

Underwater

*Rising Seas and the Implications for U.S. Coastal
Real Estate*

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Matrix of Voices: Insights From Market Experts
on the Financial Risks of Sea Level Rise

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To better understand the financial implications of the risks of sea level rise to coastal property markets and the wider economy, we gathered perspectives from local officials as well as market experts—including representatives from credit rating agencies, insurers, real estate investors, bond investment advisors, and mortgage and real estate industry experts. An abridged version of their insights appears in Box 2 on pages 18 and 19 of the report *Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate*. Here we provide their answers in full.

The following questions were posed to a broad set of market and policy experts:

- 1) How serious do you think the risk of sea level rise is to coastal communities (to the coastal real estate market, property tax base, credit rating etc.)? Do you currently include or plan to include sea level rise projections and risks in your business model (commercial and residential properties)? If yes, how, and over what time horizon?
- 2) What do you see as the biggest challenge or barrier to incorporating climate risks like sea level rise in your work?
- 3) From your perspective, are there key tipping points that will drive changes in the behavior of important coastal actors, for example, developers, insurers, realtors, buyers, investors, and others? What might some of those tipping points be?
- 4) Can you share some thoughts on how you see some of those market changes unfolding—for example, changes to the insurance, real estate, or bond markets—along the US coast as chronic inundation worsens in more and more communities?
- 5) Can you share some thoughts on how market trends and incentives, or current policies—federal, state, local, including disaster response, flood insurance, zoning regulations—are affecting coastal risks and resilience?

We also had off-the-record conversations with some experts and drew on publicly available reports from Moody's, Freddie Mac, and Zillow (Moody's 2017; Rao 2017; Beckett 2016). All of this information was synthesized into the six main insights that are highlighted in Box 2 of the report.

The market actors, experts, and municipal leaders who spoke to us on the record were:

- 1) **Roger Grenier**, senior vice president, global resilience practice leader, AIR Worldwide, Consulting and Client Services
- 2) **Douglas M. Poutasse**, executive vice president and head of strategy and research, Bentall Kennedy (US) LP
- 3) **Michael D. Berman**, Michael Berman Consulting
- 4) **Andrew Teras**, vice president and senior analyst, Breckinridge Capital Advisors
- 5) **Cynthia L. McHale**, director, Ceres
- 6) **Anne C. Canfield**, executive director, Consumer Mortgage Coalition
- 7) **Laurie Schoeman**, national program director for resilience initiatives, Enterprise Community Partners
- 8) **John A. Miller**, water resources engineer, University of Pennsylvania
- 9) **Philip K. Stoddard**, mayor, South Miami, Florida
- 10) **Kurt Forsgren**, managing director, infrastructure sector lead, S&P Global Ratings
- 11) **Carolyn Kousky**, director for policy research and engagement, Wharton Risk Management and Decision Processes Center, University of Pennsylvania

Below are the answers in full that were provided to us.

- 1) **Roger Grenier**, PhD, senior vice president, global resilience practice leader
AIR Worldwide Consulting & Client Services

AIR pioneered the catastrophe-modeling industry, creating the tools that changed how people think about risk management. AIR is part of the VERISK Analytics family of companies, a leading data analytics provider.

“Over the very near term, the threat to most coastal communities is small. However, some communities are experiencing significant issues even today, and, as the UCS work illustrates well, many more communities will be threatened over time. Additional factors including land subsidence, changes in ocean circulation, and increasing severity of extreme events (hurricanes, surges) will contribute to the threat as well. As a result, the impacts to the coastal real estate market, coastal businesses, and property tax bases will be geographically concentrated in the near term but will become more widespread over time.

“AIR’s catastrophe models incorporate the many physical processes related to sea level rise and climate change more generally, and we have an active research program which helps our insurer and reinsurer clients adapt the latest science to their view of risk. As the science and evidence evolve, we anticipate that market signals (insurance rates, community credit scores) will increasingly reflect a heightened risk. While the real economic impacts to coastal real estate and business interests are likely to become more apparent in the next few decades, credible scenario planning is available to begin quantifying these impacts today.

