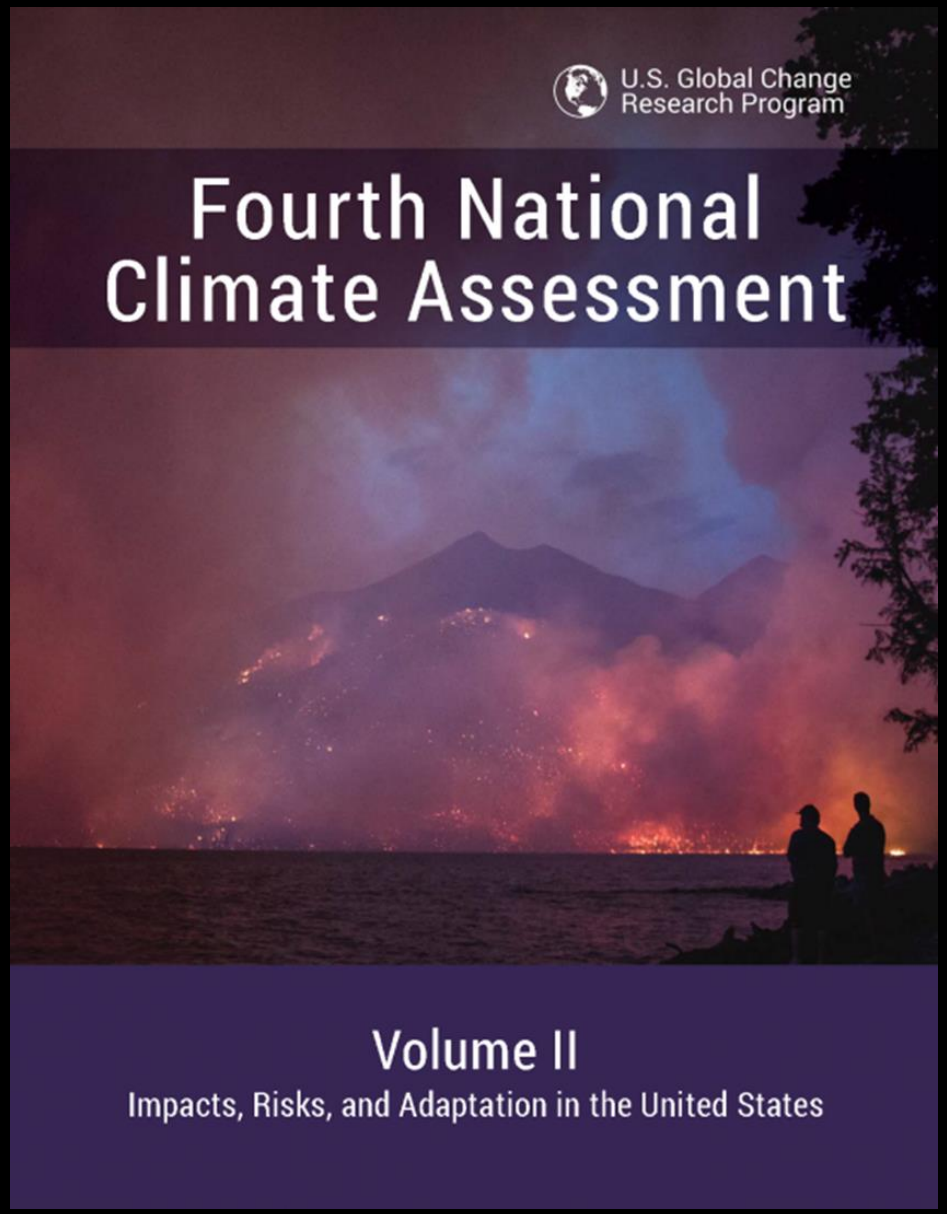
Rachel Cleetus

Union of Concerned Scientists

Underwater: Rising Seas, Chronic Floods, and the Implications for Coastal Real Estate

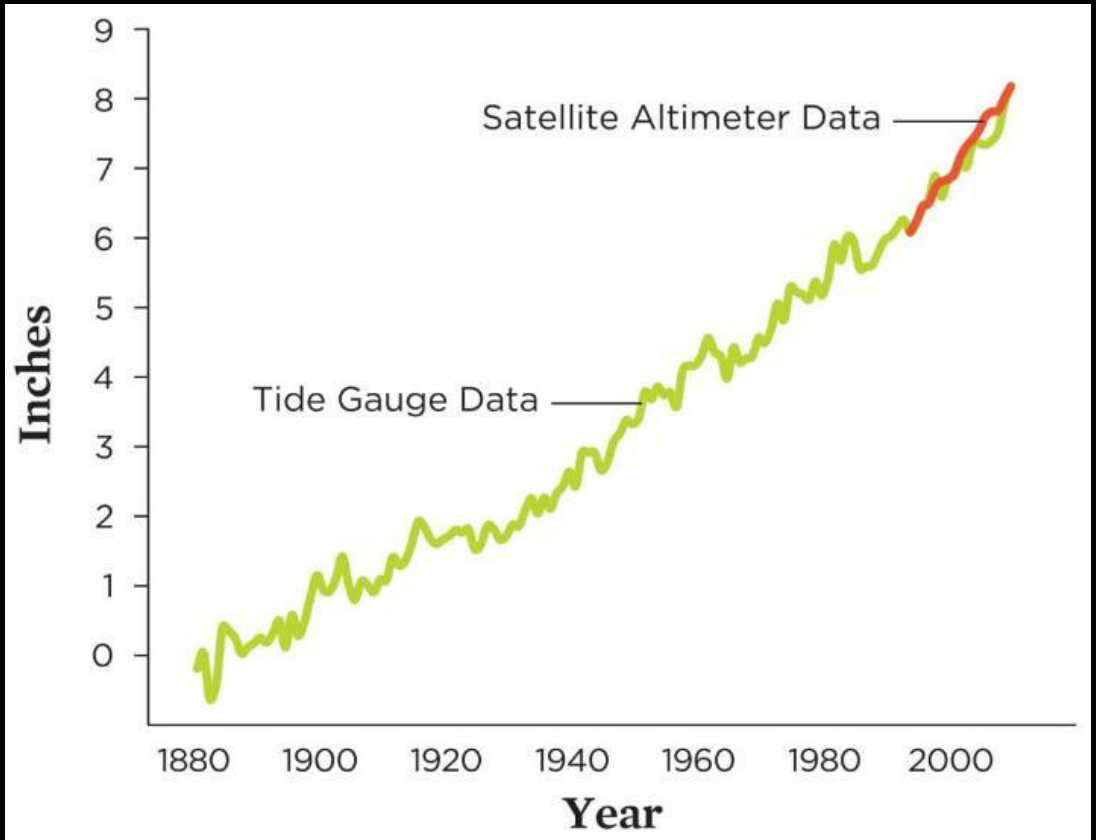
Union of Concerned Scientists

Photo: Will Brown

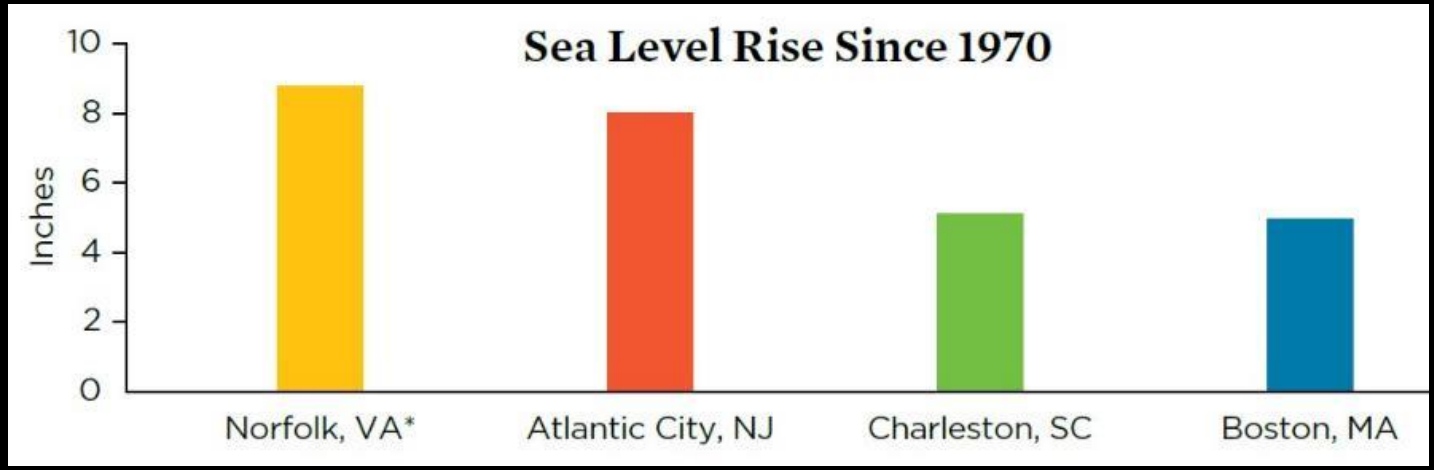

U.S. Global Change Research Program
Fourth National Climate Assessment
Volume II
Impacts, Risks, and Adaptation in the United States

