CoreLogic®

A Recipe for *(Avoiding)* Disaster

PART III:
Understanding How Physical Climate Risk Affects Traditional Risk Pathways

Contents

Introduction

This white paper is the third, and final, in a series focused on reliably assessing physical climate-related financial risks (physical climate risks). The first paper – Part I: Establishing Best Practices for the Assessment of Physical Peril Risk Models – addresses both the individual components and overall structure of a reliable peril risk model, highlighting eight best practices that provide credibility and instill trust in the model's outputs. The second paper – Part II: Constructing Climate-Coupled Catastrophe Models – provides a reliable approach to coupling peril risk models and climate models for future policymaking, resiliency measures, and risk management purposes.

In closing out the series, this paper explains how physical climate risks are manifesting for municipalities, state governments, and financial institutions via the more traditionally understood financial risk pathways of credit risk, liquidity risk, and market risk. It then provides examples of how physical climate risk data & analytics can be used to identify and quantify these risks, before outlining potential solutions to address them. Finally, it touches on the role of financial system regulators in minimizing physical climate risks, especially those affecting vulnerable communities.

For further insights into physical climate risk models, data, and analytics, visit CoreLogic Hazard HQ Command Central.

Municipalities

Climate change is a global phenomenon with effects that are felt on a local level. As a result, municipalities and county-level governments have become the front line for combating physical climate risks through a variety of initiatives including mitigation projects, re-zoning efforts, and building code reform, which are necessary to combat the detrimental effects that climate change has on a municipality's budget, resources, and — most importantly — its citizens.

Credit Risk

Municipalities accumulate credit risk through the issuance of municipal bonds, securities, and other financial vehicles that act as funding mechanisms for local infrastructure projects, including housing developments, transportation systems, and communications networks. Traditionally, this credit risk is managed through local revenue streams that can raise enough funds to pay for the initial bond offering, including taxes (e.g., general obligation bonds) or revenues from a specific project or source (e.g., revenue bonds). However, "as extreme storms and other climate change impacts become more frequent and more intense, state and local governments are facing mounting infrastructure-related mitigation, adaption, and resiliency planning costs."[1]

These higher costs, in turn, have affected the way in which credit ratings agencies and Wall Street investors price municipal bonds, leading to devaluations that make it more expensive for local governments to raise the capital needed to fund infrastructure projects — including the very mitigation actions that could decrease future physical climate risks and improve the overall financial health of these municipalities.

Liquidity Risk

Liquidity risks arise from a municipality's inability (whether real or perceived) to meet its cash and contractual obligations without incurring unacceptable losses.[2] These risks can manifest in the aftermath of climate-driven natural hazard events which can lead to unanticipated emergency response costs, infrastructure repair costs, loss of revenue, and increased costs of adaptive strategies.[3] Liquidity concerns can further exacerbate the credit risks identified above, as "the municipal securities market is characterized by relatively low liquidity" and a lack of transparency, which lead to "high overall levels of markups and other transaction costs" as market participants develop alternative means to value municipal bonds.[4]

Additionally, municipalities are largely dependent on property tax collections to fund their operations—according to the Tax Foundation, property taxes were responsible for 72.2 percent of local tax revenue in fiscal year 2020.[5] When property damage occurs due to a natural disaster, the overall value of the property decreases, which leads to lower property tax revenues for the local government.[6] This loss in revenue can be further exacerbated as some property owners move out of the area due to increased physical climate risks. Couple this with post-disaster business interruptions that reduce sales tax revenue, and municipalities are left with less revenue overall, leading to lower liquidity levels and increased exposure to future natural hazards.[7]

Market Risk

Market risk encompasses the risk of financial loss resulting from movements in market prices.[8] This type of risk tends to have a disproportionate effect on municipalities, as they often have less flexibility and fewer resources to respond to significant market shifts. Historically, assessments of market risk have focused on issues such as interest rate changes, commodity price variations, impacts to Gross Domestic Product (GDP) growth, unemployment levels, exchange rate fluctuations, and the dynamic prices of stock investments, all of which are influenced by a changing climate.

The effects of climate-related market risk on municipalities are perhaps best summarized by Albany Law School Professor Christine Sgarlata Chung: "A local government does not have the same tools as an insurance provider at its disposal. For practical and often legal reasons (such as restraints on levy power, limits on indebtedness, political consequences of tax increases), a local government cannot easily increase "premiums" (property tax, sales tax, use fees) in response to climate risk, nor can it provide infrastructure or services to some residents but not others based on climate risk assessment. Local governments also are not free to exit the market for infrastructure or municipal services. They are obligated to provide at least basic infrastructure and health and safety services for all residents at all times, and, as noted above, they cannot just exit the market because risks are increasing, or costs are high."[9]

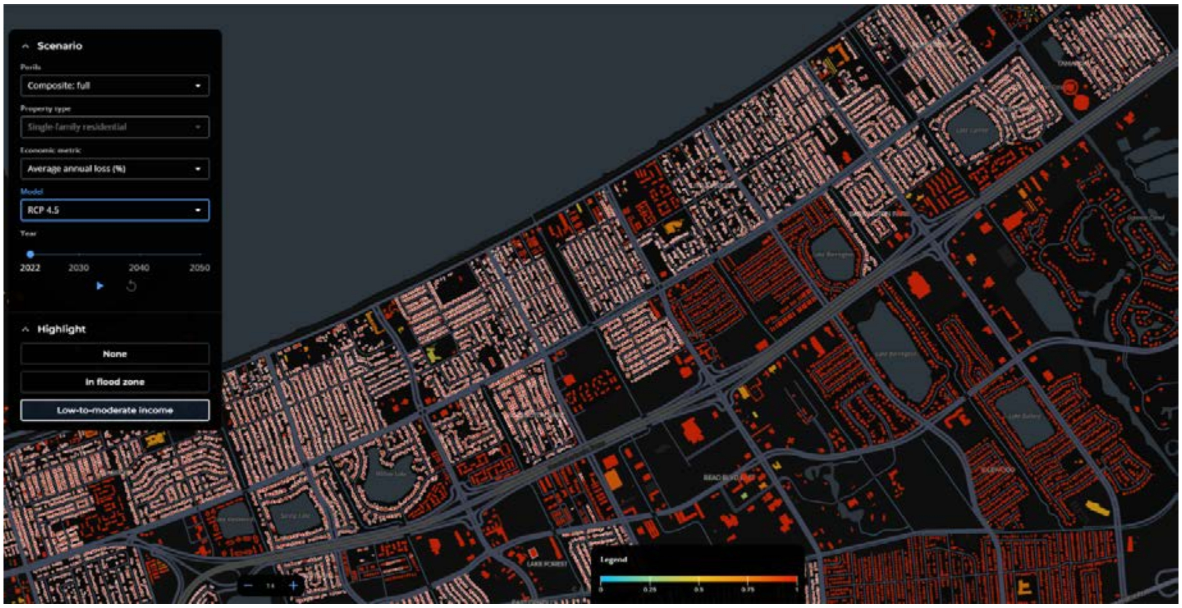
Application of Data & Analytics

Given these circumstances, municipalities need to be able to identify and prioritize projects that mitigate the effects of future physical climate risks and protect their overall financial health and well-being. Thankfully, "the rapidly growing field of climate analytics can help local governments adopt a more proactive approach by identifying risks, developing climate action plans, and implementing strategies that limit the harms of both chronic and acute climate stresses".[10] Through the use of a reliable climate-coupled catastrophe model™, local and county governments can identify potential physical climate risks to both their current built environment and their planned infrastructure projects from future private housing developments to new public-use buildings like schools and courthouses.

Below is an example that shows the risk profile of an individual property in Fort Lauderdale, Florida, nearly quadrupling over time (see bottom-right graph), with hurricane wind being the highest contributing factor. In terms of financial implications, the Average Annual Loss (AAL) for this property nearly triples in the next 30 years, meaning it is likely to suffer increasing losses from natural hazard events.