“The uncertainty around sea level rise and other potential climate impacts is a challenge for the insurance industry. Insurers operate in a highly regulated environment, and rate indications must be credible and supportable to obtain regulatory approval. The inability to precisely quantify near-term impacts from climate change is challenging from that perspective; while there are commonly accepted scenarios which could be used to inform pricing, these may not be sufficient to pass regulatory muster. Furthermore, market considerations require that rates remain competitive, which limits (a) significant loads for potential, but uncertain, climate change impacts, and (b) industry-wide, collective assessments of the impact of sea level rise on pricing (owing to anti-trust concerns). Providing competitively priced products that can be successful in the market is an important fiduciary responsibility for insurers.

“A few tipping points could include (a) continued expansion of the private flood market into coastal areas, coupled with the shrinking of the National Flood Insurance Program policy base in these areas, which may result in strong price signals to drive behaviors; (b) significant state or federal regulatory changes that to drive more resilience land use planning and building code adoption; (c) adoption of resilience and climate adaptation measures as part of community credit ratings programs; (d) a significant ‘shock loss’ or series of events that cause widespread destruction and drives public action. Less likely, but still plausible, tipping points include abrupt changes in the physical environment that greatly accelerate sea level rise—for example, a sudden collapse of ice sheets or a breakdown of the Atlantic overturning circulation, both of which could have dramatic regional impacts.

“The continued evolution of the private flood market could result in significant changes to the status quo. While it is too early in the evolution to predict precisely how the market will unfold, a few possibilities exist. On the one hand, the private flood market may extend into coastal regions, replacing the National Flood Insurance Program in these areas and likely resulting in higher rates for many properties, and possibly exclusions on more frequent nuisance flooding events. The higher price signals could drive a gradual and orderly retreat and repurposing of land for more appropriate uses (best case) or a collapse in real estate values and either no action or poorly planned efforts towards mitigation (worst case). On the other hand, the private flood market may restrict or avoid writing policies in certain areas, as is common today when an adequate rate is not available. In this instance the National Flood Insurance Program may evolve into a high-risk pool for coastal flood insurance, which has an economic consequence (i.e., fewer policies, and hence less premium overall to cover the potential for large surge events) and could lead to potential political and social concerns over subsidization of coastal communities.

“The National Flood Insurance Program includes a significant number of discounted and grandfathered policies, which effectively creates a program of subsidized insurance coverage for Americans to live at the coast, and an explicit cross-subsidy from inland to coastal areas encourages more development in coastal regions. In addition, the Stafford Act, which is designed to provide federal relief following disasters, requires that the disasters occur *before* mitigation monies can be approved. The Federal Emergency Management Agency’s recent focus on pre-disaster mitigation emphasizes that the 4x or 6x return on mitigation dollars is a compelling argument for greater up-front investment in mitigation before disaster occurs. At the local level, policies need to evolve to drive greater enforcement of building codes and more risk-based assessment of land use policies to ensure safe and sustainable economic development. In addition, current funding mechanisms often stop at state and/or local borders; more regional planning should be encouraged to optimize infrastructure investments. Finally, the economic incentives of the real estate industry, construction industry, and local chambers of commerce are often not aligned with risk-informed policies and practices; public awareness of hazards and resilient design and planning may be viewed as ‘bad for business’ in the eyes of these stakeholders. Since these entities are frequently engaged at the public ‘point of sale,’ we need more incentives to drive awareness of risk mitigation.”

2) **Douglas M. Poutasse**, executive vice president and head of strategy and research, Bentall Kennedy (US) LP

Bentall Kennedy is one of the largest global real estate investment advisors and a leading provider of real estate development and property management services in North America.

