partners 2013). The storm did extensive damage to public housing in New York City and many low-income renters have been left without affordable housing options.[90]

Although insurance rates in most coastal areas do not adequately reflect true actuarial risk, a rapid rise in insurance premiums could be regressive and force many low-income or fixed-income property owners to sell their homes, go into foreclosure, or forego flood insurance coverage. Nationwide, some low-income and fixed-income home owners are already unable to afford flood insurance even at subsidized rates and have had to make the risky choice to go without insurance. For example, in the wake of Hurricane Katrina in 2005, it became clear that many older residents of New Orleans who were on fixed incomes had let their flood insurance policies lapse. As a result, they had few options for rebuilding or relocating when their properties were destroyed by flooding. Similar stories are emerging in the aftermath of Sandy.[91] Instituting a program of vouchers (ASFPM 2013a), rebates, or other subsidies can help low-income property owners cope with higher rates that reflect true risks, while ensuring that they have insurance coverage for natural disasters (see the recommendations).

Of the more than half a million households seeking federal aid after Hurricane Sandy, 43 percent reported annual incomes of less than $30,000.

Low-income communities are often among the hardest-hit by major storms. Hurricane Katrina, which hit in 2005, had a devastating impact on low-income communities and communities of color. Pictured here, a New Orleans resident searches for salvageable items in her home, located in the Lower Ninth Ward. Seven years later, the impacts of Hurricane Sandy were also especially severe on low-income communities in New Jersey and New York.

© Andrea Booher/FEMA

- **Discourage development in floodplains.** *FEMA should discourage continued building and rebuilding in high-risk areas by reducing payouts for repetitive losses and increasing rates in the event of repeated losses.* Some of these changes will be implemented as part of the Biggert-Waters Act. State and local planning authorities also have a major role to play in driving development decisions along exposed coastlines. They need to ensure that the threat of future sea level rise is factored into all long-term choices.

- **Remove unfair subsidies.** *NFIP should remove grandfathering provisions that unfairly subsidize some property owners at the expense of others and perpetuate risky development in coastal floodplains.* Grandfathering provisions could be phased out in stages and coupled with needs-based rebates or vouchers to help protect low-income home owners. The Biggert-Waters Act aims to first phase out grandfathering provisions for second homes and commercial properties and then also for homes in areas that adopt new FEMA maps (FIRMs). This reform needs to be extended to all primary residences, however, which are the majority of grandfathered properties.

- **Allow for home buyouts.** *Federal and state governments should make options for home buyouts and relocation more widely available in some of the highest-risk areas prone to repeated flood and storm damage.* Governor Andrew M. Cuomo of New York, for example, has suggested an interest in using a part of the funds from the U.S. Hurricane Sandy Relief Act for such options.[92] FEMA also has a home buyout program

OUR COASTAL COMMUNITIES AT RISK

Virginia: Historic Landmarks and Military Installations Face Flooding

The Hampton Roads metropolitan region of Virginia, which includes the cities of Newport News, Norfolk, and Virginia Beach, has more than 1.6 million people living under significant flooding threat. The area is also critical to U.S. national security; its dozens of military facilities include Naval Station Norfolk, the biggest naval base in the world, and Langley Air Force Base. It is also home to a gigantic shipbuilding industry and a massive civilian port complex that handles coal, grain, petroleum, timber, and car exports. The inconvenience and costly damage associated with flooding is already commonplace for residents of the Hampton Roads area.

The Virginia coast is no stranger to the impacts of storms. When Hurricane Isabel hit in September 2003, it left 32 dead and more than $925 million in insured property damages in the commonwealth, including damage to hundreds of thousands of priceless artifacts due to flooding in historic Jamestown (NOAA 2004; St. John Erickson 2003).

Virginia has a coastline of approximately 112 miles, however the tidal shoreline is more than 3,315 miles long (NOAA 1975).[93] While only 29 percent of Virginia's land mass is within the coastal zone, roughly 60 percent of Virginia's almost 8.2 million residents live in these areas, and approximately 113,000 people live within four feet of the local mean high tide (Climate Central n.d.; VDEQ n.d.; USCB 2013b). The Virginia coast has seen local sea level rise of 14.5 inches during the last 80 years.[94] A recent study from the Virginia Institute for Marine Science (VIMS) projected a sea level rise range of between 1.5 and 7.5 feet by 2100, with a best estimate for planning purposes of 1.5 feet (18 inches) during the next 20 to 50 years (VIMS 2013).[95] Indeed, coastal storms, storm surge, erosion, inundation, and rising sea level together will bring significant changes to the Virginia coastline this century.[96]

Virginia ranks ninth within the United States for the number of policies in force under the federally backed National Flood Insurance Program (NFIP) (FEMA 2013a).[97] Since 1978, NFIP policy payouts for the commonwealth have reached almost $620.5 million (FEMA 2013a). Along with the upcoming increases to NFIP rates under the Biggert-Waters Act, residents in coastal Virginia are also dealing with rate hikes for basic home owner's policies.[98] Additionally, only 7 percent[99] of the commonwealth's communities participate in the Community Rating System (CRS) program, a program that can help lower NFIP insurance rates through investments in measures that reduce flood risks. All are rated as a seven or higher, showing that most communities are not taking all possible measures to reduce their flood risks (FEMA 2012b).