[Recent Global Sea Level Rise

Sea Levels have risen 8 inches since 1880



East Coast is a Sea Level Rise Hotspot



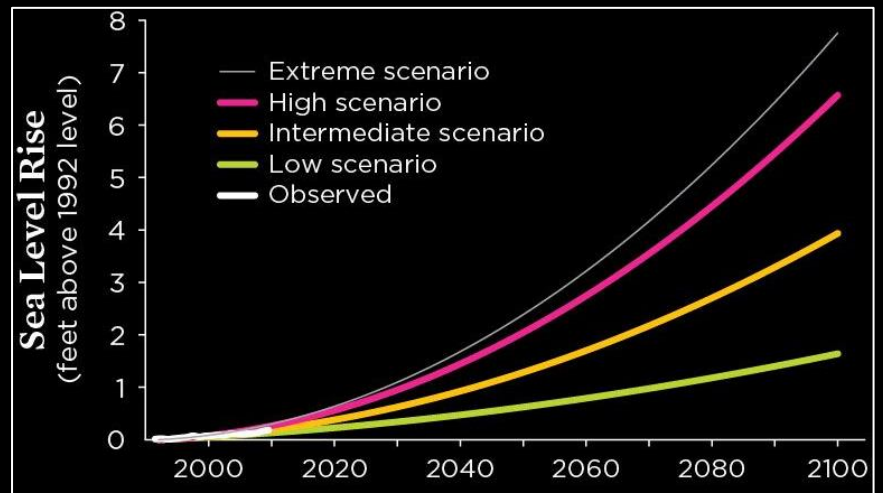
[Defining Chronic Inundation

Photo: Emily Michot/The Miami Herald via AP

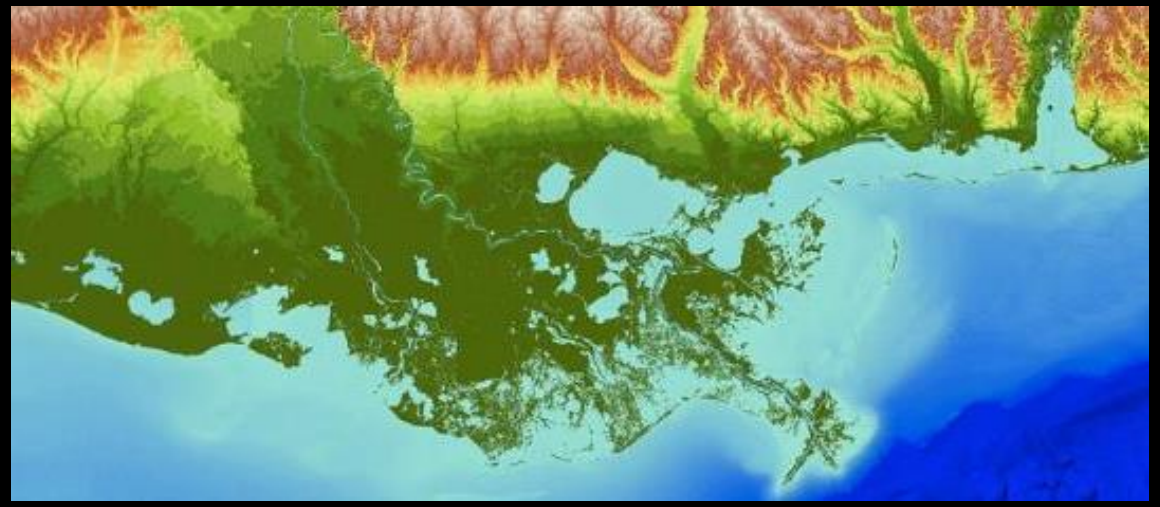
[Mapping Chronic Inundation

1. Tide gauge records

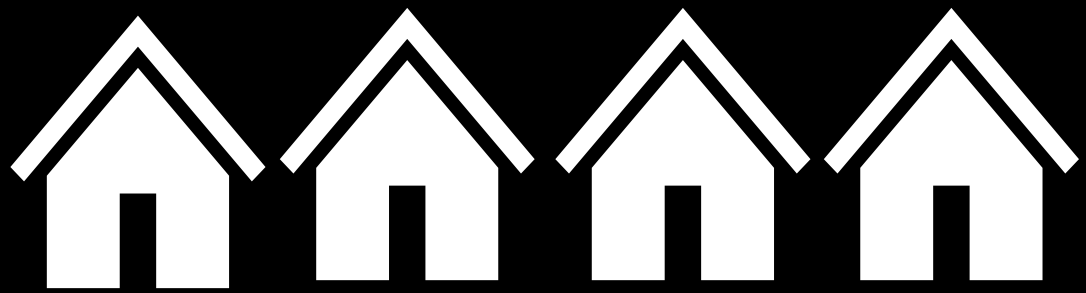
2. Sea level rise projections



3. Digital Elevation Models



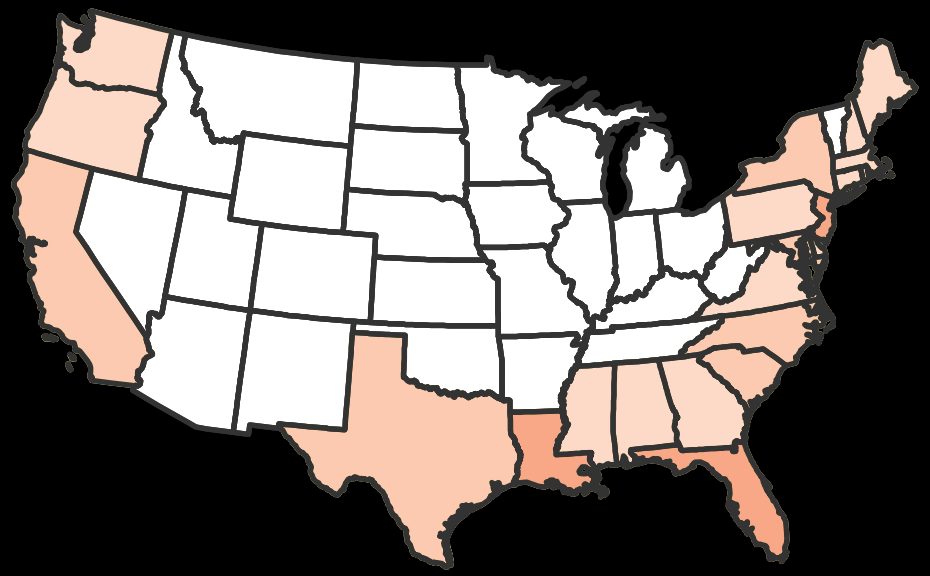
4. Property data from Zillow



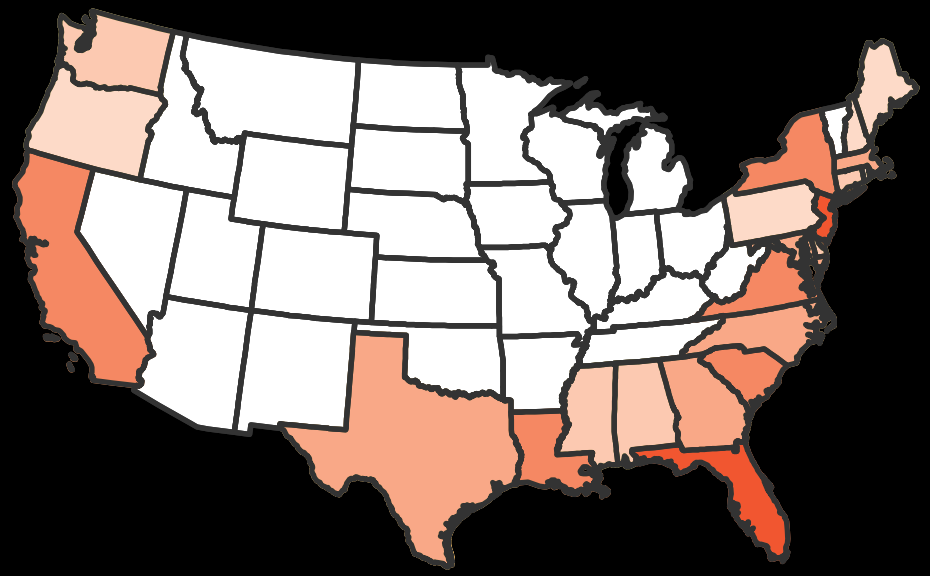
[Homes at risk

A National Overview

2045



2100