“We believe the risk is serious and has the potential to materially impact commercial property values in certain coastal areas within a foreseeable time frame. We are currently monitoring the risks in our analysis of new opportunities in potentially affected areas and plan to introduce more rigorous analysis as better projections become available.

“[There is a] lack of reliable forecasts of when sea level rise will impact specific locations and/or access those locations. A vague concern can be used to decline to invest, but reliable estimates of specific timing and degree of impairment are necessary to fully incorporate into investment underwriting.

“I draw an analogy to properties erected on leasehold land: in the United States ground leases have historically been for 99 years, compared to much longer periods in the United Kingdom and parts of Western Europe (where they are also more common). Usual practice holds that the economic value of the leasehold improvements (the building(s)) is not materially impacted until the remaining term is less than 50 years, with some investors even willing to only make moderate adjustments for leaseholds with 40 years remaining. But once you get inside 40 years, the value of the leasehold usually begins to decline markedly unless there is a contractual right to an extension, as the ‘zero value’ point is within the investment horizon. I would assume that sea level risk would be viewed by investors in a similar fashion. There is no magic to 40 or 50 years; different investors have different risk tolerances, but it is somewhere in that range.

“The previous response addresses the initial ‘trigger,’ but once the properties enter the ‘decline’ phase, the behavior of owners changes. They invest less new capital in maintaining and improving their properties, because the shortened time frame to receive a return on additional investment necessitates a higher rate of return. This becomes a self-reinforcing mechanism, as properties with lower reinvestment become less attractive to tenants and occupants, further weakening their competitive position and lowering their value.

“Flood insurance creates risky behavior when it is extended to new development. Zoning regulations should be considering the 100-year outlook for the land, including the future cost of providing access and infrastructure to the land, incenting construction in areas without sea level rise risk and ‘charging’ areas with it to cover the future public costs of mitigating those risks. Building owners are already taking measures to protect their building infrastructures from storm surge, incented by tenant

requirements for continuous operation, but those are a band-aid that will only postpone the inevitable if the building is going to be subject to routine flooding within 50 years.”

3) **Michael D. Berman**, Michael Berman Consulting

Michael Berman, a resident of Miami Beach and Boston, was a senior advisor for housing finance for Department of Housing and Human Development Cabinet Secretary Shaun Donovan at the time that he chaired the Hurricane Sandy Task Force. Berman is a member of the Rockefeller 100 Resilient Cities working group and sits on the board of Enterprise Community Partners, where his work focuses on the intersection of affordable housing and flood risk.

“My focus is on coastal population concentrations—my top five cities include New Orleans, New York City/Rockaways, Annapolis/Baltimore, Miami/Miami Beach, and Norfolk (especially important in light of the naval base).

“Education—so few people are focused on this issue in an insightful way. That is likely a function of many factors, including lack of information/focus and fear of facing the reality of future conditions. Short-term thinking and a simple view of the world tends to prevail in our culture, including our business and political cultures—climate change is long term and complex. If the risks were presented as more immediate and more simple along with a range of potential solutions, it might be easier for decisionmakers to engage in the issues. Denial is partly a function of fear as well as ignorance.

”Along with more frequent major storm events, key tipping points will include (a) substantial increases in flood insurance premiums over the next five to 10 years as we move to risk-based pricing (which the National Flood Insurance Program is targeting for 2019-2020 and which the private markets already do); (b) denial of 30-year mortgages in some areas in say 15 to 20 years; and (c) significant infrastructure projects over the next five to 10 years which impact real estate taxes as well as perceptions (for example, the sea wall in lower Manhattan; septic systems in Miami-Dade County).

“The November 2017 report by Moody’s is the beginning of increased focus by the rating agencies on municipal bonds. At some point, that Wall Street focus may also incorporate looking at concentrations in mortgage pools of loans collateralized by mortgages in flood prone areas—even if those loans are backed by Ginnie Mae (Government National Mortgage Association - GNMA) or the government-sponsored enterprises (GSEs), flood risk will impact prepayment velocity, which impacts bond pricing.