The city of Norfolk is spending millions to raise roads, build flood defenses, and improve storm water management.[100] As a result of these efforts, Norfolk was named one of the "20 Leading Resilient Cities Responding to Climate Change & Extreme Weather"[101] (City of Norfolk n.d.; ICLEI 2013).

The low-lying coastal communities of the Commonwealth of Virginia are home to several important military installations. In 2003 when Hurricane Isabel made landfall in Virginia, it flooded parts of Langley Air Force Base, which lies along the Branch Back River near the mouth of Chesapeake Bay.

that is 75 percent federally funded but administered through states and local communities. Few home owners take advantage of it, though, because funds are limited and with low insurance rates there is not a big incentive to move.[102,103]

- **Communicate flood risks.** *State insurance regulators should require that coastal flood maps be shared with home buyers and small-business owners prior to the purchase of coastal property to increase buyers' awareness of coastal flood risks.*

- **Mandate flood insurance.** *The federal government, under NFIP, should create enforceable mandates so that all property owners in high-risk areas have adequate insurance; the mandates also should strongly encourage property owners outside the highest-risk areas—but still in an area where the risk of flooding is not zero—to purchase insurance.* Special programs that meet the need of lower-income property owners, for example by offering rebates or vouchers, should also be included. These mandates should also be forward-looking, recognizing that some areas that do not face high risks currently may

OUR COASTAL COMMUNITIES AT RISK

New Hampshire: The Granite State Faces Rising Seas

Parts of the U.S. coast, including coastal New Hampshire, face flooding during regularly occurring high tides. Twice a month, during the full and new moon, when the pull of the moon and sun on the earth are in alignment, the ocean tides are highest. The highest tide of the year is colloquially called a "king tide." Pictured here is the Bratskellar Restaurant near Portsmouth in New Hampshire during low tide on the left, and the highest tide of the year in 2011 on the right.

In the fall of 1991, New Hampshire suffered significant coastal flooding, when it was hit with a double whammy: Hurricane Bob[104] in August and then the Halloween nor'easter, also dubbed the "Perfect Storm" [105] (NOAA 2013; Cousineau 2011; ReadyNH 2010b).

Flooding, both coastal and inland, is considered one of the greatest natural hazards within New Hampshire, and some portion of the state experiences flooding each year (NHDS n.d.). The largest storm-related flooding the state experienced occurred in 1938 as a result of the Great New England Hurricane, which caused $22 million in damages (more than $370 million in today's market) and 13 deaths. That catastrophe led to the construction of a series of flood control dams during the 1950s and 1960s, which the U.S. Army Corps of Engineers operates to this day (Cousineau 2011; ReadyNH 2010a; ReadyNH 2010b).

New Hampshire's primarily rocky coastline is the smallest of any state: only 13 miles[106] (NOAA 1975). Yet fully 23 percent of its just over 1.3 million residents live in coastal communities[107] (USCB 2013a; Wilson and Fischetti 2010). Furthermore, more than 3,000 residents live within four feet of the local mean high tide (Climate Central n.d.). Warmer temperatures and increased risk of flooding from sea level rise, storms, and extreme precipitation will also have significant implications for New Hampshire's Great Bay ecosystem and for communities in the Great Bay watershed (Great Bay National Estuarine Research Reserve 2011).

As of May 2013, New Hampshire ranked forty-second within the United States for the number of policies in force under the federally backed National Flood Insurance Program (NFIP) (FEMA 2013a)—fewer than 1 percent of the policies nationwide.[108] Since 1978, NFIP paid out losses totaling almost $48 million for policyholders in New Hampshire (FEMA 2013a). Only 2 percent[109] of communities participate in the Community Rating System (CRS) program, a program that can help lower NFIP insurance rates through investments in measures that reduce flood risks. All are rated as an eight or nine, showing that they have not taken advantage of measures to reduce their exposure to flooding (FEMA 2012b).

Today, however, many New Hampshire communities are taking a proactive approach to prepare for future sea level rise and coastal flooding. In July 2009, the town of Seabrook commissioned a report looking at strategies for the town in the face of rising sea levels and increased risks of flooding due to climate change.[110] The report recommended that any new development and infrastructure should be planned only outside current and future flood hazard areas, and that elevation requirements should exceed town, state, and FEMA standards (RPC 2009). A more recent 2012 study found that, over the long term, taking action to build resilience in coastal New Hampshire is significantly more cost-effective than doing nothing. The study identified critical infrastructure such as the Hampton Sewage Pump Station and the Seabrook Wastewater Treatment Plant as being particularly at risk from sea level rise and storm surge[111] (Merrill et al. 2012). This year, the city of Portsmouth released a Climate Change Vulnerability Assessment and Adaptation Plan, which assessed the vulnerability of infrastructure and made adaptation recommendations; it is intended to inform the city's upcoming master planning process, scheduled to begin in the fall of 2013 (CRI 2013).

With years of mismanagement of our coastal risks and growing threats from sea level rise, reforms to NFIP are overdue and are badly needed.

face future costs from rising seas. Parallel mandates in state-backed wind insurance markets are also necessary.

- **Offer incentives for relocation and upgrades.** *Federal and state authorities should ensure that taxpayer-subsidized programs include incentives to relocate away from the coast and to invest in property upgrades that help adapt to rising seas and coastal flooding.* Priority should be placed on those communities that are most at risk and/or have suffered from a high percentage of repetitive losses, with provisions to ensure that incentives are fairly distributed across all income levels and do not end up simply subsidizing the wealthiest. Special attention should also be paid to sites of particular historical or cultural significance.