Individual Property Risk Profile

The ability to measure physical climate risks at the property level allows for further insights into potential correlations at the community level, providing local decision-makers with the ability to identify those properties most at-risk to the physical effects of climate change. The example below depicts a census tract within the Seabrook & Little Woods neighborhoods of New Orleans — a low-to-moderate (LMI) income community where the majority of residents are African American [11],[12] — which faces higher physical climate risks compared to nearby, predominately white neighborhoods. In this image, LMI homes are highlighted with white boundaries and make up the majority of the homes in this high-risk area.



Identification of LMI Households in a High-Risk Community

Translating into Solutions

Once these physical climate risks have been identified at both an individual property level and community level, municipalities can begin to prioritize public works projects and infrastructure initiatives that are not only resilient to future climate scenarios but also provide the most benefit to their citizens, specifically those living in vulnerable communities. This prioritization needs to be incorporated into all local government activities and functions, including land-use planning, transportation systems, emergency services, mitigation efforts, resilience and adaptation plans, risk communication, and bond disclosures, among others.

Land-use Planning – Knowing where to build is crucial to decreasing risk. Understanding physical climate risks at an individual property level allows local officials to plan, site, and construct new public infrastructure using energy-efficient, green building approaches such as upgraded stormwater systems, green roofs, and passive survivability techniques, all of which can reduce future levels of physical climate risks.[13] When planning local infrastructure projects—whether a public school, new hospital system, or private housing development—forward-looking physical climate risk assessments must be incorporated into every step of the planning process.

Transportation Networks – While many transportation projects are funded through discretionary grant programs and funding grant programs administered by the federal government, the planning and execution of those projects is often handled at the local level. Constructing roads, bridges, and railways that meet fortified resiliency standards can mitigate the effects of future hazard events and ensure that homeowners have access to resources in the aftermath of a disaster.

Emergency Services – When disaster strikes, homeowners often rely on emergency services—fire and rescue, law enforcement, medical service providers, etc.—to get back on their feet. These services are operated at the local level, and it is critical that they are accessible to citizens in the immediate aftermath of a natural hazard event. As the climate continues to change, forward-looking risk assessments need to be incorporated into all aspects of emergency services planning.

Risk Communication – As repeated studies have shown, Americans tend to trust their local government much more than they trust the federal government, at least when it comes to solving local problems.[14] Accordingly, local governments are in a better position to effectively communicate mitigation and adaptation strategies with their constituents in order to decrease physical climate risks at both the household and community level. This can come in the form of active face-to-face communication via mitigation events such as community cutting/thinning projects, landscape clean-up days, slash hauling, or 'woodchipper days'; or second-hand passive communication via brochures, news releases, or websites that direct community members to climate adaptation and mitigation resources.[15]

Adaptation & Resiliency Efforts – Local governments also play a vital role in hardening the built environment to withstand physical climate risks. Using the property-level insights described above, local officials can identify the most vulnerable areas within their current built environment and plan adaptation & resiliency projects that can proactively decrease physical climate risks in those areas, from knowing which homes may need to be elevated to avoid future flooding to identifying where to clear out combustibles to prevent the spread of wildfires. Municipalities should ensure that these structure-specific priorities are included in all forward-looking adaptation plans, structure and infrastructure projects, planning & zoning initiatives, floodplain protection efforts, and property acquisitions or relocations.[16]

Enhanced Disclosures – Future public works projects funded via municipal bonds, securities, or other financial vehicles must include forward-looking physical climate risk assessments in order to ensure that the projects themselves will be resilient to rising physical climate risks. Disclosing this information during the issuance process will give additional assurance to financial backers that the project will be resilient enough to provide them with an expected return on their investment.

These actions, in turn, provide further benefits to the municipalities themselves by decreasing the credit risk of subsequent municipal bond offerings issued for new projects, ensuring adequate levels of liquidity before, during, and after a disaster, and providing for a more stable local economic market.

State Governments

No two states are the same – depending on their geographic location and general topography, each individual state is exposed to a diverse array of physical climate risks. These risks, in turn, require unique responses from each state regarding pre-disaster mitigation strategies and post-disaster recovery priorities that account for both a property-level understanding of physical climate risks, as well as an aggregate view of physical climate risks at the county, census block, core-based statistical area (CBSA), and state level.

Credit Risk

Like municipalities, state governments can issue bonds, securities, and other financial vehicles to fund infrastructure projects — including transportation systems, emergency services, and communications networks — that are paid for through subsequent tax collections or other revenue streams. Therefore, physical climate risks can affect the credit risk of state governments in much the same way that it affects the credit risk of municipalities (e.g., devaluations).

Public pension funds are another source of credit risk for state governments, with aggregate assets in state-administered defined benefit plans totaling roughly $4.44 trillion in 2022, of which 98 percent is held in long term investments — such as real estate — that could lose value due to the economic effects of climate change.[17] As noted by the Department of Labor's Employee Benefits Security Administration (EBSA): "Climate-related financial risks can affect retirement savings to the extent they may affect the downgrade and/or default risk of an issuer, a risk that currently exists in the market as rating agencies increasingly factor climate risk into their rating assessments. Credit rating downgrades affecting a pension plan's assets can cause spread widening and perhaps sales to remain in compliance with guidelines, potentially crystalizing underperformance versus a discount rate that may not directly experience these spread movements."[18] While the EBSA has certain oversight and regulatory authorities for private pension funds, state governments are responsible for establishing their own rules and regulations for managing their state's public pension plans.[19]

Liquidity Risk

In the aftermath of a natural disaster event, state governments are called upon to provide funding to rebuild critical public infrastructure — including roads, hospitals, and government buildings such as courthouses, post offices, and first responder headquarters — in a timely and efficient manner to ensure their citizens have the resources necessary to rebuild their own lives.

As natural disasters continue to increase in severity due to climate change, state governments are forced to spend more on these rebuilding efforts. While one-off events may be easily covered, the increase in frequency of these events creates liquidity pressures on state governments to provide for their citizens. These pressures can push states to dip into rainy day funds to cover disaster costs or raise premiums within their state-backed insurance plans, which an increasing number of homeowners are turning to as their 'insurer-of-last-resort' as private insurance companies continue to pull out of specific geographic markets due to increased physical climate risks.[20]

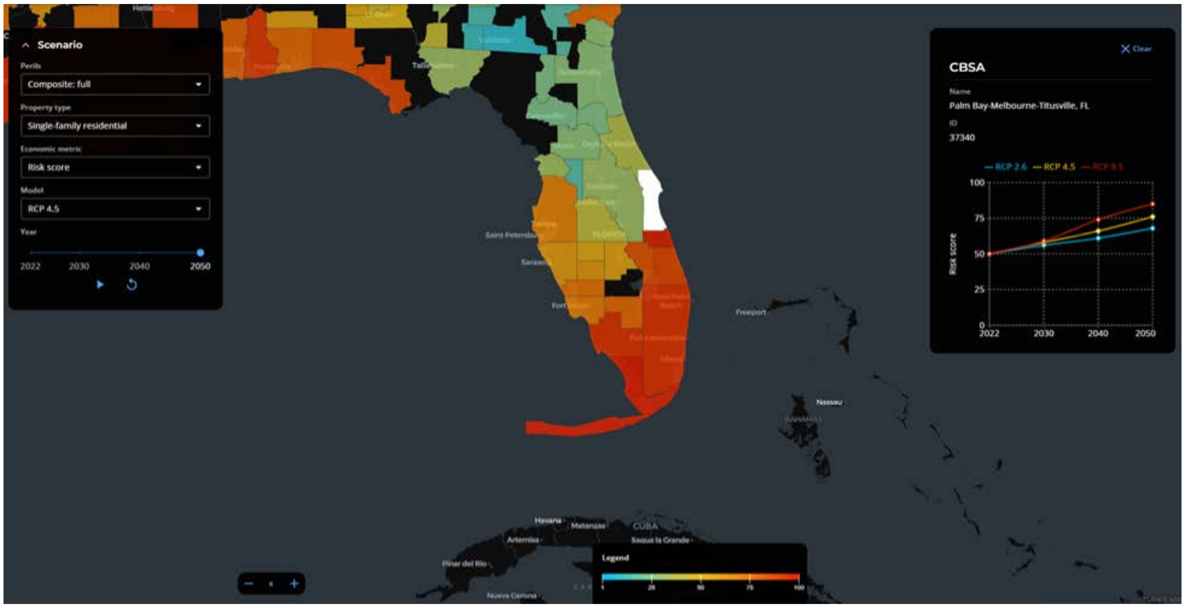
Market Risk

In addition to the credit and liquidity risks identified above, state governments are also exposed to many of the same market risks affecting municipalities, including interest rate changes, impacts to GDP growth, unemployment levels, commodity price variations, exchange rate fluctuations, and the dynamic prices of stock investments. However, these risks can be amplified for state governments due to their larger budgets and the additional responsibilities outlined above (e.g., management of pension funds).