“The policy world is responding very slowly to these risks. Some exceptions include New Orleans, New York City, and Miami Beach, but generally policymakers have been slow to act. The Rockefeller 100 Resilient Cities program is helping to focus policymakers, but this is just beginning to get traction in most U.S. cities that are part of the 100 Resilient Cities. The National Flood Insurance Program is working on a new risk rating system for insurance premiums, and when this is launched in the next two years, it is likely to be a wake-up call. The fact is that our policymakers are slow to be educated and slower to act. All we need to do is to compare the way the state of Florida responded to Hurricane Andrew (1992) with a hardening of the building code for the entire state to address wind risk, to the relative lack of any substantial efforts regarding flood risk. We even have a governor who refused to acknowledge climate change—that might be acceptable if he addressed increased flood risk in the state, but that is not the case. Most zoning and building codes have either not changed at all or have addressed only new construction building elevation—a small step. The National Flood Insurance Program made a bold step toward risk-based pricing in 2012 with Biggert-Waters and then quickly retreated. Now the effort is being renewed. Compare this to the way in which seismic risk in California has been addressed over the decades. There is almost nothing being done by policymakers in many vulnerable parts of the United States in the flood risk arena.”

4) **Andrew Teras**, vice president and senior analyst, Breckinridge Capital Advisors

Breckinridge Capital Advisors is a Boston-based, independently owned investment advisor specializing in investment-grade fixed-income portfolio management.

“Sea level rise is a serious issue that could have direct implications for municipal credit ratings, which may in turn affect the value of some municipal bonds. Also, if the tax base contracts substantially, that could weaken the ability of municipalities to pay back bond investors.

“As an investment manager, one of the biggest challenges is the disconnect between time horizons for investments in bonds—sometimes they can be as short as three to five years—and the time frame for significant tipping points when, say, 50 to 70 percent of a city’s tax base is at risk of flooding.”

5) **Cynthia L. McHale**, director, Ceres

Ceres is a sustainability nonprofit working with influential investors and companies to drive sustainable solutions throughout the economy.

“While sea level rise is a major risk to coastal communities, the timeframe for this risk to become ‘known’ and factored into coastal real estate markets, property taxes, and credit rating for mortgages is the bigger question. Certainly, this will also vary depending on the local area, both in terms of its geographic characteristics as well as the political landscape. There are many reasons why local communities, developers, realtors, property owners, banks—really all aspects of the real estate market—are ignoring the risk of a serious drop in property values due to sea level rise. There’s a lot of money at stake, and local/national economies will be impacted.

“[Credit rating agencies] only look out a maximum of five years in terms of their credit ratings, and there are significant uncertainties related to the timing, severity, nature, and impact of climate change risks, including sea level rise. I do think that the leading credit rating agencies such as Moody’s are taking climate change risks more and more seriously—see Moody’s report from March 2018 (Moody’s 2018).

“I think there most certainly will be key tipping points that will drive changes in coastal markets. Likely triggers will include (a) severe weather events such as hurricanes; (b) more frequent flooding/chronic flooding; and (c) key market actor(s) that begin to price the risk of sea level rise to coastal properties, for example, retail banks that sell mortgages, prospective coastal property buyers, etc. Private residential insurance excludes flood risk, so this reduces the risk for insurance companies (although they are still on the hook for flood losses to autos). However, the National Flood Insurance Program will continue to run in the red—so both the federal government and local property owners will carry more and more of the losses from flooding-related damages.

“Markets seem to unfold in fits and starts—and I do worry (along with many others) that the situation will worsen a lot because adequate action is not being taken. As risks increase, insurers will pull out of markets, limit coverages/increase deductibles/raise rates. Coastal real estate will lose value, local markets will become soft, and some homeowners/businesses will declare bankruptcy and/or walk away from property. And when significant volumes of property value decline and mortgage delinquencies increase, there are major ramifications for our entire financial system as we experienced in the 2008 financial collapse caused by the mortgage-market meltdown.