- **Set smart guidelines for rebuilding.** *The federal government, in coordination with state governments, should set guidelines to ensure that rebuilding dollars are used for climate-resilient reconstruction and other measures to reduce exposure to future events, especially in an era of rising sea levels.* This is particularly pertinent for taxpayer-subsidized rebuilding efforts. It also applies to programs administered by HUD and coastal protection measures such as seawalls and beach replenishment undertaken by the U.S. Army Corps of Engineers.

- **Raise awareness of the CRS.** *FEMA and state and local authorities need to raise awareness of the CRS program and expand the number of communities participating in it nationwide, as a way to increase investments in better floodplain management and to help reduce flooding risks.* In spite of its high exposure to flooding, New York City, for example, does not yet participate in the CRS. Communities should also be encouraged to increase their rating within the system by taking further protective actions, such as providing more accessible information to make people aware of flood hazards and ways they can help protect themselves, investing in flood risk mapping for areas not yet mapped by FEMA, preserving open space, relocating or retrofitting flood-prone buildings, and improving storm water and drainage systems.[112] The CRS itself should be improved to provide recommendations that target a particular community's flood risks.

- **Use risk transfer tools.** *NFIP and state-subsidized insurance programs should (where allowed by law) consider using financial mechanisms strategically, to transfer some financial risk to the broader capital market through reinsurance purchase and bond issuance.* Such mechanisms could help provide an avenue to improve the financial solvency of these programs. However, before going down that route, it will be essential to ensure that the effect of such changes is not to further encourage risky coastal development or large taxpayer bailouts.

- **Update protective recommendations.** *FEMA and state and local authorities should regularly update the list of recommended protective measures (including building codes and zoning regulations) to reflect risk and advances in engineering, and should increase enforcement to ensure compliance.*

Conclusion

Against a backdrop of growing coastal population growth and development, climate change is raising the risk of costly damages to coastal properties by contributing to more intense hurricanes, accelerating sea level rise, and bigger, more damaging storm surges. The National Flood Insurance Program is already more than $20 billion in the red because of its flawed structure of rates, risks, and incentives, and is becoming more financially compromised due to an uptick in extreme weather events such as Hurricane Sandy. State-subsidized wind insurance programs are similarly a growing source of financial exposure for taxpayers.

Important steps are under way to reform our current system of coastal property insurance through the Biggert-Waters Flood Insurance Reform Act of 2012. It will be critical to ensure the act is implemented without being weakened or delayed. Indeed, we need to go further, especially in incorporating sea level rise projections in coastal flood risk maps and in coastal development and rebuilding decisions. Otherwise, home owners will continue to make choices that do not reflect the actual threats they face, and U.S. taxpayers will find themselves increasingly paying more to help coastal communities rebuild after storms and floods.

Insurance reform is one important tool to help communities realize they need to make better decisions to adapt to climate change. As communities grapple with the new realities, they also need a more comprehensive framework to assess true risks and vulnerabilities, as well as a set of tools to help them make the best choices for protecting themselves. It is also worth noting that one of the most important ways to build resilience to climate impacts is to limit their severity as much as is still possible by making deep cuts in carbon emissions.

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Notes

1 For the purposes of this report, the term "coastal" encompasses those states or counties of the contiguous United States that lie along the Pacific and Atlantic Oceans and the Gulf of Mexico. It does not include states or counties along the Great Lakes, nor does it include Alaska, Hawaii, or the U.S. island protectorates.

2 Local sea level rise along the U.S. continental Pacific Coast is, in general, not as dramatic as along the Gulf and East Coasts. In many places it is lower than the global average (and there are even instances where sea level is falling due to land uplift). See this UCS sea level rise infographic for information on observed local sea level rise along U.S. coasts: *www.ucsusa.org/sealevelrise.*

3 The massive storm surge caused by Hurricane Katrina was mainly caused by the hurricane's large size, with hurricane-force winds extending at least 75 nautical miles to the east from the center of the storm. The total water level was further increased by waves including those generated the day before the hurricane made landfall, when it was an even stronger storm (NOAA 2011).

4 A recent paper makes a useful distinction between flooding and inundation: "We propose that the term 'flooding' be used when dry areas become wet temporarily—either periodically or episodically—and that 'inundation' be used to denote the process of a dry area being permanently drowned or submerged" (Flick et al. 2012).

5 An additional risk is that saltwater could reach further into coastal groundwater, increasing the salinity of freshwater used for drinking and agriculture. Saltwater intrusion into coastal aquifers can render them unusable and require costly remedial measures (Barlow and Reichard 2009; Stanton and Ackerman 2007). Salinization can also degrade coastal wetland ecosystems, as is occurring in the Florida Everglades (Ross et al. 2000).

6 Human-caused global warming is the primary driver for accelerating global sea level rise. Many places along the East and Gulf Coasts of the United States are experiencing higher and faster rates of local sea level rise because of additional local factors such as land subsidence, changes in ocean

currents, and the effects of groundwater depletion (UCS 2013; NOAA 2012a; NOAA 2012b).

7 The underlying cause is that global warming is making the ocean warmer.

8 The Knutson et al. study concludes that future projections consistently indicate that global warming "will cause the globally averaged intensity of tropical cyclones to shift towards stronger storms, with intensity increases of 2–11% by 2100"; studies also "consistently project decreases in the globally averaged frequency of tropical cyclones, by 6–34%; substantial increases in the frequency of the most intense cyclones; and increases of the order of 20% in the precipitation rate within 100 km of the storm center" (Knutson et al. 2010).