> 300,000 homes at risk

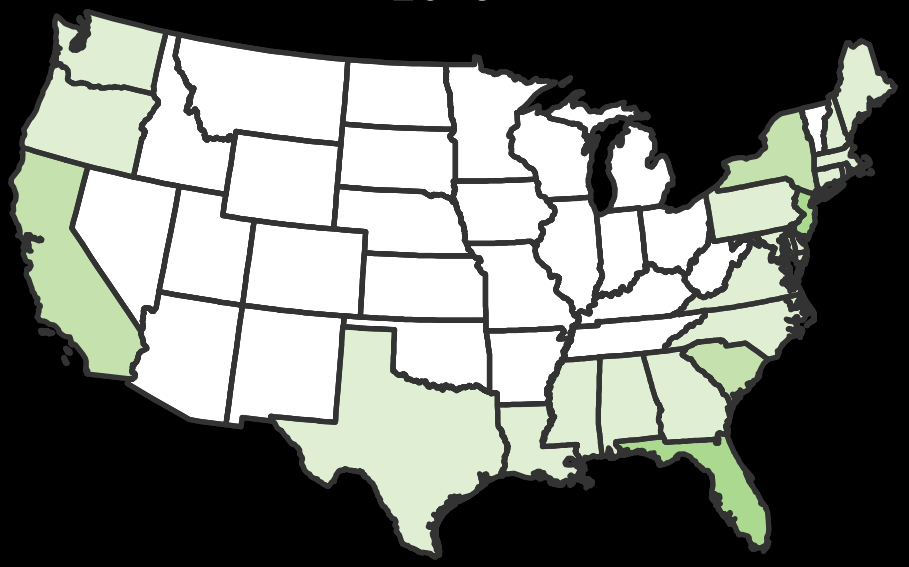
2.4 million homes at risk

Data provided by third parties through the Zillow Transaction and Assessment Dataset (ZTRAX). More information on accessing the data can be found at https://www.zillow.com/ztrax.

[Value at risk

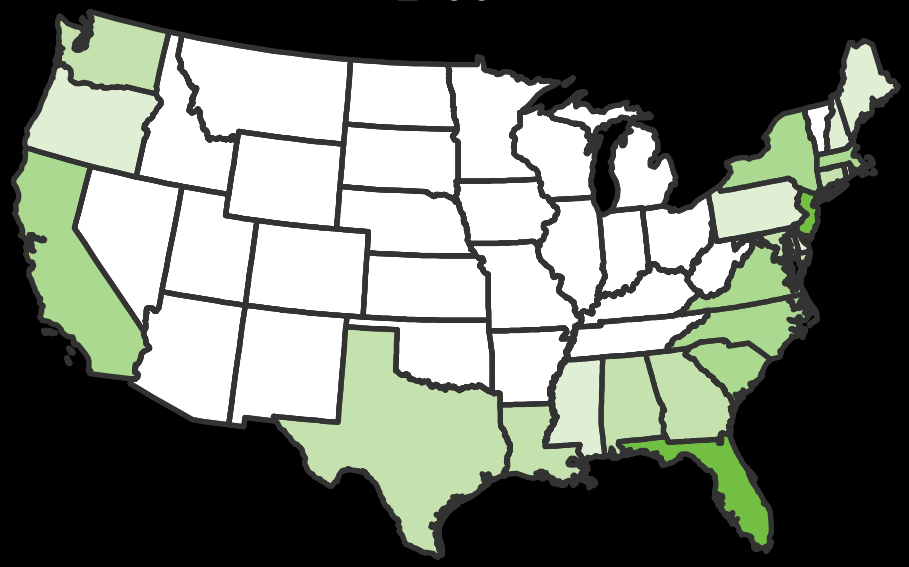
A National Overview

2045



$117.5 Billion

2100



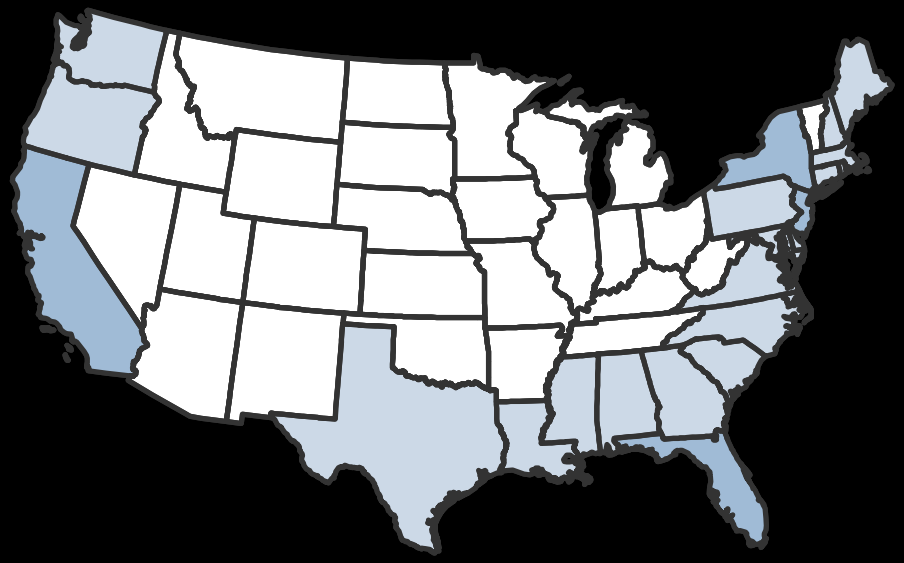
$1 Trillion

Data provided by third parties through the Zillow Transaction and Assessment Dataset (ZTRAX). More information on accessing the data can be found at https://www.zillow.com/ztrax.