“I’m aware of a number of state and local actions that are being taken to, ultimately, increase resilience to growing coastal flooding risks. Their stage of development/implementation, comprehensiveness, feasibility, and effectiveness all need to be evaluated. The concern I always have is that, ultimately, only some portions of the vast US coastline will be protected: major

urban areas. Many, many other portions of the coast, along with their respective people and livelihoods, will remain in harms' way.”

6) **Anne Canfield**, executive director, Consumer Mortgage Coalition

The Consumer Mortgage Coalition is a trade association of national mortgage lenders, servicers, and service providers, organized as a research and policy development organization.

“The rise in sea levels is an issue that is just beginning to be of concern and understood by consumers who live in the affected areas and the lenders, guarantors, and investors who finance their mortgages. Having a better and broader understanding of the threat is the first step in meeting the challenges posed by rising sea levels. Once the risk levels are understood, consumers and communities can work together to implement sensible land development and mitigation policies to address their unique situations. As an example, some communities might be able to mitigate risk by building a sea wall, but these types of mitigation measures will not work in other places, such as South Florida, where they have a porous substrate.

“Lenders, guarantors, and investors can also play a helpful role in working with communities and property owners to develop and implement comprehensive plans and solutions to help communities and property owners avoid and mitigate risk.

“UCS is serving an important role in better-informing property owners and communities about the risks they are facing. We look forward to continuing to work with you and other stakeholders to both raise awareness of the risks and implement common-sense solutions to avoid or mitigate those risks.”

7) **Laurie Schoeman**, national program director for resilience initiatives, Enterprise Community Partners

Enterprise improves communities and people’s lives by making well-designed homes affordable. It brings together nationwide knowledge, partners, policy leadership, and investment to multiply the impact of local affordable housing development.

“[The risk of sea level rise to coastal communities (and real estate market, tax base, etc.) is] extremely serious. Projections of even one or two inches could mean increase in coastal surge during storm events and increase in water table which will lead to interior flooding in basements. We have seen this occurring more and more throughout New York City, where increasing tidal inundation is impacting sewers and underground pipelines, causing flooding to occur in buildings.

“We are always paying attention to how changing climate and climate risks impact our partners and our coastlines.

“[The challenge to incorporating climate risks like sea level rise in coastal development is] substantiating the importance of including climate risk in the design and development model of a residential facility—both new construction and retrofit. Developers build to current code and regulation, and anything outside of that needs to have clear justification for including in the project. For example, in the case of incorporating mitigation for climate risks in a building project, fire mitigation and seismic seem to be the most rigorously regulated and enforced climate-related risks in the building industry (you can’t get a Certificate of Final Occupancy or even permit if you don’t comply with standards). Flooding and other climate-related risks (heat, high precipitation) are not as closely inspected but are extremely detrimental to the short- and long-term health and safety of the building.

“Identifying funding for the improvements [to buildings and to increase flood resilience is needed]. There are a variety funding sources available for energy efficiency but not for mitigation and adaptation. We need to start identifying ways of financing this work.

“More frequent and intense storms are a major driver for cultivating an awareness around the importance of incorporating climate mitigation in projects. This is the most important factor. Followed by the insurance industry shifting its calculation of risk and the federal administration moving toward privatization of flood insurance.”

8) **John Miller**, PE, CFM, CSM, MS, water resources engineer, University of Pennsylvania

John Miller is a water resources engineer with a background in flood policy and climate adaptation at the federal level. He is also active locally, having founded the New Jersey Association for Floodplain Management and served on the Lambertville, New Jersey, Planning Board and Emergency Management Council.

“[A few challenges I see to credit rating agencies] include the newness of the issue and the granularity of data for them to use.