9 The study by Mendelsohn et al. models the increase in damage caused by global tropical cyclones (hurricanes and typhoons) by 2100 and finds that the United States is the country with the highest average aggregate damage of $25 billion/year. That projection is based on the prediction that the United States will have more frequent high-intensity tropical cyclones.

10 Data from 1953 to 2011 show a significant increase in the number of major disasters for which there have been presidential disaster declarations. The taxpayers' share of relief costs for major storms has also been increasing, growing from 6 percent for Hurricane Dianne in 1955 to more than 75 percent for Hurricane Sandy in 2012 (Michel-Kerjan 2013).

11 Unfortunately, most of the sea level rise we will experience through the middle of this century is already locked in due to warming from our past global heat-trapping carbon emissions. Cutting our carbon emissions sharply, however, could slow the pace and reduce the magnitude of sea level rise later in the century. By how much is uncertain, as it depends greatly on the dynamics of how large ice sheets respond to the warming climate, and on our emissions choices over the next few decades.

12 The report was commissioned at the recommendation of the Government Accountability Office (GAO), which suggested that the impact of climate change on the National Flood Insurance Program (NFIP) be analyzed.

13 The coastal areas of the United States at high risk of floods are designated Special Flood Hazard Areas (SFHAs), which correspond to the 1 percent annual chance floodplain area. A 1 percent annual chance flood (or base flood) has a 1 percent annual chance of being equaled or exceeded in any given year. The 1 percent annual chance floodplain consists of those areas that are expected to be inundated by the 1 percent annual chance flood.

14 The study uses a probabilistic approach (Monte Carlo simulations) to model changes in future risk based on a number of relevant input parameters. The climate factors considered for the coastal analysis include sea level rise and the changing character of storms. The estimate cited is the median estimate (the fiftieth percentile, i.e., half are greater and half are less) for the increase in the coastal SFHA, assuming a fixed shoreline, with very wide regional variability. In contrast, negligible change in coastal SFHA is projected assuming a receding shoreline; in that case, the amount of new coastal SFHA resulting from rising sea levels will be equally offset by the land area lost to sea-level-rise-induced inundation and erosion, when averaged over time and shoreline length (AECOM 2013).

15 The study assumes sea level rise of four feet by 2100, based on widely cited work by Vermeer and Rahmstorf (2009). This scenario also assumes a fixed shoreline.

16 The increased risk of flooding by 2100 is a national average that includes inland and coastal areas, and could vary widely from region to region. According to the report authors, the estimated 30/70 split is based on "developed areas that are of most interest to NFIP (National Flood Insurance Program)." For example, in more underdeveloped areas, population growth will likely play a smaller role in increasing flooding risks, whereas it may play a larger role in more densely populated areas. Maps in the report indicate that along the Northeast, Mid-Atlantic, and Northwest coastlines, the increase in flood risks related to climate factors is particularly pronounced.

17 Storm surge can be amplified particularly when the coastal topography has a low slope.

18 The states of California, Florida, Louisiana, New York, and North and South Carolina have the most residents living on land that is within 3.3 feet above high tide levels. Depending on our global heat-trapping carbon emissions—and the resulting warming of the oceans and loss of land ice—we could see that amount of sea level rise within this century (NOAA 2012a; Strauss et al. 2012).

19 According to the study, a mid-range scenario of sea level rise of approximately 26 inches of sea level rise by 2100 would leave more than $1 trillion of property nationwide vulnerable to being lost simply because of its low elevation. Of that, approximately $554 billion worth of property—more than half—is located in Florida. (All values are in undiscounted dollars). Adaptation measures can help reduce those costs by a factor of more than four nationwide (Neumann et al. 2010).

20 Warming atmospheric temperatures warm the oceans, causing ocean water to expand and land ice (glaciers, ice caps, and ice sheets) to melt and shrink, with both factors contributing to rising seas. The rate at which sea level is rising is also accelerating.

21 See note 6 for a description of these additional factors.

22 Recent sea level rise scenarios from NOAA show a range of sea level rise between eight inches and 6.6 feet by 2100. However, the lowest end of this range is a simple extension of historic sea level rise—and recent data indicate that this rate has nearly doubled in recent years. Three other scenarios show a more likely range of 1.6 to 6.6 feet (NOAA 2012a). Note that sea level will continue to rise beyond 2100 because the oceans take a while to respond to warming temperatures, and ice sheet dynamics will also continue to evolve as temperatures increase.

23 Warmer air holds more water vapor, which creates the conditions for these heavy rainfall events. Whether heavier rainfall events lead to more general flooding depends to a large degree on soil moisture, prior weather conditions, and ground surface composition (for example, paved surfaces in urban areas cannot absorb water, whereas porous soils in more rural areas can better handle more water).

24 Very heavy rainfall events are defined as the heaviest 1 percent of all daily events for each region.

25 There could be increases on the order of 20 percent in the precipitation rate within 100 km of tropical storm centers.

26 Additionally, nor'easters are riding on higher seas today than before, which raises the risk of damage. There is also some evidence of storm tracks shifting slightly northward (Wang et al. 2013; Wang, Swail, and Zwiers 2006). Research is ongoing into whether frequency and intensity of nor'easters is changing.