Application of Data & Analytics

To address the affects that physical climate risks have on credit, liquidity, and market risks, state governments need the ability to conduct the property-level analyses identified in the Municipalities section above, as well as aggregate analyses at the county, census block, core-based statistical area (CBSA), and state level.

Below is an example of that aggregation at the CBSA level for the Palm Beach-Melbourne-Titusville, Florida geographic area. From an overall risk score across all perils, the risk rating increases from 50% (today) to between 85% (under RCP 8.5 — high greenhouse emissions) and 68% (under RCP 2.6 — low greenhouse emissions) in 2050. This rating can be understood through financial metrics such as AAL, which projects an increase range of 7 cents (RCP 2.5) to 17 cents (RCP 8.5) on the dollar by the year 2050.



CBSA-Level Identification of Projected Climate Risk

This projected increase in AAL has direct implications for the overall value, equity, and home insurance premiums of the properties located within this CBSA.

- As the AAL projection for an individual home increases, it exerts a downward pressure on the price of the home.[21] According to the Congressional Budget Office (CBO), "properties accounting for about 7 percent of the total value of properties with federally backed mortgages face a risk of flood damage each year in the 2020 period. Among those homes, the total expected damage over 30 years is about 14 percent of the total property value."[22]
- As home values decrease, so does the amount of equity held by those homeowners. This could prevent many from accessing home equity lines of credit (HELOCs) in the aftermath of a natural disaster or during economic downturns, when funds are needed most. It could also have drastic implications for the local and regional housing markets, as homeowners with negative equity may be unable to sell, decreasing the number of available homes and leading to a general slowdown in the market.
- Insurance providers use a number of metrics, including AAL, to set premiums for their customers and are already responding to climate change by increasing the price of their products and/or exiting high-risk geographic markets altogether.[23] By identifying high-risk areas within their state, regulators can better address current and potential insurance gaps and decrease future spending on post-disaster recovery efforts.

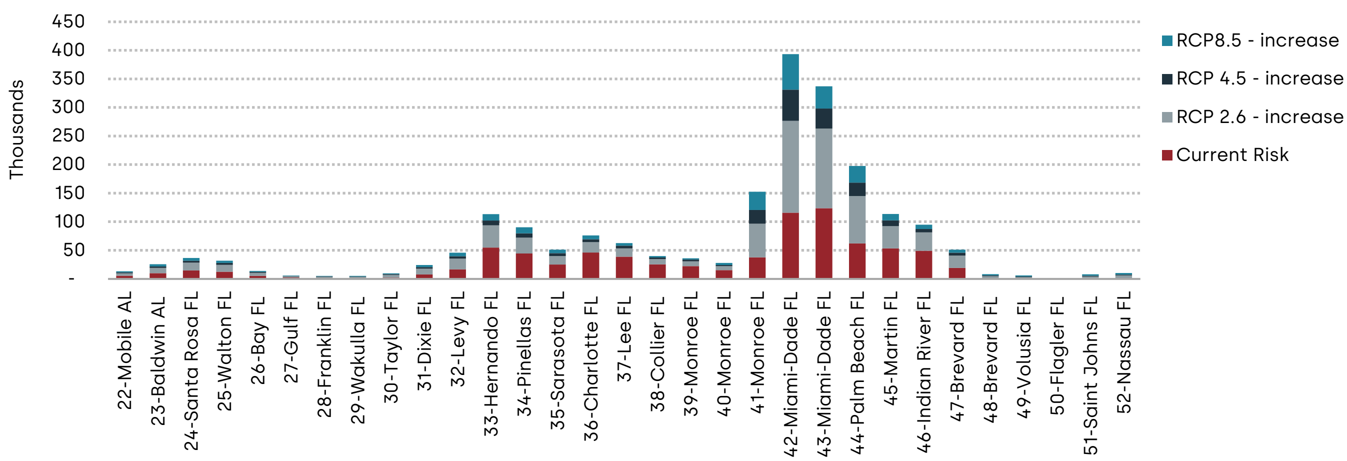
Furthermore, it is important that state governments have the ability to analyze physical climate risk data through the lens of wider demographic trends to better understand how specific populations will be affected in the future. This is especially relevant for states that have seen a recent growth in population or projected population, as more homeowners continue to move into high-risk areas.

Translating into Solutions

Once these physical climate risks have been identified, state officials can work with local governments to prioritize public works projects and infrastructure initiatives that are not only resilient to future climate scenarios but also provide the most benefit to their citizens, specifically those living in vulnerable communities. This prioritization needs to be incorporated into all state government activities and functions, including land-use planning, transportation systems, emergency services, mitigation efforts, resilience and adaptation plans, risk communication, and bond disclosures, among others.

Mitigation and Resiliency Efforts – Many federal grant programs and funding mechanisms rely upon state governments to allocate funding for hazard mitigation and resiliency efforts. For example, the Federal Emergency Management Association's (FEMA) Building Resilient Infrastructure and Communities (BRIC) program only allows eligible states, territories, and federally recognized tribal governments to submit applications for BRIC funding. Homeowners, business operators, and nonprofit organizations cannot apply directly to FEMA; they must be included as sub-applicants.[24] Thus, the role of the state government is critical in applying for, receiving, and distributing funds to high-risk communities. As part of this process, physical climate risk data & analytics can be used to compare the risk profiles of municipalities within a state to better identify those high-risk areas, as seen in the figure below.

Number of Homes Potentially Flooded by an Extreme Storm
Three climate scenarios, 2050 Time Horizon



State Funding Streams – In addition to federal funding allocations, physical climate data and analytics should be embedded within state budget processes to ensure state-level grants and funding are directed to high-risk areas. Each of the fifty states, five permanently inhabited territories, and the District of Columbia has its own emergency management office responsible for coordinating disaster response initiatives at the state level.[25] When funding these offices and their respective programs, physical climate risk data can be used to identify high-risk areas and direct funding to the communities where it is most needed.

Insurance Affordability & Availability – Insurance has been regulated at the state level for over seventy-five years as a result of the McCarron-Ferguson Act of 1945.[26] Since then, each state has developed its own regulatory system to monitor insurance affordability and availability for its citizens. As physical climate risks continue to grow, insurance providers are decreasing coverage levels or outright leaving markets in order to remain solvent. This has created nationwide insurance availability and affordability crisis, and while there is absolutely a role for the federal government to play in coordinating a response, state governments will need to shoulder the brunt of the work to ensure their citizens have access to affordable, quality insurance plans.

Pension Fund Management – As mentioned previously in this section, public pension funds represent the largest liability for state (and local) governments and can be affected by physical climate risks when their assets are hurt by physical damage to property or a certain class of investments, such as real estate, because of increases in the frequency and severity of weather disasters, or long-term environmental shifts linked to climate change.[27] State pension fund managers can proactively address these risks by ensuring investment managers can include climate scenario analyses in their economic models, which can provide state decision-makers with information about potential physical (and transition) risks to their assets and investment portfolio. Some states, such as Maryland and California, have already passed laws requiring climate analyses for their public employees' retirement funds. [28],[29]

Data Maintenance – Granular physical climate risk data can be complicated to work with, especially for local governments that lack the technical expertise, staff bandwidth, or fiscal resources to conduct their own analyses. These high up-front costs create economies of scale that are best addressed by state governments taking the lead in acquiring and managing physical climate risk data.[30] The Brookings Institutions has several policy recommendations for states to tackle this issue, including: establishing a centralized climate data office, helping local governments prepare and share complementary data (such as property records), and pooling information management funds from local governments and other regional resources.[31]

Transportation Networks – As mentioned previously in the section on Municipalities, many transportation projects are funded through discretionary grant programs and funding grant programs administered by the federal government, while the planning and execution of those projects is handled at the state and local level. State governments are often responsible for applying for those funds on behalf of their numerous municipalities by collecting sub-applications for a wide number of potential projects, then prioritizing and ranking them before submitting them to the federal government. In addition, many transportation projects involve multiple municipalities, and can even span an entire state or multiple states. State governments should lean on the databases mentioned above to embed physical climate risk assessments in all transportation project planning to ensure future infrastructure can withstand the effects of increased physical climate risks.