“[With the inevitable impacts from rising seas] I believe that we will see credit downgrades sooner than later. Property values will be impacted as chronic flooding increasingly manifests. Reinsurers will be wary ahead of exposure in coastal areas.

“The federal response to disasters is a major influence in inhibiting more progress in resiliency. It is similar to getting insurance without paying a premium and taking adaptation steps. If there were incentives and pre-disaster mitigation, locals would be forced to do more.”

9) **Philip K. Stoddard**, PhD, mayor, South Miami, Florida

Mayor Philip Stoddard is currently serving his fourth term. In 2015 Mayor Stoddard was appointed by the White House to the Governance Coordinating Committee of the National Ocean Council, where he developed national policy for sea level rise. He has also been a professor of biology at Florida International University since 1992.

“[When it comes to the risk sea level rise presents to communities] there is no risk, it’s a guaranteed total loss. The only uncertainty is the timeline.

“The state just raised the minimum base elevations in the Florida building code, and South Miami is putting adaptation action areas into our comprehensive plan right now.

“Our first infrastructure challenge is going to be loss of septic tank function. Installing municipal sewer systems after a neighborhood is built out is very expensive. We are looking at the costs and cringing. Nobody is going to help, not the feds, not the state, not the county. So, cost is the biggest barrier.

“Rising insurance costs and loss of 30-year mortgages are the two inevitable tipping points. A big hurricane or storm flood could also do it.

[As chronic inundation worsens in more and more communities, some of the changes we’ll start to see in coastal communities are] on the small scale, personal stories such as we see in Norfolk, Virginia, where people still owe money on their mortgages, their flooding houses are worthless, and they cannot afford flood insurance. Moody’s is planning downgrades in coastal cities, which will make the cost of infrastructure bonding higher. The combination will intensify the squeeze on our local tax bases, at which point the only viable economic strategy is for people to bail out and for planners to retract to high ground. This process just began in St. Augustine, when the City had to tell residents of the soggy western areas that normal municipal services could no longer be provided.

“The federal government has become its own disaster area, so we have to assume we are on our own for the time being. At the local level, coastal communities must no longer allow construction that cannot accommodate sea level rise. That’s our best hedge against market forces taking us out.”

10) Kurt Forsgren, managing director, infrastructure sector lead, S&P Global Ratings

Standard & Poor's (S&P) Global Ratings issues credit ratings for the debt of public and private companies, and other public borrowers such as governments and governmental entities and provides research and analysis in credit ratings to drive growth and transparency.

“We believe this will be an emerging area of risk over time, both as the frequency and severity of extreme weather events rise and as currently inhabited property and land parcels are exposed to flooding/tides. We also have observed growing recognition of these risks by many debt issuers, though there is not standard disclosure around these risks. We are currently exploring how best to evaluate available data to uniformly and consistently evaluate long-term risks associated with this particular risk relative to credit ratings of issuers directly impacted by climate change.

“S&P Global Ratings see the uniform and transparent disclosure by governments of the potential effects of gradual environmental change and extreme weather events as both an important input into our assessment of management’s ability to respond to the risks and one of the largest challenges to the market. Beyond disclosure and complicating it are the difficulties in quantifying/modelling the financial impact of sea level rises due to uncertainties of:

- future climate policies
- specific and more precise local sea level increases given future carbon emission trajectory
- future exposure growth (i.e., new developments and how climate resilient they are built)
- future adaptation measures (sea barrier, nature-based solutions, etc.)

“While aligning the interests and time horizons of land owners, regulators, market participants, and others is challenging, our focus is on credit risks to entities that we evaluate. We have commented on the availability of federal disaster relief and role of insurance—including to what extent policymakers confront the moral hazards of the National Flood Insurance Program—as factors that, while helping to improve the economic resilience of high-risk areas, do not give an accurate price signal about the vulnerability of some areas. If policymakers confront the National Flood Insurance Program’s moral hazards and reduce the scope of coverage it provides, or increase premiums in line with the underlying risk, development or redevelopment of coastal lands might be constrained as they become uninsurable. Then, when confronted with the full costs, people will be economically discouraged from doing so. Finally, while unfortunate, changing consumer, regulatory, and market behaviors often take a major natural catastrophe.