27 A study examining the duration and maximum wind speeds of each tropical cyclone (tropical cyclones are classified as hurricanes in the Atlantic Ocean once their internal wind speeds exceed 74 miles per hour) that formed over the last 30 years found that their destructive power has increased around 70 percent in both the Atlantic and Pacific Oceans (Emanuel 2005). Another study found that the percentage of hurricanes classified as Category 4 and 5 has increased over the same period (Trenberth 2005). The findings from both studies correlate with the rise in sea surface temperatures in regions where tropical cyclones typically originate.

28 These factors include wind speed and direction or wind sheer (Trenberth 2005).

29 Based on data for all coastal states, including Alaska and Hawaii.

30 The hurricane led to insurance claims of $15.5 billion in 1993 dollars—equivalent to $25 billion in 2011 dollars (McChristian 2012).

31 Florida also has more than 8,426 miles of tidal shoreline (NOAA 1975). The tidal shoreline includes the shoreline of the outer coasts, offshore islands, sounds, bays, rivers, and creeks up to the head of the tidewater or to a point where the tidal waters narrow to a width of 100 feet (NOAA 1975). Alaska has the longest coast, with 6,640 miles, and 33,904 miles of tidal shoreline.

32 Parts of Florida may have experienced higher levels of sea level rise than the global average during this time. This is because of local factors such as land subsidence, ocean currents, and the effects of groundwater depletion.

33 The 100-year floodplain is defined as the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood, which is the flood having a 1 percent chance of being equaled or exceeded in magnitude in any given year.

34 Between 1978 and May 2013, at almost $4 billion.

35 216 out of 458.

36 As of June 2013, the coastal counties of Miami-Dade (152,463), Pinellas (123,964), Broward (102,374), and Hillsborough (67,360) accounted for a majority of the total (787,616) CPIC policies in force (CPIC 2013).

37 Growth from 2002 to May 31, 2012.

38 The bill, SB 1770, attempts to reduce the number of policies issued by Florida Citizens by using a clearinghouse to help property owners shop for private insurance first. It also prevents Florida Citizens from insuring properties valued at more than $1 million (lowered to $700,000 by 2017) or any new construction in high-flood-risk zones built after January 1, 2014 (The Florida Senate 2013). However, by failing to raise insurance rates, the law all but guarantees that home owners will continue to look to Florida Citizens as the insurer of choice instead of the insurer of last resort.

39 Another way of stating this is that insurers expect that the events will occur independently and their risks of occurrence are not correlated. For example, a house or a small cluster of neighboring houses may burn down simultaneously but it is unlikely that a whole city would.

40 Standard home owner's insurance policies rarely, if ever, cover damage costs for flooding. Coverage for floods must be purchased through NFIP, and can be purchased for both property and contents subject to the limits under NFIP (FEMA 2012c).

41 The CBO report, based on an analysis of data on 10,000 NFIP properties, found that properties covered under NFIP tend to be more valuable than other properties nationwide and that much of the difference is attributable to the higher property value in areas close to the water. Close proximity to the shore, of course, also raises their risk of flooding.

42 NFIP was created under the National Flood Insurance Act of 1968 and further updated under the Flood Disaster Protection Act of 1973.

43 Under NFIP, building coverage is currently limited to $250,000 for residential dwellings and $500,000 for non-residential buildings. Contents coverage is available for up to $100,000 for a residence and $500,000 for a business (FEMA 2013b; FEMA 2013c).

44 The Write Your Own (WYO) Program, started in 1983, is a deliberate effort on the part of FEMA to work with private insurance companies. Participating companies issue policies in their name and receive an expense allowance for the policies they write and the claims they process, while the federal government is responsible for underwriting losses. Studies show that NFIP pays as much as one-third of the value of premiums collected to these private insurance companies that play an intermediary role but do not in reality bear any risk (Michel-Kerjan 2010).

45 The top five states (Florida, Texas, Louisiana, California, and New Jersey) account for approximately two-thirds of all NFIP policies and insurance in force.

46 As of November 2012, FEMA owed the Treasury approximately $20 billion, and had not repaid any principal on its loan since 2010 (GAO 2013).

47 According to a 2002 study, NFIP ranked second only to the Social Security program in terms of U.S. government financial obligations (Beatley, Brower, and Schwab 2002). This ranking may have changed since then. For context, in fiscal year 2012 the U.S. government had about $3.5 trillion in outlays.

48 Pre-Sandy, NFIP was still about $17 billion in debt, with the annual interest on that debt ranging widely from $80 million to $766 million per year depending on fluctuations in the interest rate (Kousky and Michel-Kerjan 2012; GAO 2009).

49 *Repetitive loss:* Any insurable building for which two or more claims of more than $1,000 were paid by NFIP within any rolling 10-year period since 1978. Two of the claims paid must be more than 10 days apart but within 10 years of each other. A repetitive-loss property may or may not be currently insured by NFIP.

Severe repetitive loss (SRL): As defined by the Flood Insurance Reform Act of 2004, SRLs are one- to four-family residences that have had four or more claims of more than $5,000 or at least two claims that cumulatively exceed the building's value. The act creates new funding mechanisms to help mitigate flood damage for these properties.

50 Coastal areas account for the bulk of these repetitive losses. The top 10 repetitive-loss communities in the United States are all coastal areas: Jefferson Parish, LA; New Orleans, LA; Houston, TX; New York City, NY; Harris County, TX; Puerto Rico, PR; St. Tammany Parish, LA; Terrebonne Parish, LA; Gulf Shores, AL; and Miami-Dade County, FL (NFIP 2011).