Emergency Services – Forty-six states and the District of Columbia have a statewide disaster account, which can be used to "cover costs incurred across state agencies, provide funding for federally required cost shares, and in some cases provide assistance for local governments."[32] Physical climate risk data & analytics should be used throughout the budget process to ensure these disaster accounts are sufficiently funded given the increased risks that many states are facing. Furthermore, many states employ insurance to protect state-owned assets from disaster losses. These states may purchase insurance from the private sector, "or they may self-insure by committing to pay for damage to state assets using state funds."[33] Regardless of the insurance mechanism, physical climate risks can leave state budgets exposed to disaster losses and must be addressed by state regulators.

Financial Institutions

Financial institutions are also exposed to the detrimental effects of physical climate risks, at both a national and regional level. As stated by the Federal Reserve, the Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC) in their joint Principles for Climate-Related Financial Risk Management for Large Financial Institutions in October 2023, "the financial sector may experience credit and market risks associated with loss of income, defaults, and changes in the values of assets, liquidity risks associated with changing demand for liquidity, operational risks associated with disruptions to infrastructure or other channels, or legal risks."[34]

Credit Risk

Financial institutions accumulate credit risk via the loans they provide to borrowers. The higher the likelihood of a borrower defaulting, the greater the credit risk associated with that loan (also referred to as 'counterparty risk'). Because physical climate risks most often manifest via material damage to the collateral underlying a loan—whether that be housing, inventory, property, equipment, or infrastructure—a financial institution's credit risk is therefore affected as soon as these physical climate risks "have a negative effect on a borrower's ability to repay and to service debt or on a bank's ability to fully recover the value of a loan in the event of default because the value of any pledged collateral or recoverable value has been reduced."[35] Credit risks can also manifest through increased insurance costs which can lead to higher deductibles or lower limits chosen by the homeowner. In both cases, hazard events become even more impactful to the borrower. These higher costs can also be passed on to the homeowner via increased insurance rates which can affect debt-to-income ratios in high-risk areas.

As natural hazards continue to increase in frequency, severity, and geographic footprint, they damage or outright destroy more and more homes every year, which directly affects financial institutions' credit risk as those homeowners are unable to make payments to lower the balance of their loan, leaving the financial institutions 'holding the bag'.

Liquidity Risk

Physical climate risks can directly affect financial institutions' loan portfolios, especially those invested heavily in sectors that are more vulnerable to effects of climate change (e.g., agriculture, tourism). These institutions can face increased defaults and losses after natural hazard events, and this reduction in assets "can result in a decrease in the bank's liquidity, making it more difficult for the bank to meet its short-term obligations."[36]

Furthermore, as the financial costs of natural disasters continue to increase, post-disaster recovery efforts become more expensive. This has increased pressure on financial institutions to not only provide additional liquidity, but to provide it quickly. "If households and corporates affected by physical climate risks need liquidity to finance recovery and other cash flow needs, they may withdraw deposits or draw on credit lines. These withdrawals could put the bank's own liquidity under pressure and lead to crystallized liquidity risks within banks."[37]

Market Risk

As our understanding of climate science continues to advance, financial institutions are beginning to incorporate physical climate risks into asset pricing. While this is a necessary step toward solving the overall climate crisis, this can also result in "downward price shocks and an increase in market volatility in traded assets" for regional, national, and international financial institutions.[38] As discussed previously, market risks can manifest in a variety of ways, including via interest rate changes, impacts to GDP growth, unemployment levels, commodity price variations, exchange rate fluctuations, and the dynamic prices of stock investments, all of which are influenced by a changing climate and affect financial institutions' books of business.

Application of Data & Analytics

Financial institutions of all sizes — whether regional, national, or international — need to incorporate property-level physical climate risk data & analytics into their risk management processes and procedures to better understand their exposure to physical climate risks. This is especially true for local and regional banks operating in defined geographic areas that are increasingly affected by natural hazards — such as the Gulf of Mexico (storm surge, hurricane wind) or the Mountain West (wildfire, hail) — as these institutions could be more likely to see a concentration of physical climate risks within their portfolios.

To incorporate this information into financial planning documents, the most reliable models will produce property-level outputs that are rooted in already-understood terminology — such as AAL, Probable Maximum Loss (PML), Loan-to-Value (LTV) ratios, etc. — which are used daily by financial industry participants who understand the correlations amongst them as well as their implications for risk management practices.

The graphic below provides a sample set of five houses across the United States, depicting an increase in AAL over the next 30 years due to physical climate risks at the three RCP levels of 2.6, 4.5 and 8.5. These examples reveal dramatic increases in expected AAL over the next 30 years, as well as an increase in the frequency and effect of certain hazards such as hurricane wind and winter storms in the shorter term (1–5 years).

Comparison of Increases in AAL Over 30 Years Amongst Sample Set of Homes

These property-level outputs can also be converted into composite risk scores, which can be used to further compare the potential financial effects of physical climate risks across a range of portfolios.

The figure below exemplifies how financial institutions can utilize physical climate risk data, analytics, models, and software tools to identify concentrations of risk. In this example, a large commercial bank engaged ten sub-servicers who were providing both performing and non-performing mortgage servicing activities on the commercial bank's behalf. For the first time, the commercial bank wanted to evaluate how physical climate risks were distributed among its sub-servicers across the portfolio of mortgage servicing rights (MSRs) for which it was responsible. As noted in the figure, six of the sub-servicers were deemed to have too heavy a concentration of physical climate risks in the MSR book they were responsible for servicing, while three servicers had a moderate concentration of risks, and only one was deemed to have an acceptable concentration of risks.

Composite Risk Score	Servicer "A"	Servicer "B"	Servicer "C"	Servicer "D"	Servicer "E"	Servicer "F"	Servicer "G"	Servicer "H"	Servicer "I"	Servicer "J"	Grand Total
1–10	16.4%	14.2%	25.3%	29.8%	12.7%	11.6%	17.4%	8.1%	8.2%	11.3%	13.1%
11–20	30.5%	14.3%	18.5%	26.9%	16.8%	14.2%	6.1%	9.4%	11.6%	17.1%	16.9%
21–30	7.6%	15.5%	8.4%	10.0%	13.9%	13.9%	16.8%	20.0%	11.3%	11.1%	13.6%
31–40	10.4%	12.5%	7.2%	8.9%	12.9%	11.2%	8.2%	6.9%	10.4%	12.2%	12.5%
41–50	9.2%	14.1%	7.9%	7.0%	12.7%	11.1%	8.8%	15.0%	12.2%	11.2%	12.5%
51–60	7.6%	7.4%	6.3%	4.6%	8.1%	8.7%	6.7%	8.8%	10.4%	8.9%	8.1%
61–70	4.8%	5.1%	7.2%	4.5%	5.7%	6.7%	9.8%	8.1%	7.9%	6.8%	5.7%
71–80	6.2%	7.0%	5.6%	4.0%	7.3%	8.5%	10.4%	8.1%	12.7%	9.2%	7.4%
81–90	4.5%	6.4%	7.7%	3.2%	6.2%	9.1%	12.5%	8.8%	9.1%	7.7%	6.4%
91–100	2.9%	3.5%	5.8%	1.2%	3.6%	4.9%	3.4%	6.9%	6.5%	4.5%	3.7%
81-100	7.40%	9.95%	13.51%	4.35%	9.83%	14.01%	15.85%	15.63%	15.55%	12.22%	10.11%
total	4,168	5,337	7,192	3,178	**83,544**	3,083	3,328	2,160	3,003	6,171	121,164

By Servicer or Portfolio | By Peril

	Hurricane Wind	Coastal Surge	Wildfire	Severe Convective Storm
	change from 50 yr to 100 year PML	change from 50 yr to 100 year PML	change from 50 yr to 100 year PML	change from 50 yr to 100 year PML
min	0.012%	0.019%	0.008%	0.038%
max	20.707%	23.611%	24.38%	21.732%
average	1.850%	2.940%	3.313%	3.441%
median	1.432%	2.481%	2.905%	3.128%
	12,046 of the 121,164 locations have the 50-100 year PML difference greater than 10%	**20,116** of the 121,164 locations have the 50-100 year PML difference greater than 10%	**26,480** of the 121,164 locations have the 50-100 year PML difference greater than 10%	**27,326** of the 121,164 locations have the 50-100 year PML difference greater than 10%

By Servicer or Portfolio | **By Peril**

Identification of Concentrations of Physical Climate Risks within Mortgage Servicing Portfolios

This level of analysis—from the property level to the portfolio level—is crucial for financial institutions looking to manage concentrations of physical climate risks, as it provides critical insights regarding uninsured loss risk, mortgage loan delinquency and default, and loss severity, including impacts to capital reserves.