“Beyond the National Flood Insurance Program, the cost of insurance could substantially increase or insurance coverage may be withdrawn as the risks become uninsurable. Thus, the availability of insurance and its cost may impact real estate prices.

“As with other broadly applicable, long-term credit issues with near-term implications (for instance, pension and other post-employment benefits), we believe that investors and other marketplace participants benefit from a clear understanding of the climate-related factors we consider material for municipal issuers and of how we assess the risk management. S&P Global Ratings is a strong proponent of increased disclosure and transparency related to climate risk exposure and acknowledges that it is a topic with evolving industry-reporting standards. In our view, long-term investment into resilient infrastructure will be a function of a clear quantification of their relative costs and benefits, and the application of economic incentives that aligns the incentives of actors.”

11) **Carolyn Kousky**, director for policy research and engagement, Wharton Risk Management and Decision Processes Center, University of Pennsylvania

The Wharton Risk Management and Decision Processes Center works to advance the practical understanding of how to manage situations of risk involving health, safety, and the environment in both the private and public sectors.

“Yes, the impacts and timing of sea level rise will vary across communities; we are already starting to see effects. An increase in coastal flooding and other related challenges, such as saltwater intrusion, will likely be the first threat. There are already multiple locations that are seeing recurrent shallow flood events.

“There is no uniform way to communicate future risk conditions, nor consensus on the time frame to consider in communication, or which model results/scenarios should form the basis of any outreach. All the information out there is not integrated into the platforms people use for the decisions, such as websites where people look for new homes or contractors.

“There may be some threshold level of flood risk that tips systems from livable to perceived as too risky, and at that time this will drive changes in behavior.

“I think it will be incredibly challenging to put the full costs of increasing risks on local communities or households; therefore, the federal government and taxpayers will continue to bear many of these costs.

“The National Flood Insurance Program allows policyholders to ‘grandfather’ their lower rates when a new map shows they are at higher risk. Not only will this become increasingly unsustainable financially for the program, but it mutes an important risk signal.”

Additional Insights from Publicly Available Reports

We also consulted publicly available reports from market experts, three of which we cite below with key quotes.

1) **Sean Beckett**, chief economist, Freddie Mac

Freddie Mac operates in the secondary mortgage market to keep mortgage capital flowing by purchasing mortgage loans from lenders so they in turn can provide more loans to qualified borrowers. Freddie Mac’s mission is to provide liquidity, stability, and affordability to the US housing market in all economic conditions extending to all communities from coast to coast.

Excerpts from *Life’s a Beach* (Beckett 2016):

“Even with significant and coordinated global action like that outlined at the Paris climate conference, some of the projected impacts of climate change appear to be unavoidable. Governments and private organizations are working on plans to mitigate impacts where possible and to adapt to changes that are inevitable. Many are taking notes from the experience of the Netherlands, which has prospered for centuries despite lying below sea level.

“However, the dikes and sea walls used by the Dutch may not solve the problems of South Florida. Florida sits on a substrate of porous limestone that holds Florida’s supply of fresh water. As the sea level rises, it infiltrates the limestone underground and contaminates the freshwater supply. A sea wall might stop storm water surges on the surface, but it can’t prevent the underground incursion of salt water.

“While technical solutions may stave off some of the worst effects of climate change, rising sea levels and spreading flood plains nonetheless appear likely to destroy billions of dollars in property and to displace millions of people. The economic losses and social disruption may happen gradually, but they are likely to be greater in total than those experienced in the housing crisis and Great Recession. That recent experience illustrated the difficulty of allocating losses between homeowners, lenders, servicers, insurers, investors, and taxpayers in general. The delays in resolving these differences at times exacerbated the losses. Similar challenges will face the nation in dealing with the impact of climate change.”