51 A study analyzing data on all new policies issued by NFIP over a 10-year period (January 2001 to December 2009) showed that, on average, only 74 percent of new policies were still in force one year after they were purchased; only 36 percent were in force after five years (Michel-Kerjan and Kunreuther 2011).

52 By FEMA's estimation, in 2012 approximately 20 percent of NFIP policies were issued at subsidized rates primarily as a result of this "grandfathering" provision. That is very likely an underestimate. For example, it does not include many more policies that could be considered subsidized because they do not include a premium to account for the risks of future sea level rise.

53 The 2012 and 2013 GAO reports on high-risk areas for the U.S. government note that disaster declarations have increased dramatically from 65 in 2004 to a record of 98 in 2011. FEMA's Disaster Relief Fund provided $80 billion in assistance for disasters from 2004 to 2011. Since the federal government does not budget for these costs ahead of time, it creates the risk of large financial exposure at any moment (GAO 2013).

54 Much of New Jersey is subject to erosion, subsidence, flooding, storms, and hurricanes due to a combination of its climate, topography, and location (NJDEP 2013; NJDEP 2011).

55 245,501 policies in force as of May 2013, accounting for 4.4 percent of total U.S. policies (FEMA 2013a).

56 Approximately $5.2 billion was paid out to the state between 1978 and May 2013 (FEMA 2013a).

57 59 of 550.

58 Of these, all are rated as a six or higher, showing that they are still not taking advantage of all possible measures to reduce flood risk (FEMA 2012b).

59 The state plans to provide financial assistance toward the rebuilding of housing, with a focus on low- and moderate-income housing, and the development of affordable rental housing. Additionally it plans to develop more storm-resistant housing to prepare against future events. Finally, it hopes to be able to offer incentives to residents who decide to stay and rebuild. To ensure economic recovery, the state plans to provide assistance to small businesses through assessment and the issuing of grants. Also, it plans to repair and improve infrastructure in business sectors. Additionally, through the restoration of public parks, recreational areas, streetscapes and public spaces, the state hopes to encourage economic revitalization. Finally, it plans to conduct a workforce study and to provide job training as needed. Infrastructure, being a necessary component of any community, must be repaired and improved for New Jersey to move forward. To this end, the state, with funding from FEMA and other sources, will be conducting studies to mitigate future hazards and rebuild with more resilient facilities.

60 Another example is the $8 million restoration of the 1.3-mile-long boardwalk in Belmar, which reopened just before Memorial Day; for this project, the city did opt to use synthetic material for the reconstruction but also had the pilings supporting them secured deeper underground (Zarroli 2013).

61 The initiative will be distributing $780 million among home owners to facilitate rebuilding and improvement/elevation costs (State of New Jersey Office of the Governor 2013b). This announcement was closely followed by President Obama's visit to the New Jersey shore on May 28, 2013 (seven months after Hurricane Sandy made landfall on the coast) and his declaration that the "Jersey shore is back and open for business" (State of New Jersey Office of the Governor 2013c).

62 Both the New Jersey Association for Floodplain Management and the Association of State Floodplain Managers have written letters to the governor urging him to veto the bill.

63 Zones classified as A or V (each of which has sub-classifications) are considered high-flood-risk zones or SFHAs. SFHAs are areas subject to inundation by a flood that has a 1 percent or greater chance of being equaled or exceeded during any given year. A 1 percent type of flood is referred to as a base flood. The base flood is a regulatory standard used by federal agencies, and most states, to administer floodplain management programs, and is also used by the National Flood Insurance Program as the basis for insurance requirements nationwide. Moderate- to low-risk areas are classified as B, C, or X; areas for which flooding risks have not been mapped are classified as D.

(FEMA. Definition of FEMA flood zone designations. Online at *https://msc.fema.gov/webapp/wcs/stores/servlet/info?storeId=10001&catalogId=10001&langId=-1&content=floodZones&title=FEMA%2520Flood%2520Zone%2520Designations*.)

64 California's Natural Hazard Disclosure Law (AB 1195), passed in 1998. requires disclosing if a property is in an SFHA, as designated by FEMA flood maps. There is some evidence that such a required disclosure may have caused small declines (on the order of 4 percent) in property values in floodplain areas in relation to comparable non-floodplain properties (Pope 2008; Troy and Romm 2004). However, it also provides a strong incentive to purchase insurance.

65 A description of flood maps from FEMA is online at *http://www.region2coastal.com/coastal-mapping-basics*).

66 Draft maps for coastal communities, including in Florida, Louisiana, New York, and New Jersey are being released over the next year and are expected to be finalized by the end of 2014 after a public comment process. In some cases, such as Arlington County and Lancaster County, VA, the maps have been updated and finalized and will go into effect by the end of 2013.

67 Preliminary flood maps for Atlantic, Bergen, Burlington, Cape May, Cumberland, Essex, Hudson, Middlesex, Monmouth, Salem, Ocean, and Union Counties in New Jersey and New York City, NY, have been released. Maps for Bronx, Kings, Richmond, Queens, and Westchester, NY, will be released soon. See *https://sites.google.com/site/region2coastal/sandy/abfe*.

68 FEMA released updated preliminary flood maps for the Greater New Orleans area including Jefferson, Orleans, Plaquemines, St. Bernard, and St. Charles Parishes on November 12, 2012. See *http://www.fema.gov/fema-region-vi-updating-flood-maps-greater-new-orleans-area*.