[Tax base at risk

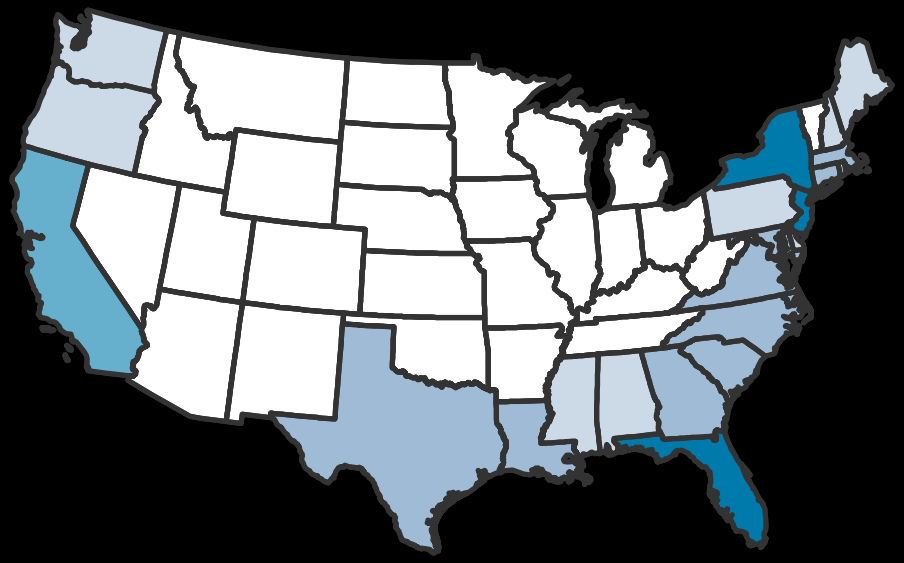
A National Overview

2045

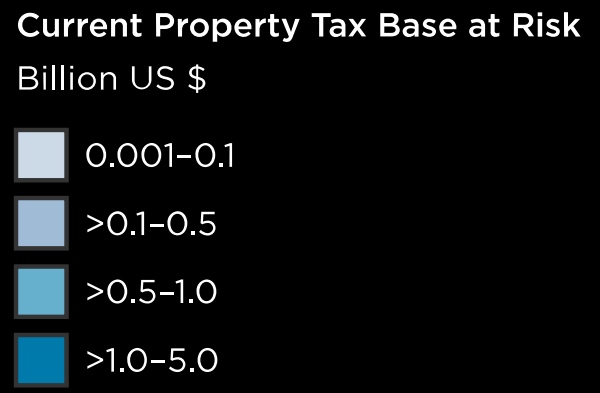


$1.5 Billion

2100



$12 Billion



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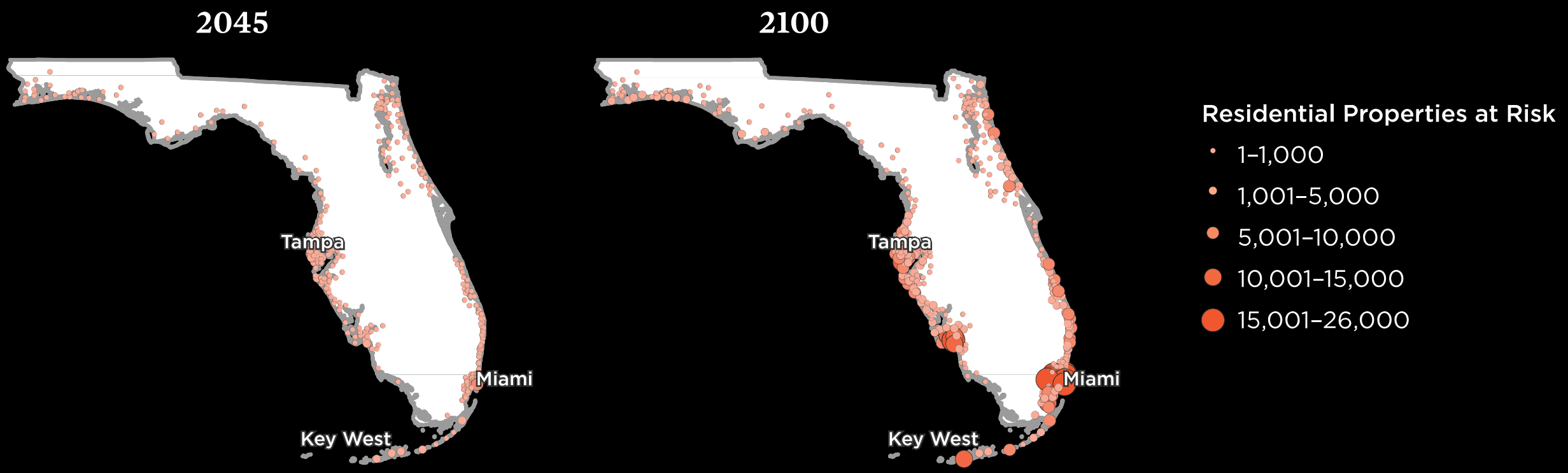
[Acute exposure in Florida: Homes at risk



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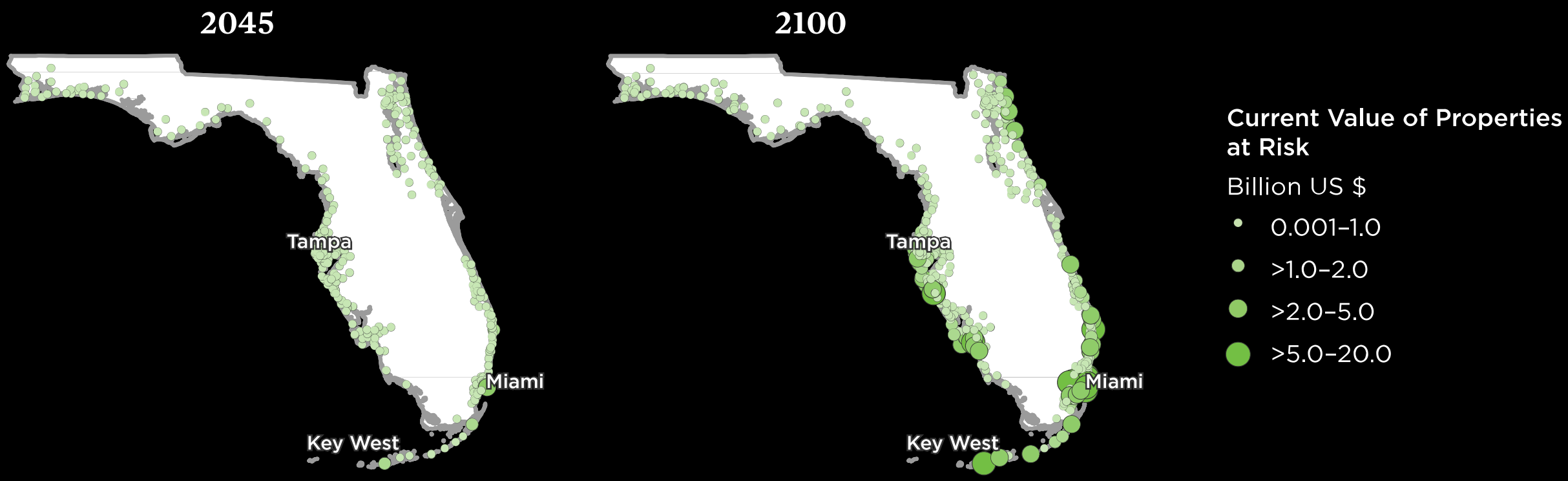
Acute exposure in Florida: Value at risk

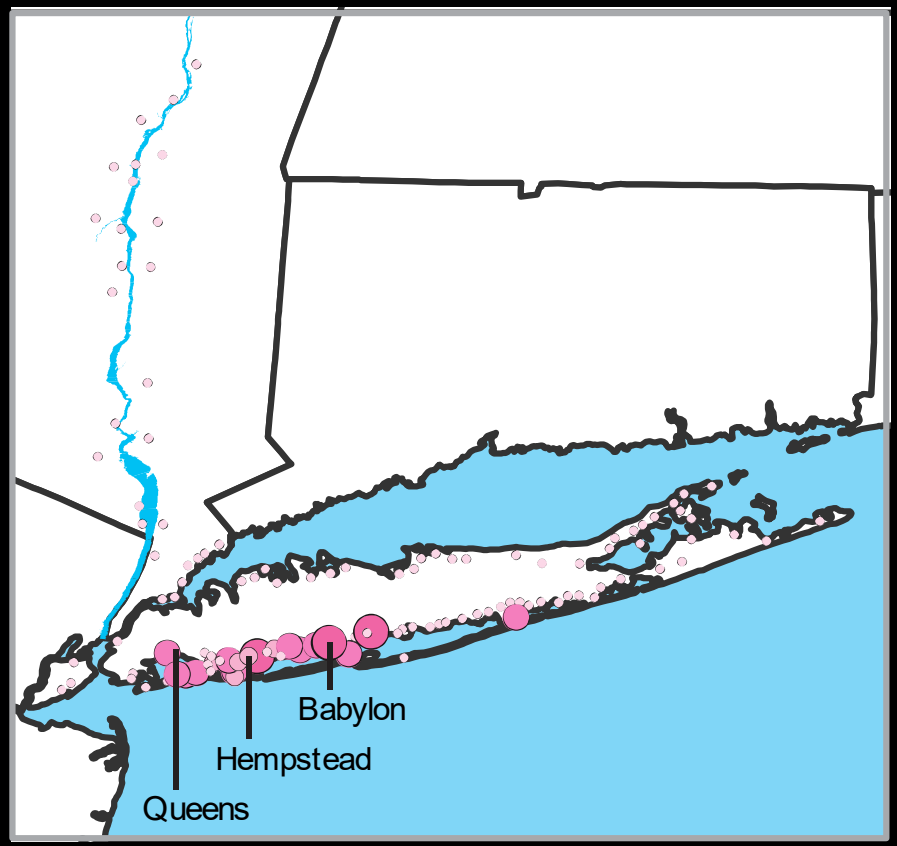


Data provided by third parties through the Zillow Transaction and Assessment Dataset (ZTRAX). More information on accessing the data can be found at https://www.zillow.com/ztrax.