Translating into Solutions

With the ability to measure physical climate risks 'from property to portfolio', financial institutions can be more proactive in addressing the effects of climate change by incorporating physical climate risk assessments into every stage of the loan process and credit risk lifecycle. Doing so can help to minimize delinquencies & defaults, uninsured losses, and general investment risks while also providing insight into capital reserve calculations, credit risk transfer opportunities, and federal regulatory materiality disclosures.

Minimize Delinquencies & Defaults – Incorporating physical climate risk data into the loan process provides financial institutions with a better understanding of the true value of the collateral underpinning their loans which, in turn, allows for more accurate AAL and PML forecasts. This helps financial institutions better predict the effects of a future disaster on borrowers' incomes and their ability to continue making payments. Financial institutions can be proactive in minimizing this risk by incorporating physical climate risk data into lender/servicer disclosures at every stage of the loan process: origination, underwriting, approval, securitization, reporting/disclosure, and general portfolio management. This data should be pulled anew any time a decision is made based upon the value of the collateral underlying the loan, the loan-to-value ratio, or the equity of the homeowner (for mortgage loans). In doing so, changes in risk levels can be more accurately tracked throughout the life of the loan, providing confidence to all participants that all potential physical climate risks have been accounted for.

Minimize Uninsured Loss – Taking the steps above also allows financial institutions to measure their potential uninsured risk and minimize their potential uninsured losses. This is done by using accurate RCVs to compare PML calculations to the current insurance coverage for the underlying collateral, and to monitor changes in AAL to ensure premiums are in line with current assessments of risk. This should be done repeatedly throughout the life of the loan to identify assets that are underinsured or may become underinsured due to increased physical climate risks, to identify potential concentrations of underinsurance in specific portfolios, and to monitor levels of counterparty risk.

Minimize Investment Risk – With varying magnitude, all financial investments are exposed to physical climate risks, which must be quantified in order to have an accurate assessment of the investments' true value. This is especially true for investments with direct real estate exposure, including both private and public real estate holdings, real estate investment trusts (REITs), mortgage-backed securities (MBSs), as well as equity and loans to funds or funds-of-funds that participate in such vehicles. Even money market funds, typically considered near-cash risk level investments, are collateralized by treasury securities, including mortgage-backed securities.[39] Additionally, insurance assets are highly affected by physical climate risks, and since insurance premiums are perceived to be steady income streams, many large pension plans and lower-risk-seeking investment assets are highly exposed to this area. Lastly, investments may also face indirect exposure to physical climate risks, particularly for financial institutions that rely heavily on income-generating physical assets. The energy and mining industries are two examples, as well as some municipal bonds that accumulate physical climate risk exposure from both the tax revenue stream and the asset itself. To address this exposure, investments and investment courses of action should be selected only after incorporating physical climate risk data across the portfolio(s) in question to understand the effects of climate change. Financial institutions may elect to diversify their portfolio of properties to better balance the types of physical climate risks that pose material financial risks to their institution.

Ensure Adequate Capital Reserves – As mentioned previously, physical climate risks can directly affect financial institutions' loan portfolios via increased defaults and reductions in asset values following natural hazard events, which, in turn, can negatively affect liquidity levels.[40] As such, financial institutions should integrate physical climate risk data into their internal risk management frameworks to ensure adequate capital reserves given potential depreciations due to climate change. This integration must occur at the individual asset-level using AAL and PML calculations that reflect forward-looking climate scenario data, such as that provided by the International Panel on Climate Change (IPCC).[41] Once integrated, financial institutions will be able to consider how physical climate risks affect the specific components of their capital framework—including the minimum ratio, capital conservation buffer, countercyclical capital buffer, global systemically important bank (GSIB) buffer, and risk-weighted assets—and use these insights to achieve specific policy objectives.[42]

Identify Credit Risk Transfer Opportunities – It is crucial for investors in both the residential and commercial MBS markets (as well as the municipal bonds market) to understand any potential physical climate risks associated with the securities they are looking to buy or sell. By integrating forward-looking climate scenarios into their internal economic assessments, financial institutions can better understand the effects that potential credit risk parameters may have on their profit and loss (P&L) estimates.[43] As the industry continues to improve its credit risk assessment capabilities, physical climate risk data & analytics will be fundamental in deciding what credit risk to hold privately and at what price.

Prepare Materiality Disclosures – As federal regulators get closer to finalizing a set of rules to enhance and standardize climate-related disclosures for investors, it is crucial that financial institutions understand what information will need to be disclosed and how they will go about attaining and confirming that information.[44] While individual institutions may differ on what qualifies as 'material' information, most would agree that physical damage to a company's headquarters or other owned properties would meet that benchmark. (After all, what can be more 'material' than the actual physical materials used to build the company?) However, knowing how to measure and disclose these material risks can still be a complicated affair, depending on the type of company and the use cases that would apply to their specific physical climate risk assessments. As such, financial institutions should proactively engage with third parties who have the ability to quantify these physical climate risks at a granular level, as noted throughout this white paper.

It is important that these solutions are not limited in focus to the profitability of the individual financial institution, as they will be critical in promoting broader societal advancements that protect vulnerable populations, prioritize post-disaster assistance, and uplift historically disadvantaged communities.

Identify Pre-Disaster Mitigation Opportunities – Financial institutions can (and should) use physical climate risk data & analytics to help protect the communities in which they operate from the physical harms that result from a changing climate. By identifying the most at-risk property-backed loans in their portfolio, institutions can better target their pre-disaster financial assistance which can help decrease property damage amounts when disaster strikes. This is especially true for communities of color, which are disproportionately affected by natural hazards, both in terms of total property damage and their ability to accumulate wealth following a disaster, which are tightly coupled issues.[45] Financial institutions can use physical climate risk data & analytics to focus on the former (informing mitigation strategies that lead to decreased property damage amounts) in order to help relieve the latter (understanding that post-disaster wealth accumulation is easier when property damage is minimal). These mitigation opportunities can take the form of financial incentives to homeowners for specific strengthening projects or energy efficiency projects, as well as increased coordination with municipalities to invest in community-level structural upgrades.

Prioritize Post-Disaster Financial Assistance – When disaster strikes, it is imperative that homeowners and families get help as soon as possible. Financial institutions can use physical climate risk data & analytics to identify which properties are most likely to be affected by a natural disaster (see Part 1 and Part 2 of this series), as well as the financial capabilities of those homeowners to recover. Doing so can drastically reduce the time between a disaster occurring and relief arriving.

Uplift Disadvantaged Communities – Financial institutions can use physical climate risk data & analytics to address potential inequities in their lending programs that are negatively affecting disadvantaged communities. For instance, low-income borrowers are less likely to live in an energy efficient home and thus less likely to qualify for green mortgages (loans that come with a lower interest rate and are designed to finance energy efficient homes).[46] As financial institutions begin to incorporate physical climate risk data into their decision-making processes, these LMI homeowners could be further excluded from less expensive financing opportunities that higher income borrowers are able to access. Financial institutions can address this issue by revising their internal fair lending and affordable housing strategies.