69 In some cases the new maps are moving properties into high-risk flood zones where flood insurance purchase is mandatory.

70 The Biggert-Waters Flood Insurance Reform Act of 2012 could help address this in the future because it authorizes FEMA to factor in information such as changing coastal topography, erosion rates, sea level rise projections, and changes in intensity of hurricanes in its future maps. But when these new maps will be created is uncertain.

71 FEMA's Advisory Base Flood Elevations (ABFEs) reflect the "1%-annual-chance flood elevations and flood zones" in an area.

72 The lowest scenario from the research is not represented since it is a simple extension of historic sea level rise—and data indicate that the current rate in recent years is already twice the historic rate.

73 The CRS provides discounts for both high-flood-risk areas (SFHAs) and non-SFHA policies for 18 creditable activities that can be classified into four categories: public information; mapping and regulations; flood damage reduction; and flood preparedness. See *http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-rating-system*.

74 Approximately 56 percent of CRS communities have a low rating of eight or nine, 43 percent have a CRS rating of five to seven, and only 0.9 percent have the best rating of one to four (FEMA 2012a). A national map of communities participating in the CRS and their ratings can be found at *http://www.fema.gov/library/viewRecord.do?id=6200*.

75 Also known as actuarial rates in insurance industry parlance.

76 The annual rate increases, however, can be 25 percent for some classes of property including repetitive-loss properties and second homes. Previously, annual rate increases had been capped at 10 percent.

77 Under the act, grandfathering of low insurance rates for second homes and commercial properties will be phased out. However, that new provision does not address the majority of grandfathered properties, which are primary residences.

78 The Association of State Floodplain Managers points out that an increase of $15 to the annual premium of a flood insurance policy—that is, an average increase of just 1 or 2 percent—could generate about $75 million per year to support mapping activities, a substantial fraction of the recent annual cost of $100 million to $115 million (ASFPM 2013b).

79 At last count, there were six such bills filed in Congress.

80 Increases in insurance rates are frequently resisted by coastal communities and realtors, in part because of the perception that they could negatively affect property values. For example, although the National Association of Realtors has said they strongly support the Biggert-Waters Act (which will raise insurance rates), they have also worked to delay a key element of the act: removing the generous subsidies available under the grandfathering provisions of NFIP (NAR 2013a; NAR 2013b).

81 Traditionally, FAIR Plans were primarily for urban areas while Beach and Windstorm Plans were primarily for coastal areas, but that distinction is starting to blur. In states such as New York that do not have Beach and Windstorm Plans, FAIR Plans serve as the insurer of last resort (Hartwig and Wilkinson 2012).

82 Florida and Louisiana have unique state-subsidized insurance plans called the Florida Citizens Property Insurance Company (Florida Citizens) and Louisiana Citizens Property Insurance Corporation (Louisiana Citizens), respectively. Alabama, Mississippi, North Carolina, South Carolina, and Texas have state Beach and Windstorm Plans.

83 Policies under the FAIR and Beach and Windstorm Plans combined more than tripled from 931,550 in 1990 to 3.3 million in 2011.

84 Including hurricanes and earthquakes.

85 Based on analysis using Swiss Re's proprietary storm surge model.

86 Alabama recently entered into a three-year contract with Swiss Re for a premium of $800,000 per year that will guarantee a $5 million payout in the event of a category 3, 4, or 5 hurricane (with wind speeds in excess of 111 mph). The Massachusetts state-subsidized wind insurance program (Massachusetts Property Insurance Underwriting Association) sold $96 million of catastrophe bonds to protect against hurricane damage in a deal managed by Munich Re (Bandel and Hwang 2010). California has also issued catastrophe bonds for earthquake insurance. The California Earthquake Authority undertook two $150 million reinsurance transactions in 2011 and 2012 with the Bermuda-based Embarcadero Reinsurance Ltd., which in turn sold three-year catastrophe bonds for that value to investors. Outside the United States, Mexico and Taiwan have also made use of catastrophe bonds.

87 Based on the recent experience of these states, the catastrophe bond rate is at least 7 percent higher than the three-month Treasury rate.

88 Some of these funds could also potentially be used to set up a home buyout program, although it would have to be carefully structured so as to avoid raising the risk of yet another source of taxpayer liability.

89 The geological uplift or subsidence of coastal areas can affect local rates of sea level change dramatically. Areas such as the northern Gulf of Mexico have seen sea level rise six times the global average because of coastal subsidence (Anderson, Milliken, and Wallace 2010).

90 Overall, almost 20 percent of New York City Housing Authority's 178,000 total units were in buildings that were damaged by Sandy. See *http://www.nyc.gov/html/nycha/downloads/pdf/nycha-developments-affected-by-hurricane-sandy.pdf*.

91 The elderly tend to be highly vulnerable during natural disasters. The data show that 27 percent of households in the area flooded by storm surge from Hurricane Sandy included seniors over the age of 65; moreover, 12.1 percent of households had seniors living alone (Furman Center and Moelis Institute 2013).

92 Governor Andrew M. Cuomo also indicated in his 2012 State of the State speech that he would consider using the State of New York's Recreate NY Smart Home Program as a vehicle for offering relocation options to coastal residents, using some funds from the Hurricane Sandy Relief Act. See *http://takingnote.blogs.nytimes.com/2013/01/24/cuomo-bows-to-mother-nature/?hp*.