[Snapshot of densely populated places at risk (2045)

California

New York

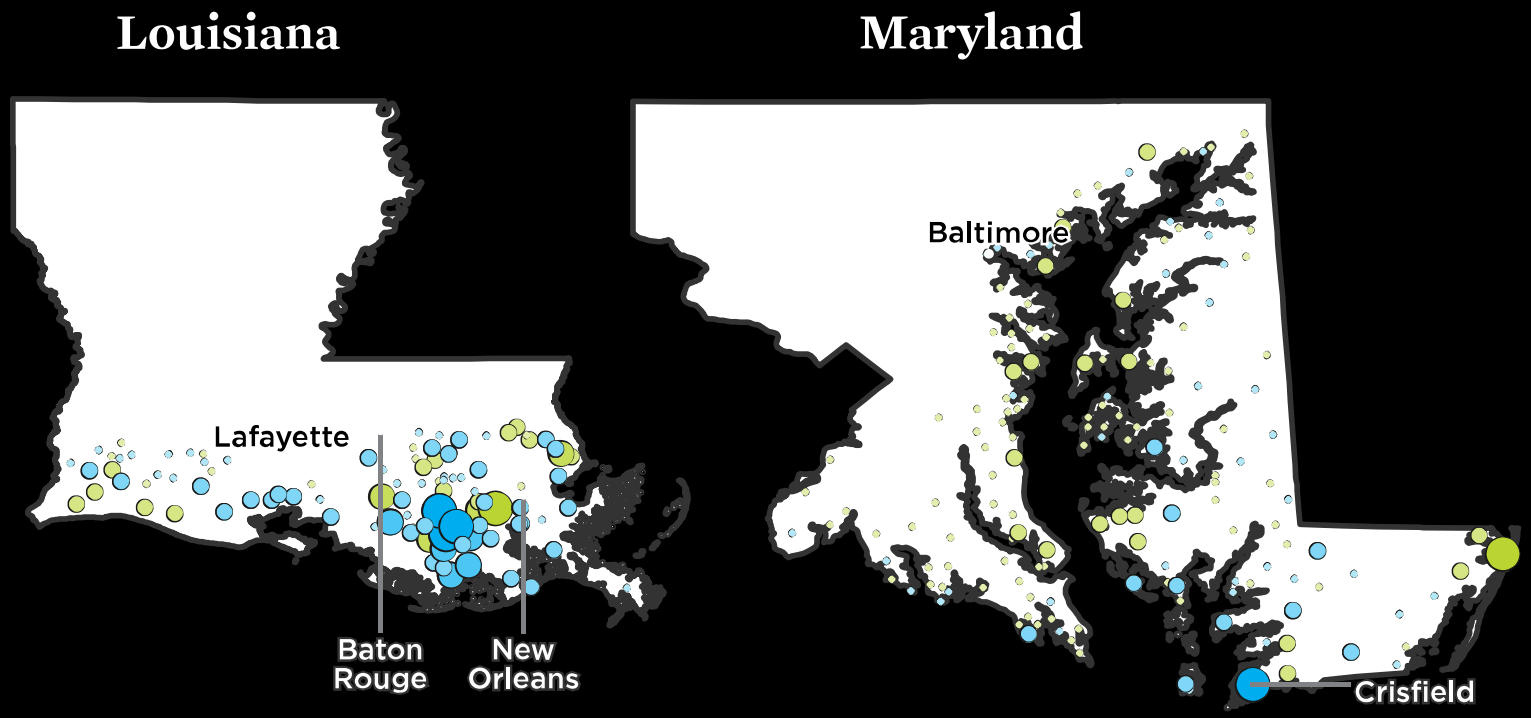


Current Population Living in At-Risk Properties

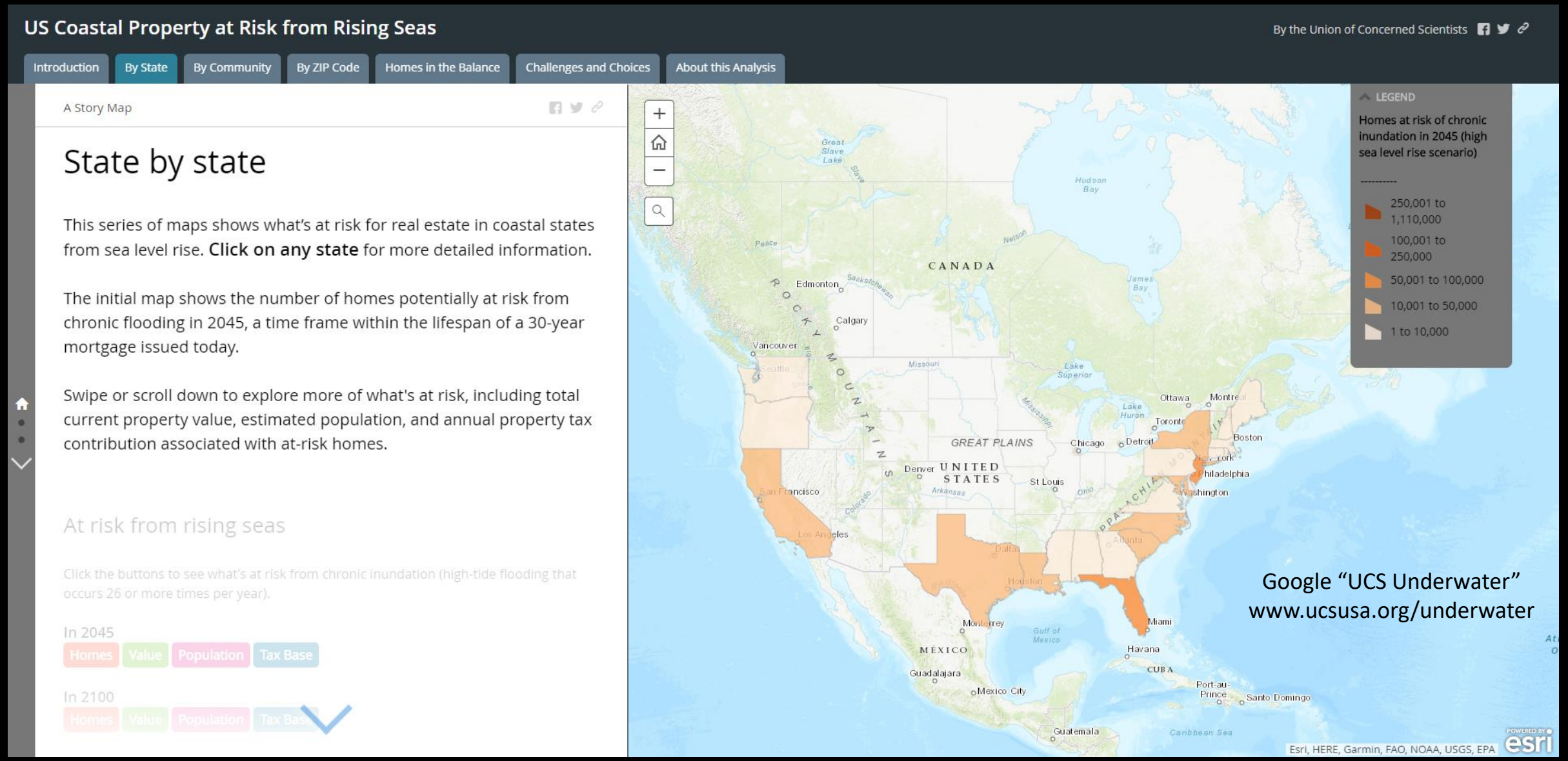
- 1–500
- 501–1,000
- 1,001–2,500
- 2,501–5,000
- 5,001–11,000

Data provided by third parties through the Zillow Transaction and Assessment Dataset (ZTRAX). More information on accessing the data can be found at https://www.zillow.com/ztrax.