Federal Regulators

Given these increases in credit risk, liquidity risk, and market risk for municipalities, state governments, and financial institutions, how can federal regulators apply physical climate risk data & analytics to provide solutions that will promote the safety and soundness of our nation's economy while also protecting homeowners? In short, the focus of regulators should revolve around a handful of common themes: quantifying exposure, increasing subsidies, understanding the role of insurance, protecting the most vulnerable, and establishing industry standards that push financial institutions to do the same.

Oversee Risk Management Activities

Perhaps the most prominent role regulators can play in assessing and managing physical climate risks is through the monitoring of risk management activities of their covered institutions. This monitoring can take the form of industry regulations, general guidance, reporting requirements, or examinations of internal controls, corporate governance practices, and operations.

This begins with the ability to conduct 'climate audits' that can identify and address the credit, liquidity, and market risks discussed throughout this paper. These analyses should address a financial institution's policies, procedures, and internal controls, which should be used to provide trustworthy financial reporting, facilitate compliance with rules and regulations, and achieve efficient and effective operations.[47] Regulators should incorporate climate scenario analyses into their evaluations of potential future shocks on the resilience of financial institutions or the resilience of the financial system as a whole.[48]

The next step is to identify and implement industry standards that can limit the spread of physical climate risks within our financial system. These standards should focus on the quality of the underlying physical climate risk data (e.g., granularity requirements), the structure of the physical climate risk models (e.g., stochastic event set development), the manner in which physical climate risk data is used (e.g., aggregation capabilities), and the model verification process (e.g., backtesting capabilities & third-party validation). For example, regulators could issue guidance that outlines how physical climate risks should be incorporated into the Uniform Financial Institutions Rating System (also known as CAMELS), which is used to assess the soundness of financial institutions, as "tying a bank's CAMELS rating to [climate-related] efforts will encourage [community] banks to take climate risks more seriously."[49] In crafting new guidance or standards, financial oversight agencies should coordinate amongst themselves to enhance the sharing of physical climate risk data.

Finally, regulators can use physical climate risk data & analytics to strengthen disclosure requirements for both consumers and covered financial institutions. The Securities and Exchange Commission (SEC) has led the effort on this front, with their widely anticipated climate disclosure rules for investors expected to be released in the spring of 2024.[50] However, there are several pre-existing disclosure laws that could also be used to further incorporate physical climate risk information into our financial system and provide consumers with more clarity regarding potential risks.

This includes consumer protection reporting and disclosure mechanisms that could be leveraged to assess the role climate data plays in mortgage discrimination or used to make consumers aware of the physical climate risks to the properties they are buying or investments they are making. For example, every mortgage borrower is required to receive a loan estimate and closing disclosure via the TILA-RESPA Integrated Disclosure (TRID) rule, so it may make sense to incorporate physical climate data into that disclosure. However, we also understand the extremely complicated nature of the TRID rule and the breadth of information that is already required to be disclosed, so it may not be the best mechanism to use. Regardless, it is an example of the type of rules that should be explored as potential options to increase consumer knowledge of physical climate risks.

Identify & Address Insurance Gaps

Arguably the most important objective in undertaking scenario analyses is to identify insurance gaps — referring to the disparities between the actual insurance protection in place and the level of coverage needed to effectively mitigate risks — which are steadily growing as physical climate risks to properties continue to increase.[51](According to NOAA, homeowners, businesses, and agricultural entities were uninsured/underinsured to the tune of $57 billion in 2021, which accounted for 37% of all disaster-related costs that year. [52]) If not addressed, this increase in uninsured losses could drastically affect the global economy.[53]

There are several steps federal regulators can take — in coordination with industry participants — to address these insurance gaps, starting with an accurate assessment of projected underinsured losses from the property–level to the portfolio–level. For financial institutions to calculate their uninsured loss projections at a property level, they need (at a minimum) three critical pieces of information: the current loan balance, the amount of insurance in place for the property, and climate adjusted AAL calculations:

- **Current Loan Balance** – Also referred to as the unpaid principal balance, the current loan amount indicates the exact financial exposure of the lender, which can be used to judge whether current insurance limits are appropriate. While it may be too difficult to ingest and manage monthly updates, assessing current loan amounts on a quarterly or semi-annual basis should be sufficient for lenders.
- **Amount of Insurance** – In general, this refers to the Coverage A amount for the property, also referred to as 'dwelling coverage' or 'structure coverage' as it only covers damage to the primary structure (e.g., foundation, frame, roof). Coverage A does not cover damage to other structures on the property (e.g., detached garage,

storage shed), personal property (e.g., household contents), or loss of income due to business interruption. However, these can be covered under additional insurance policies that should also be factored into uninsured loss projections.

- **Climate-adjusted AAL** – This means that any AAL calculations for the property have incorporated physical climate risk projections. These calculations can be represented as a range depending on the specific climate scenarios used (i.e., the five Shared Socioeconomic Pathways (SSPs) created by the IPCC).[54]

Unfortunately, these calculations are difficult to conduct due to the segmented nature of this information within the industry. Regulators can play a role in bringing this information under the same roof, which would allow for reliable uninsured loss projections based on sourced data rather than best-guess assumptions. Ideally, this would involve the establishment of a public-private partnership framework to coordinate amongst financial institutions, insurance companies, physical climate risk assessors, and others.

Promote Adaptation and Resiliency Efforts

Physical climate risk data & analytics can be used to incentivize homeowners, municipalities, state governments, and financial institutions to invest in physical adaptation solutions and resiliency measures that decrease physical climate risks and allow for quicker recoveries post-disaster. For example, regulators could incentivize municipalities and state governments to integrate physical climate risk assessments into their land use planning activities. This integration should begin with an analysis of the existing built environment, identifying the individual properties and community infrastructure most likely to experience climate-affected natural hazards (particularly those that are chronically underinsured) and crafting solutions focused on those at-risk communities. These solutions can come in the form of property-specific retrofits or strengthened municipal infrastructure, or — for higher risk areas — strategies for managed retreat.

For future planning purposes, physical climate risk data can be used to provide federal incentives for investments in long-term projects that decrease risk at a property level (e.g., stronger building codes) or at a community level (e.g., improved drainage systems, wildfire buffer zones, or limited development in high-risk areas). These incentives can take many forms but in order to succeed they need to be provided to participants throughout the infrastructure planning, development, and purchasing processes: from the local government (e.g., Community Disaster Resilience Zone funding) to the project financer (e.g., Greenhouse Gas Reduction Fund financing) to the builder (e.g., Inflation Reduction Act funding) to the eventual homeowner/business operator (e.g., government-backed adaptation-retrofit loans).

Improving post-disaster recovery efforts that help homeowners and businesses get back on their feet is another way to increase community resiliency to climate change. At the property level, new technologies can be used to improve coordination and standardization between aid sources, such as state and local grants, Small Business Administration (SBA) loans, FEMA grants, and HUD Community Development Block Grants for Disaster Recovery (CDBG-DR) that might have duplicative fulfillment processes. At the community level, physical climate risk data & analytics can be used to strengthen or design safer evacuation routes, protect critical public infrastructure and utilities, or formulate emergency response strategies. It can also be used to inform government lending programs for mortgage servicers, providing them with access to additional liquidity in times of crisis.

Addressing Vulnerable & Disadvantaged Communities

The need to help vulnerable communities from physical climate risks has been a common theme throughout this paper. Accordingly, it should be a primary focus for federal and state regulators who can act via the authority provided to them under current fair lending laws.

For example, the Community Reinvestment Act (CRA) "requires regulators to determine if banks are providing access to loans and credit to communities without discrimination" and, thus far, has been the main focus of federal regulators looking to address physical climate risks in LMI communities.[55] In October 2023, the Federal Reserve, Treasury Department, and FDIC released updates to the CRA that established "a separate category of community development for activities that assist individuals and communities to prepare for, adapt to, and withstand natural disasters, weather-related disasters, or climate-related risks", thus allowing financial institutions to earn credit for funding climate resilient activities.[56] While a positive step forward, these regulations will not become effective until January 2026, and there are additional measures that regulators can take in the meantime, such as considering innovative ways to use the 'planning presumption clause' to provide state and local governments with the opportunity "to organize a suite of investments, including those that help prepare for the next disaster, that could qualify for CRA consideration".[57] Regulators can also learn from state-level community reinvestment actions that are working to tackle physical climate risks, such as those taken by the New York Department of Financial Services in February 2021 to outline financing activities that support climate resiliency and may qualify for credit under the New York CRA.[58]

In conjunction with the CRA, there are a number of established federal fair housing laws and regulations that can be leveraged to address physical climate risks to vulnerable and disadvantaged communities.