93 The tidal shoreline includes the shoreline of the outer coasts, offshore islands, sounds, bays, rivers, and creeks up to the head of the tidewater or to a point where the tidal waters narrow to a width of 100 feet (NOAA 1975).

94 Sea level rise as measured at Sewell's Point in the Norfolk Naval Station. Local land subsidence is responsible for a significant part of the rise along Virginia's coast; however, sea level rise resulting from climate change is projected to accelerate in the coming decades.

95 The lowest end of the range is based on historic rates of sea level rise and does not incorporate acceleration. Recent data indicate that the rate of sea level rise has nearly doubled in recent years (Church and White 2011). The highest end is based on estimated consequences of sea level rise combined with the maximum possible contribution from ice sheet loss and glacial melting. In between are two additional scenarios: a low scenario of 3.2 feet by 2100 based on the B1 scenario from the IPCC 4th Assessment Report; and a high scenario of 5.6 feet by 2100 which is based on the upper end of projections from semi-empirical models using statistical relationships in global observations of sea level and air temperature (VIMS 2013).

96 Most often these threats work together. For example, an intense storm drives the surge along the coastline, which helps to accelerate erosion; increased erosion in turn can lead to less protection for the coastline, thereby facilitating inundation. Such risks to the Virginia coastal region are due not only to the issue of climate-change-related sea level rise and increased storm intensity, but also to isostatic adjustment (in this case, subsidence) in response to the retreat of the ice sheets from the last glacial period (Hershner and Mitchell 2012).

97 According to FEMA, as of the end of May 2013, Virginia residents carried 116,488 NFIP policies that accounted for approximately 2.1 percent of all NFIP policies issued (FEMA 2013a).

98 Since 1995 the insurance companies with the largest shares of home owner's policies for the state (State Farm, Allstate, and USAA) have filed rate increases 42 times, while they have requested rate decreases only eight times. One example, a home owner who purchased a home in 1995 was then paying $477 a year; in 2013 the same policy for the same home is now $3,000 a year and will most likely continue to rise. Between the rising costs of both the home owner's policies and NFIP policies, insurance might become the limiting factor for coastal living in Virginia (Varble 2013).

99 21 of 289.

100 Specifically, the city of Norfolk has many storm water projects added to its Capital Improvement Program each year; they include system upgrades and infrastructure improvements, general construction and planning improvements, and "green infrastructure" additions to slow floodwater movement, allowing it to soak into the soil and spread out more, lessening runoff in the area. Additionally, through regional, state, and federal partnerships, the city is working to address flooding concerns throughout the Hampton Roads area.

101 Based on a recent ranking by ICLEI Local Governments for Sustainability USA (ICLEI 2013).

102 Under the plan, the land on which purchased properties stand must be converted to public open space and cannot be used for future development. To date, 20,000 properties have been bought out under the program around the country. See *http://www.fema.gov/application-development-process/hazard-mitigation-assistance-property-acquisition-buyouts*.

103 There are examples of the program being put to good use in a limited way after inland flooding disasters, such as the record flooding along the Mississippi in 1993 and 1995 (FEMA).

104 Hurricane Bob hit southern and central parts of the state in August, causing $2.5 million in damages, mostly coastal, and three deaths (Cousineau 2011; ReadyNH 2010b).

105 The Halloween nor'easter, or "Perfect Storm," which caused widespread coastal flooding throughout New England and $5.6 million in damages in New Hampshire (Cousineau 2011; NOAA 1991).

106 Or 131 miles for the tidal shoreline (NOAA 1975).

107 As of 2008.

108 This accounts for only 0.17 percent of all NFIP policies. The number of policies seems to have steadily increased over the years, probably in direct response to increasing coastal population.

109 4 of 214.

110 The report was produced by the Rockingham Planning Commission (RPC), which looked at similar studies and plans for Miami-Dade County, Florida, and the State of Rhode Island to determine what kind of mapping would be beneficial, along with guidance for suggestions for local regulations.

111 The study was funded by the Environmental Protection Agency's Climate Ready Estuaries Program. It looked at areas in coastal New Hampshire and Maine and utilized COAST (Coastal Adaptation to Sea level rise Tool) to create a cost/benefit analysis (with a 3.5 percent discount rate) factoring in sea level rise and storm surge predictions. Based on the findings, the EFC made comparisons between the cost of a "no action" strategy and an adaptation strategy designed to protect against the occurrence of a 100-year flood in 2100; it found that, for both public and private assets, the cost of inaction is significantly higher in the long term. Additionally, the study presented findings on threshold elevations for key structures (e.g., Hampton Sewage Pump Station, Seabrook Wastewater).

112 A full list of the 19 creditable activities available under the CRS program is here: *http://www.floodsmart.gov/floodsmart/pages/crs/crs_activities.jsp*.

Drastic Measures Today, Standard Practice Tomorrow?

Some New Jersey home owners are opting to elevate their homes in the wake of Hurricane Sandy and the implementation of the Biggert-Waters Flood Insurance Reform Act of 2012 (see box, p. 13).

Elevation not only better protects homes from storm surge and subsequent flooding, but can also help reduce insurance premiums for home owners.

Rising sea levels are significantly increasing the risks of coastal flooding. Actions to help build the resilience of coastal communities, including insurance reform, are urgently needed, and we must also invest in measures to reduce our carbon emissions to help slow the rate of sea level rise.

This report is available on the UCS website at *www.ucsusa.org/floodinsurance.*

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The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with citizens across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

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