[Poverty, race, and flooding create hotspots of risk



Underwater Interactive map



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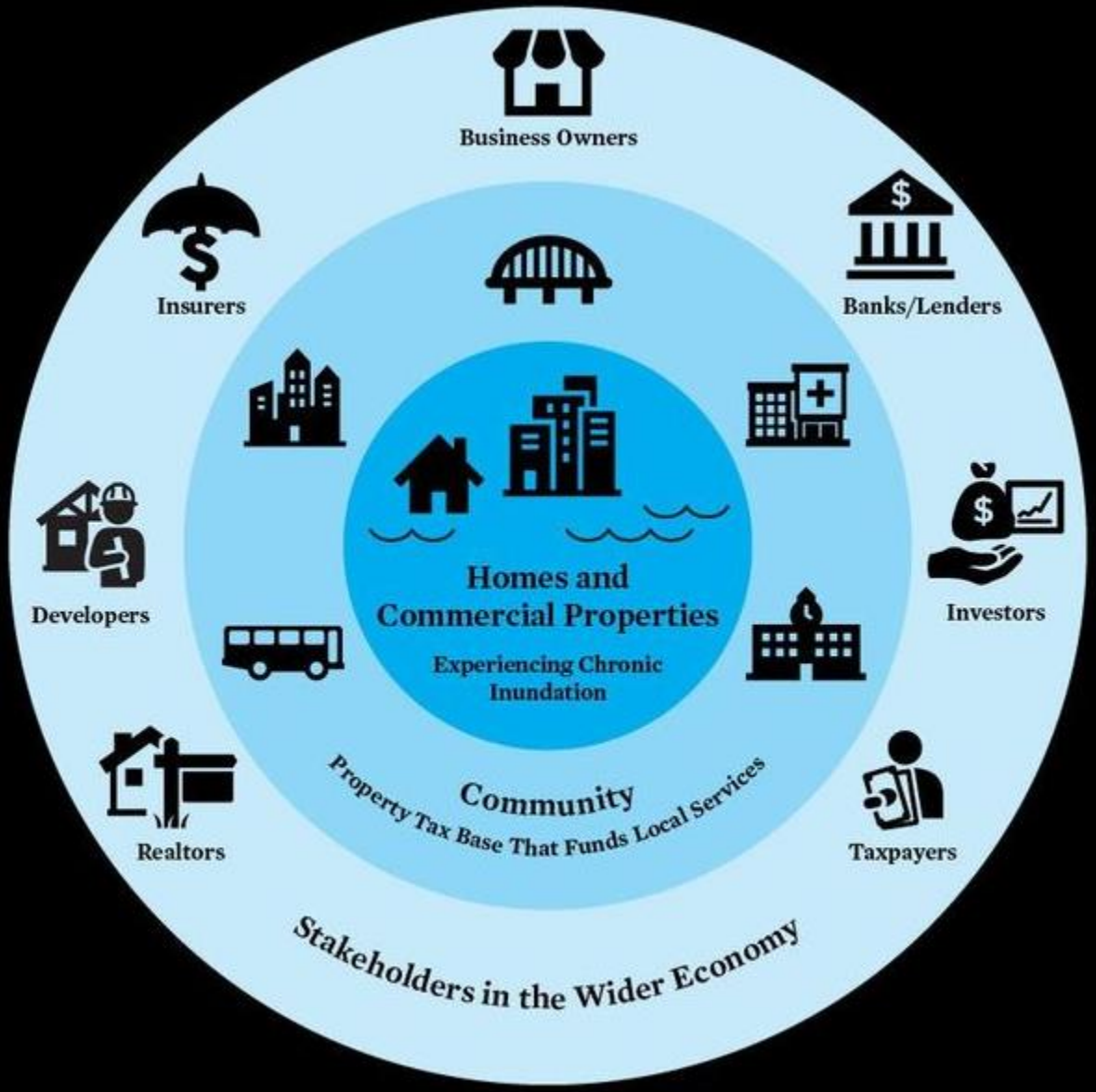
Economic Reverberations of Chronic Flooding



Using “Response Time” Wisely

There are Limits to Adaptation

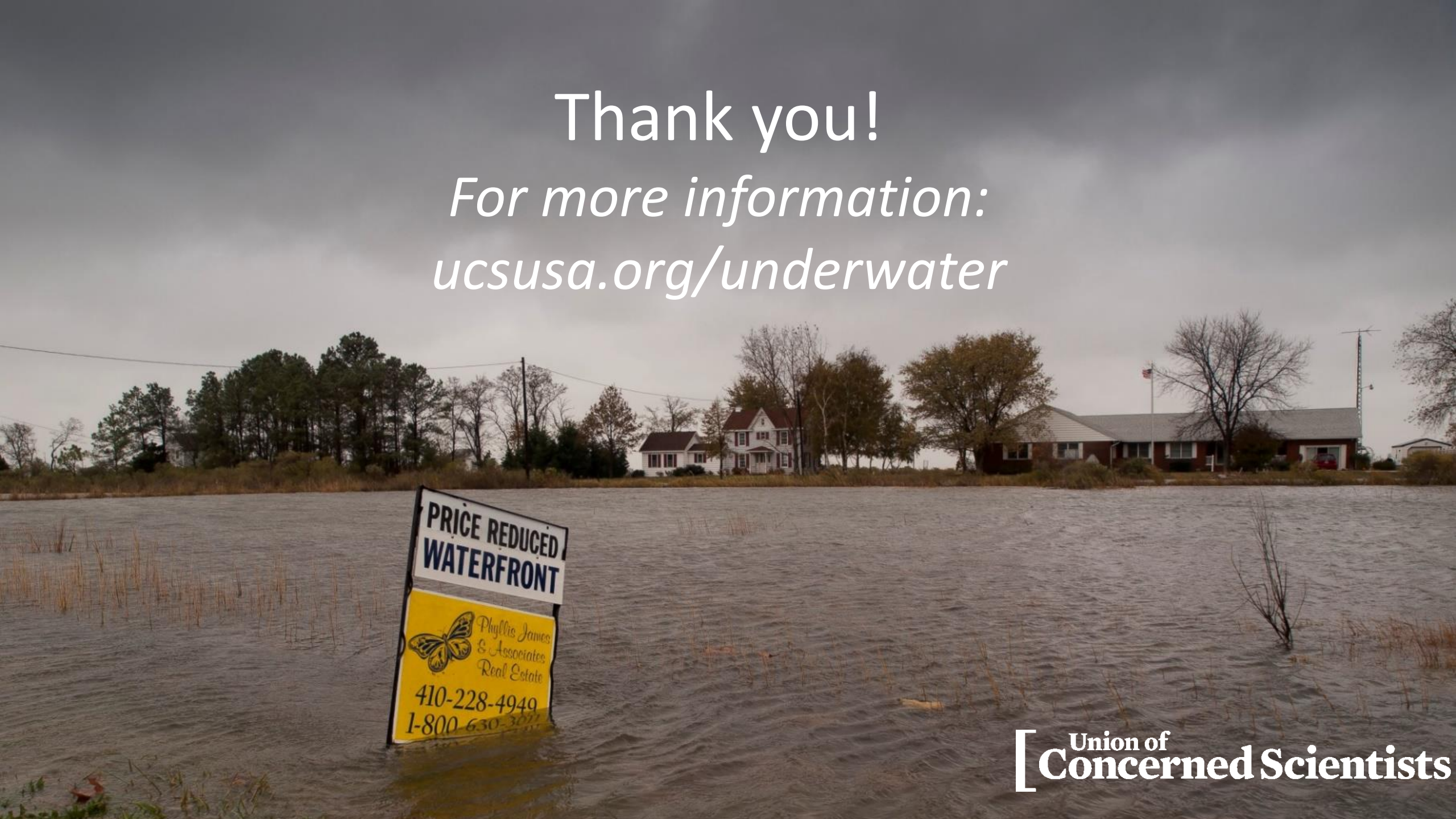
Our Challenges and Choices

- Communicate risks and mandate risk disclosure (BUT need to be mindful of equity considerations)
- Realign policies and market incentives
- Invest in bold, transformative, equitable federal/state/local policies
- Build just, inclusive governance structures and processes

Thank you!

For more information:

ucsusa.org/underwater



Union of Concerned Scientists

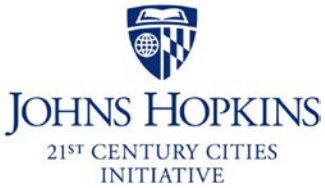
Prof. Amine Ouazad

HEC Montreal
The 21st Century Cities Initiative

Identifying and Assessing Climate and Natural Disaster Risk to Enhance FHFA's Supervisory and Regulatory Framework

Matthew E. Kahn Amine Ouazad

Johns Hopkins University
The 21st Century Cities Initiative



21CC.jhu.edu

Who We Are

We are **not** consultants but rather **researchers** looking for ways to help households adapt to rising climate risk.