“Some thorny issues to ponder:

- The government-supported [National Flood Insurance Program] currently incorporates a subsidy for homeowners. Suggestions to raise premiums to reduce or eliminate the subsidy so far have met with resistance from homeowners in Special Flood Hazard Areas (SFHAs). However, taxpayers may balk at covering escalating losses as sea levels rise in light of the predictability of the losses. Taxpayers may feel that the affected homeowners ignored decades-long warnings of the risks they were bearing.
- A large share of homeowners' wealth is locked up in their equity in their homes. If those homes become uninsurable and unmarketable, the values of the homes will plummet, perhaps to zero. Unlike the recent experience, homeowners will have no expectation that the values of their homes will ever recover.
- In the housing crisis, a significant share of borrowers continued to make their mortgage payments even though the values of their homes were less than the balances of their mortgages. It is less likely that borrowers will continue to make mortgage payments if their homes are literally underwater. As a result, lenders, servicers, and mortgage insurers are likely to suffer large losses.
- Some homeowners outside the impacted areas will nonetheless suffer losses as businesses are forced to relocate, taking employment opportunities with them. Companies that sell services to these relocating businesses also will suffer losses.
- Additionally, the effects on homeowners not in the impacted areas, but are nearby, will be complicated by the fact that there may be increased demand for their homes.
- Non-economic losses may be substantial as some communities disappear or unravel. Social unrest may increase in the affected areas.”

2) Moody's Investors Service

Moody's Investors Service provides credit ratings and research covering debt instruments and securities.

Excerpts from *Evaluating the Impact of Climate Change on US State and Local Issuers* (Moody's 2017):

“Global climate change is forecast to increase the US' exposure and vulnerability to a range of factors such as severe heat, changes in precipitation patterns, and rising sea levels. The primary quantifiable impacts are damage to coastal property as a result of floods and rising sea levels, changes in agricultural production, lower labor productivity, health impacts, and increased energy use. Changes in environmental policy and adaptive mitigation strategies will likely reduce these costs.

“Credit risks resulting from climate change are embedded in our existing approach to analyzing the key credit factors in our methodologies. Our analysis of economic strength and diversity, which signals the speed with which an economy may recover, captures climate-driven credit risks such as economic disruption, physical damage, health and public safety, and population displacement. Fiscal strength, access to liquidity, and levers to raise additional revenue are also key to our assessment of climate risks as is evaluating asset management and governance. This provides the basis for our view of states' credit resiliency to climate change and is the framework for evaluating the credit risk to local government issuers.

“Local, state, and federal tools for both immediate response and long-term recovery enhance resilience to the physical and economic impact of extreme weather events. US municipal issuers benefit from local, state, and federal processes to help areas affected by climate shock manage the immediate physical impacts of extreme weather. Issuers also benefit from a variety of resources to expedite the long-term recovery of their economic base.”

3) **Krishna Rao**, senior director, Analytics at Zillow

Launched in 2006, Zillow is an online real estate and rental marketplace providing consumers with data and knowledge.

Excerpts from *Climate Change and Housing: Will a Rising Tide Sink All Homes?* (Rao 2017):

“If sea levels rise as much as climate scientists predict by the year 2100, almost 300 US cities would lose at least half their homes, and 36 US cities would be completely lost.

“One in eight Florida homes would be under water, accounting for nearly half of the lost housing value nationwide.

“Nationwide, almost 1.9 million homes (or roughly 2 percent of all US homes)—worth a combined \$882 billion—are at risk of being underwater by 2100. And in some states, the fraction of properties at risk of being underwater is alarmingly high. More than one in eight properties in Florida are in an area expected to be underwater if sea levels rise by six feet, representing more than \$400 billion dollars in current housing value. In Hawaii, almost one in 10 homes are at risk.”

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