The Fair Housing Act (FHAct) "prohibits discrimination in loans that are secured by residential real estate or that are for the purchasing, constructing, improving, repairing or maintaining a dwelling."[59] The Obama Administration's 2015 Affirmatively Furthering Fair Housing (AFFH) rule took further steps to incorporate environmental justice issues into fair housing assessments, but more work can be done to expand this framework's capability to address physical climate risks.[60] We recommend placing an enhanced focus on identifying and providing assistance to communities where physical climate risks disproportionately affect a protected class of individuals. These communities can be identified via property-level physical climate risk analyses coupled with loan-level demographic data, which are then aggregated at the community level to compare the effects of physical climate risks on both LMI and non-LMI populations. Once identified, these communities should then qualify for increased federal assistance (both financial and technical) to decrease/eliminate the local disparities in physical climate risks. This assistance could be implemented via current programs or through the establishment of a new program designed specifically to address these disparities, with oversight responsibilities falling under the purview of the Office of Fair Housing and Equal Opportunity (FHEO) working alongside state- and local-level Fair Housing Assistance Programs (FHAPs). Furthermore, the federal government could offer incentives – similar to those currently provided via the Community Disaster Resilience Zones (CDRZ) Act – for financial institutions and community organizations to invest in solutions that decrease physical climate risks to these communities.

Finally, the Government-Sponsored Enterprises' (GSEs) Affordable Housing Goals and Duty to Serve Mandate could both be leveraged to improve access to mortgage financing for underserved markets expected to see an increase in physical climate risks. The Affordable Housing Goals could be enhanced to provide sellers/servicers with additional credit should they invest in GSE mortgage loan programs designed for climate adaptation, with additional credit provided for investments that target LMI communities and underserved markets. The Duty to Serve plans could adopt language that more specifically addresses how the GSEs will use physical climate risk data & analytics to identify loan-level physical climate risks, concentrations of physical climate risks within their portfolios, and their potential to accumulate physical climate risks from private investors via the credit risk transfer market. Since these plans are organized around a three-year time period, with the next iteration of these plans expected to be released in late 2024 and span the three-year period of 2025-2027, now is the time to act.[61]

Endnotes

1 Chung, C. S. (2019, September 12). Rising tides and rearranging deckchairs: How Climate Change Is Reshaping Infrastructure Finance and Threatening to Sink Municipal Budgets. Environmental Law Review. https://www.law.georgetown.edu/environmental-law-review/wp-content/uploads/sites/18/2020/04/Rising-Tidesand-Rearranging-Deckchairs-How-Climate-Change-Is-Reshaping-Infrastructure-Finance-and-Threatening-to-Sink-Municipal-Budgets.pdf

2 Board of Governors of the Federal Reserve System. (2023, September 5). Liquidity Risk Management. Supervisory Policy and Guidance Topics. https://www.federalreserve.gov/supervisionreg/topics/liquidity_risk.htm

3 Okuji, K., Wertz, M., Kurtz, K., & Jones, L. (2017, November 28). Evaluating the impact of climate change on US state and local issuers. Environmental Risks. https://southeastfloridaclimatecompact.org/wpcontent/uploads/2017/12/Evaluating-the-impact-of-climate-change-on-US-state-and-local-issuers-11-28-17.pdf

4 U.S. Securities and Exchange Commission. (2012, July 31). Report on the Municipal Securities Market. https://www.sec.gov/files/munireport073112.pdf

5 Loughead, K., Walczak, J., & Koranyi, E. (2022, August 25). Unpacking the state and Local Tax Toolkit: Sources of state and Local Tax collections (FY 2020). https://taxfoundation.org/data/all/state/state-local-tax-collections/

6 Ortega, F., & Taspinar, S. (2018, July 4). Rising sea levels and sinking property values: Hurricane Sandy and New York's housing market. Journal of Urban Economics. https://www.sciencedirect.com/science/article/abs/pii/S0094119018300354?via%3Dihub

7 Kousky, C., Kunreuther, H., LaCour-Little, M., & Wachter, S. (2020, November 30). Flood Risk and the U.S. Housing Market. Journal of Housing Research. https://www.tandfonline.com/doi/full/10.1080/10527001.2020.1836915

8 Board of governors of the Federal Reserve System. (2023b, December 15). Market Risk Management. Supervisory Policy and Guidance Topics. https://www.federalreserve.gov/supervisionreg/topics/market_risk_mgmt.htm

9 Chung, C. S. (2019, September 12). Rising tides and rearranging deckchairs: How Climate Change Is Reshaping Infrastructure Finance and Threatening to Sink Municipal Budgets. Environmental Law Review. https://www.law.georgetown.edu/environmental-law-review/wp-content/uploads/sites/18/2020/04/Rising-Tidesand-Rearranging-Deckchairs-How-Climate-Change-Is-Reshaping-Infrastructure-Finance-and-Threatening-to-Sink-Municipal-Budgets.pdf

10 Schuetz, J., Tomer, A., Gill, J., & George, C. (2023, December 4). How climate risk data can help communities become more resilient. Cities & Communities. https://www.brookings.edu/articles/how-climate-risk-data-can-helpcommunities-become-more-resilient/

11 Department of Housing and Urban Development Office of Policy Development and Research (PD&R). (n.d.). Overview of 2023 and 2024 Small DDAs and QCTs. 2023 and 2024 Small DDAs and QCTs. https://www.huduser.gov/portal/sadda/sadda_qct.html?locate=22071001724

12 U.S. Census Bureau (2022). American Community Survey 5-year estimates. Retrieved from Census Reporter Profile page for Census Tract 17.24, Orleans, LA http://censusreporter.org/profiles/14000US22071001724-census-tract-1724-orleans-la/

13 Environmental Protection Agency. (2023, May 19). Smart Growth and Climate Change. Smart Growth. https://www.epa.gov/smartgrowth/smart-growth-and-climate-change

14 Jones, J. M. (2023, October 13). Americans Trust Local Government Most, Congress least. Politics. https://news.gallup.com/poll/512651/americans-trust-local-government-congress-least.aspx

15 Coalitions & Collaboratives, Inc. (2021, April). Community wildfire mitigation pocket guide. Mitigation Pocket Guide. https://co-co.org/wp-content/uploads/2021/11/Mitigation-Pocket-Guide.pdf

16 Baxter, J., Helbrecht, K., Robinson, S. F., Reynolds, S., Reeder, A., & Kendro, H. (2013, January). Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. https://www.fema.gov/sites/default/files/2020-06/fema-mitigationideas_02-13-2013.pdf

17 United States Census Bureau. (2023, June 14). 2022 Annual survey of public pensions: State & local tables. Historical Tables. https://www.census.gov/data/tables/2022/econ/aspp/aspp-historical-tables.html

18 Insight Investment. (2022, May). Information for Employee Benefits Security Administration on Climate-Related Financial Risk. https://www.dol.gov/sites/dolgov/files/EBSA/laws-and-regulations/rules-and-regulations/publiccomments/1210-AB52/00231.pdf

19 U.S. Department of Labor Employee Benefits Security Administration . (n.d.). FAQs about Retirement Plans and ERISA. https://www.dol.gov/sites/dolgov/files/ebsa/about-ebsa/our-activities/resource-center/faqs/retirement-plansand-erisa-for-workers.pdf

20 Wile, R., & Cui, J. (2023, June 17). Homeowners in California and Florida are running out of options to protect their homes. Climate in Crisis. https://www.nbcnews.com/business/consumer/homeowners-go-without-insurance-instates-where-its-too-expensive-rcna88578

21 Based on multiple CoreLogic studies correlating hazard risk assessments and home prices, including Understanding the Impact of Wildfires on California Property Values, How Wildfire Risks Impact Property Values in San Diego County, and The Impact of Wildfires on Rent & Home Prices.