We are concerned about the potentially **unequal impact of climate change** on minorities and lower-income households (Banzhaf, Ma, Timmins, 2019).

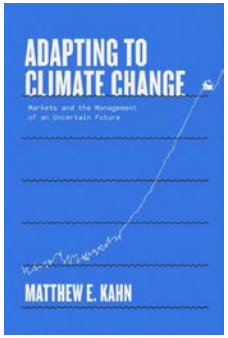
We think that **FHFA** has **a key role in setting rules** to guide households through the challenge of climate change adaptation (Nordhaus 1992, Alley et al 2003, Nordhaus 2019).

Our career has focused on climate change **adaptation, housing finance, real estate finance, social justice and urban segregation**.

"**Credit Standards and Segregation**" estimates the impact of mortgage credit supply on urban segregation.

NBER
the NATIONAL BUREAU of ECONOMIC RESEARCH

"**Adapting to Climate Change**" considers how individual economic choices in response to climate change will transform the larger economy.



"**Mortgage Finance and Climate Change**" estimates the impact of natural disasters on the securitization of climate risk

Our Research Agenda

How can we …

- **Transfer risk** to private counterparties to **protect the American taxpayer** against tail events?
- Ensure **equal and transparent information** for borrowers, lenders and securitizers?
- Ensure **broad and equal access to mortgage lending** for all Americans regardless of their neighborhood, race, color, national origin, disability, age, sex, and religion.
- Provide lenders with incentives to **share their local knowledge** and their "climate" human capital with borrowers and the agencies?
- **Price agency mortgage guarantees** to accurately reflect climate risk – and signal danger?
- Pool climate risk across MBS securities to **turn the systemic risk of climate change into harmless diversified idiosyncratic risk.**

→ We believe that FHFA can be the “Adult in the Room” that guides present and future homeowners through the challenge of climate change adaptation in a fair and equitable way.

Observations

Our analysis suggests that every year, about **10% of mortgage originations** US-wide are in areas exposed to hurricane storm surges.

Our assessment also suggests substantial origination and Agency securitization volumes in areas exposed to **wildfires and riverine flooding.**

Households exposed to hurricane storm surge risk are more likely to be **minority households**, more likely to be **below the poverty line**, have **lower income**, and are **less likely to have health coverage**.

Adapting our institutions

A **resilient U.S housing policy** to encourage more Americans to become homeowners while providing incentives for them to take increased precautions to increase their own and their community's climate resilience.

By building stronger institutions, we will face **less risk from the next Texas Freeze** and other inevitable shocks that will occur.

Michael Craig, PhD

HUD
Office of Policy Development and Research
Housing Finance Analysis Division

Climate Change and Natural Disaster Risk to Mortgage Finance

HUD
Office of Policy Development and Research
Housing Finance Analysis Division
Michael Craig, PhD

More Intense and More Frequent Natural Disasters.

NOAA reports $119 billion (inflation adjusted) natural disasters since 2010

- Twice as many than the previous decade

Discussion will focus on flooding

- Increased flood damage correlated to increased precipitation and increased development (Davenport et al. 2020)

Wave of mortgage defaults similar to sub-prime mortgage crisis

- Losses from Direct defaults from storm damaged homes
- Indirect defaults from community-wide depreciation in property values
- Abrupt tightening of lending in flood prone areas
  - Negative feedback loop of further depreciation-tightened lending

How?
Diagnosing the Problem

Because this problem is so broad, we have broken it down into 9 topics across 3 general contexts.

- Pre-flood
- Post-flood
- The Secondary Mortgage Market

Pre-Flood

1. How flood risk is assessed and how climate change and development patterns are increasing the risk footprint

2. Financial risk, flood insurance markets and the NFIP

3. What measures individual homeowners and communities take to mitigate physical flood risk

Post-Flood

4. Borrower behavior and financial outcomes post flood

5. Community behavior and outcomes post flood, and the role of federal assistance

6. Behaviors of participants in the mortgage market
   - mortgage originators, GSEs, federal agencies and regulators, and purchasers of MBSs

Secondary Mortgage Market

7. Portfolio exposure for the GSEs and Ginnie Mae

8. Secondary market responses to climate risk

9. Parallels between the 2007 subprime lending driven housing crisis and a potential climate change driven housing crisis

Housing market does not fully price in flood risk to home values

- Evidence of some floodplain discount, though not enough (Hino & Burke 2020)
- Possible that NFIP and other disaster relief measures encourage/subsidize rebuilding and new building in high-risk areas (Kousky 2018; Kunreuther et al. 2018)
- NFIP premiums too low (Kousky 2018; Kunreuther et al. 2018; Hino & Burke 2020)
- GSEs cannot (or do not) price in flood risk in guarantee fees or otherwise (Owens 2020, Hurst et al. 2016)

Insurance plays critical role in reducing financial risk

- Reduces post flood risk of delinquency and default (Gallagher & Hartley 2016; Kousky, Palim & Pan 2020; HUD-2M 2020)
- Can increase prepayment if homeowners decide to sell rather than rebuild/repair (Gallagher & Hartley 2016; Kousky, Palim & Pan 2020)
- Evidence that local vs nonlocal lending institution plays a role in decision to rebuild or prepay (Gallagher & Hartley 2016)

Households are severely underinsured against flood risk

- Perception of binary flood risk based on location in or out of SFHAs (Kousky 2018; Kunreuther et al. 2018)
- Inaccurate/out of date flood maps (Kousky 2018; Kunreuther et al. 2018, First Street Foundation 2020)
- Incomplete enforcement of mandated insurance for agency/federally backed mortgages within SFHAs (HUD-2M 2020)
  - Lack of real-time data to track insurance compliance
  - Non-compliant properties subject to “surchargeable damage” provisions

Market participants are beginning to understand climate risk

- Banks securitizing more homes with flood risk and keeping less risky loans (Ouazad & Kahn 2019; Keenan & Bradt 2020)
  - Transfers flood risk to GSEs and the federal government
- Interest only loans to protect home buyers from equity loss due to flooding (Ouazad 2020 – working paper, unpublished)

Market participants are beginning to understand climate risk

- Purchasers of MBSs securities less willing to accept bundles with flood prone homes (Politico Nov 2020)
- Development of new climate risk tools for estimating exposure of MBS's (RiskSpan, GARP)
- RMBS market underprices climate risk (Blackrock Investments, Fitch Ratings)

We welcome further discussion

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Adam Hoffberg

Director, Housing Finance Analysis Division

adam.hoffberg@hud.gov

Thank you!

Dr. Clifford Rossi

University of Maryland

UNIVERSITY OF MARYLAND
ROBERT H. SMITH SCHOOL OF BUSINESS

Climate & Natural Disaster Risk Management for Housing Finance Agencies

Dr. Clifford Rossi

March 4, 2021
FHFA Listening Session

Suggested Focus of Housing Finance Agencies on Natural Disaster and Climate Risk Management

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- Integrate climate risk management governance and processes with existing enterprise risk management capabilities
- Determine the potential risk exposure associated with specific types of natural disaster and climate-related events by major financial and nonfinancial risk type (e.g., credit risk) for these entities
- Conduct analytics to quantify the direct impact of natural disaster and climate-related events on key risk types (e.g., impact on mortgage default from hurricanes) for conducting forward-looking scenario analysis
- Disclose findings from such analysis in public financial statements

The Case for Practical Climate Change Risk Analysis for Informed Decision-making

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- Weak linkages between climate and integrated assessment model (IAM) outputs and housing finance agency financial and risk data preclude direct leveraging of existing climate scenarios for meaningful analysis
- Climate models appear to significantly overestimate the expected path of projected temperature anomalies
- Climate model path projections beyond 2025 are too disperse to provide reliable input for housing finance agency scenario analysis
- IAMs suffer from a number of technical issues and assumptions that call into question their reliability for financial and risk modeling by the housing finance agencies
- Integrating transition risk into housing finance agency scenario analysis would be of limited value due to confounding and compounding effects of the climate models and IAMs

Weak Linkages Exist Between Climate Science and Mortgage Risk

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- Climate and IAMs used to establish climate scenarios (SSPs and RCPs) produce outputs that are of limited value to conduct housing finance agency scenario and stress test analyses
- Transition-state scenarios, should not be imposed on the housing finance agencies for a variety of reasons:
  - These scenarios are too diffuse to implement into traditional financial scenario and stress test analysis
  - There is a paucity of data and empirical evidence linking climate change model outputs to financial and nonfinancial risk outcomes
  - The time horizons of these scenarios extend well beyond traditional financial regulatory stress test analyses – in some cases decades, and thus limit the reliability of any scenario analysis beyond a 1-5 year horizon
  - Even the NGFS acknowledges severe limitations of their scenarios:
    - "***Modelling the GDP impacts from transition risk and physical risk is subject to significant uncertainty.*** (NGFS Climate Scenarios 2020)
- Climate models and IAMs have not undergone model validations *consistent* with financial regulatory agencies.