22 Congressional Budget Office. (2023, November). Flood damage and federally backed mortgages in a changing climate. https://www.cbo.gov/publication/59753

23 Flavelle, C., Cowan, J., & Penn, I. (2023, June 2). Climate shocks are making parts of America uninsurable. it just got worse. https://www.nytimes.com/2023/05/31/climate/climate-change-insurance-wildfires-california.html

24 Federal Emergency Management Agency. (2023, October 20). Before you apply for Building Resilient Infrastructure and Communities (BRIC) funds. Hazard Mitigation Assistance Grants. https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/before-apply

25 Federal Emergency Management Agency. (2024, February 5). State Hazard Mitigation Officers. Hazard Mitigation Assistance Grants. https://www.fema.gov/grants/mitigation/state-contacts

26 Insurance Information Institute. (n.d.). McCarran-Ferguson Act. Insurance Handbook. https://www.iii.org/publications/insurance-handbook/regulatory-and-financial-environment/mccarran-fergusonact

27 Yousofi, F., Mennis, G., & Mills, M. (2023, May 15). How states can account for climate risks to pension system assets. https://www.pewtrusts.org/en/research-and-analysis/articles/2023/05/15/how-states-can-account-for-climaterisks-to-pension-system-assets

28 Maryland General Assembly. (2020, February 3). Maryland Pension Risk Mitigation Act. Legislation - HB0993. https://mgaleg.maryland.gov/mgawebsite/Legislation/Details/HB0993/?ys=2018rs

[29] SB-964 Public Employees' Retirement Fund and Teachers' Retirement Fund: investments: climate-related financial risk. California Legislative Information. (2018, September 24). https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB964
[30] Schuetz, J., Tomer, A., Gill, J., & George, C. (2023, December 4). How climate risk data can help communities become more resilient. Cities & Communities. https://www.brookings.edu/articles/how-climate-risk-data-can-helpcommunities-become-more-resilient/
[31] Ibid.
[32] The Pew Charitable Trusts. (2020, May). How states pay for natural disasters in an era of rising costs. https://www.pewtrusts.org/-/media/assets/2020/05/how-states-pay-for-natural-disasters-in-an-era-of-risingcosts.pdf
[33] Ibid.
[34] Office of the Comptroller of the Currency, Federal Reserve System, Federal Deposit Insurance Corporation. (2023, October 30). Principles for Climate-Related Financial Risk Management for Large Financial Institutions. Federal Register. https://www.federalregister.gov/documents/2023/10/30/2023-23844/principles-for-climate-relatedfinancial-risk-management-for-large-financial-institutions
[35] Basel Committee on Banking Supervision. (2021, April). Climate related risk drivers and their transmission channels. Bank for International Settlements. https://www.bis.org/bcbs/publ/d517.pdf
[36] Lang, Q., Ma, F., Mirza, N., & Umar, M. (2023, March 9). The interaction of climate risk and bank liquidity: An emerging market perspective for transitions to low carbon energy. Technological Forecasting and Social Change. https://www.sciencedirect.com/science/article/abs/pii/S0040162523001658
[37] Basel Committee on Banking Supervision. (2021, April). Climate related risk drivers and their transmission channels. Bank for International Settlements. https://www.bis.org/bcbs/publ/d517.pdf
[38] Ibid.
[39] https://www.sec.gov/files/mmfs-and-the-repo-market-021721.pdf
[40] Lang, Q., Ma, F., Mirza, N., & Umar, M. (2023, March 9). The interaction of climate risk and bank liquidity: An emerging market perspective for transitions to low carbon energy. Technological Forecasting and Social Change. https://www.sciencedirect.com/science/article/abs/pii/S0040162523001658
[41] International Panel on Climate Change. (2024). IPCC Data. https://www.ipcc.ch/data/
[42] Holscher, Michael, David Ignell, Morgan Lewis, and Kevin Stiroh (2022). "Climate Change and the Role of Regulatory Capital: A Stylized Framework for Policy Assessment, "Finance and Economics Discussion Series 2022-068. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2022.068.
[43] Phaure, H., Jan, O., Dugelay, E., & de Jenlis, N. (2020). The Predictive Power of Stress Tests to Tackle Climate Change. https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/sustainability-services/deloitte_climate-riskassessment.pdf
[44] Office of Management and Budget - Office of Information and Regulatory Affairs. (2023, December). Climate Change Disclosure. View Rule. https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202310&RIN=3235-AM87
[45] Howell, J., & Elliott, J. R. (2018, December 4). As Disaster Costs Rise, So Does Inequality. https://journals.sagepub.com/doi/10.1177/2378023118816795
[46] Beal, D., Reeves, K. N., Benayad, A., Husain, Z., & Jiang, C. (2023, May 25). Banks Can Ensure an Equitable Climate Transition. BCG. https://www.bcg.com/publications/2023/banks-can-ensure-an-equitable-climate-transition
[47] Federal Insurance Office, U.S. Department of the Treasury. (2023b, June). Insurance Supervision and Regulation of Climate-Related Risks. https://home.treasury.gov/system/files/136/FIO-June-2023-Insurance-Supervision-and-Regulation-of-Climate-Related-Risks.pdf
[48] Ibid.
[49] Fellowes-Granda, L., & Weise, C. (2023, April 28). How U.S. regulators can help community and regional banks address climate-related financial risks. https://www.americanprogress.org/article/how-u-s-regulators-can-helpcommunity-and-regional-banks-address-climate-related-financial-risks/
[50] Office of Management and Budget - Office of Information and Regulatory Affairs. (2023, December). Climate Change Disclosure. View Rule. https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202310&RIN=3235-AM87
[51] Lis, M. (2023, September 1). Bridging the insurance gap: A global challenge for financial resilience. https://www.milliman.com/en/insight/bridging-the-insurance-gap-global-challenge-financial-resilience
[52] Brunetti, C., Dennis, B., Kotta, G., & Smith, A. (2023, September 7). Analyzing State Resilience to Weather and Climate Disasters. Economic Research - FEDS Notes. https://www.federalreserve.gov/econres/notes/feds-notes/analyzingstate-resilience-to-climate-change-20230907.html
[53] European Central Bank. (2023, April 24). ECB and EIOPA call for increased uptake of climate catastrophe insurance. Press Release. https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.pr230424~a242491813.en.html
[54] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf
[55] Johnson, L. (2023, October 26). CRA update lets banks get credit for climate resilience. Dive Brief. https://www.bankingdive.com/news/bank-climate-risk-resilience-credit-cra-disaster-preparedness-occ-fdic-fedhsu/697947/
[56] Department of the Treasury, Federal Reserve System, Federal Deposit Insurance Corporation. (2023b, October 24). Federal Register Notice: Community Reinvestment Act. https://www.federalreserve.gov/aboutthefed/boardmeetings/files/frn-cra-20231024.pdf
[57] Keenan, J. M., & Mattiuzzi, E. (2019, June). Climate Adaptation Investment and the Community Reinvestment Act. Community Development. https://www.frbsf.org/community-development/publications/community-developmentresearch-briefs/2019/june/climate-adaptation-investment-and-the-community-reinvestment-act/
[58] Lacewell, L. A. (2021, February 9). Industry letter: CRA consideration for activities that contribute to climate mitigation and adaptation. Industry Letters. https://www.dfs.ny.gov/industry_guidance/industry_letters/il20210209_cra_consideration
[59] U.S. Department of Housing and Urban Development. (n.d.-a). Fair Lending. https://www.hud.gov/program_offices/fair_housing_equal_opp/fair_lending

[60] Haberle, M. (2017, February 24). Fair Housing and Environmental Justice: New Strategies and Challenges. https://www.prrac.org/pdf/AH_26-2_06Haberle.pdf

[61] Federal Housing Finance Agency. (2023c, August 10). 2023 Duty to Serve Public Listening Sessions. https://www.fhfa.gov/PolicyProgramsResearch/Programs/Pages/DTS-Announcements.aspx

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