Climate Scenarios are Incompatible with Housing Finance Agency Data and Risks

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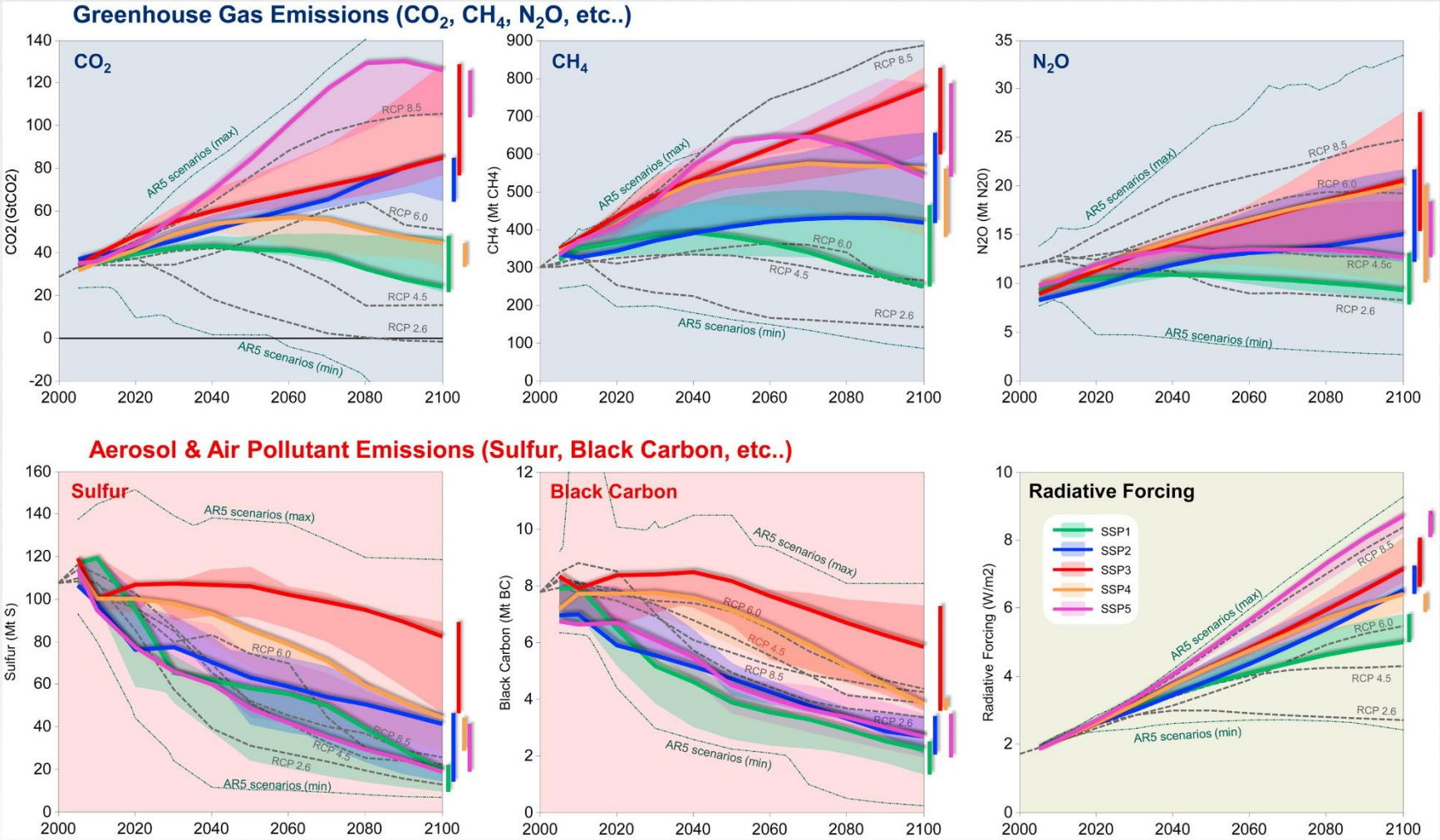
Shared Socioeconomic Pathways (SSPs) are simply incompatible with housing finance agency scenario analytics that are based on direct financial and economic factors



Climate Model Projections are Disconnected From Recent Experience

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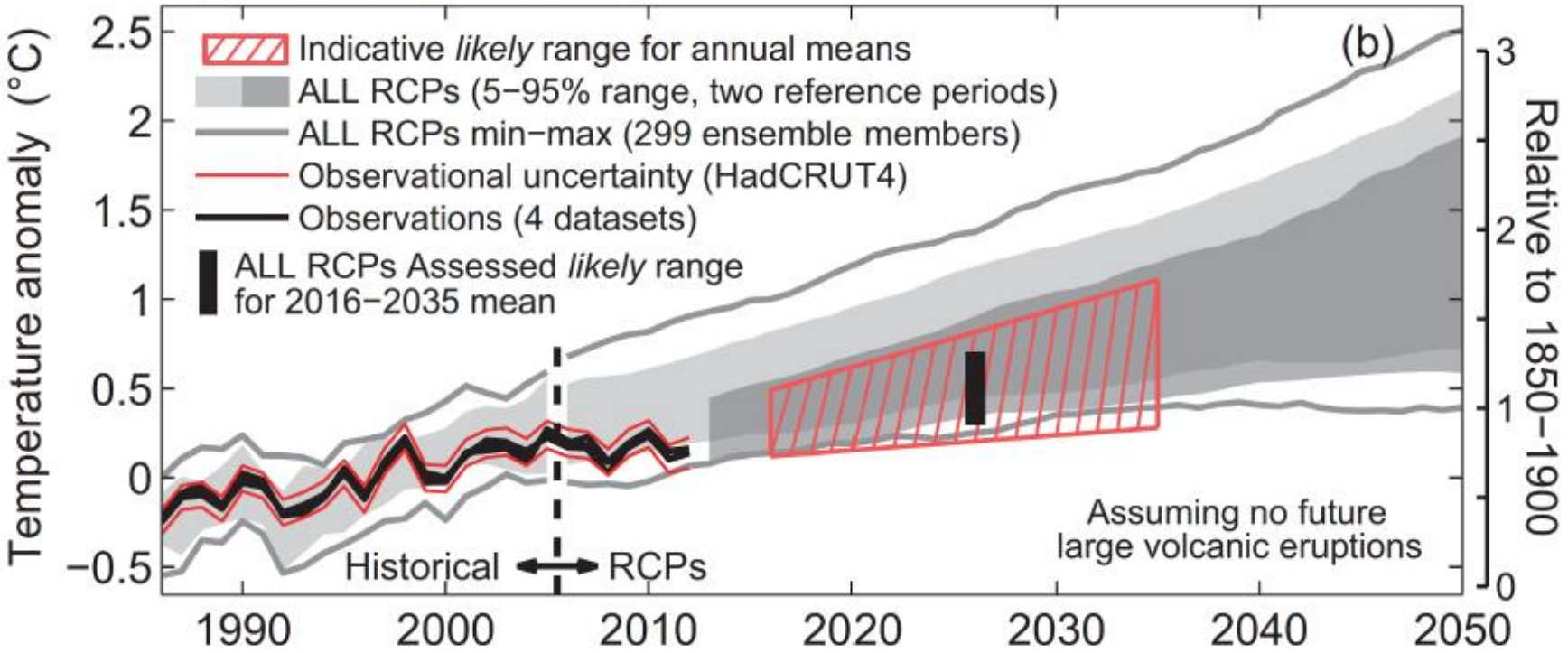
- The long-term drift of simulated paths of climate models is significantly above actual experience
- Furthermore, the variability in path projections is too high to be informative for financial institution scenario analysis

Figure 11-25b, IPCC (2013)



Integrated Assessment Models are Subject to Significant Model Risk

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- Model issues include:
  - Significant degree of model complexity and structural interactions making it difficult to understand model errors
    - ***Due to the structure of most IAMs, global aggregate metrics or otherwise highly aggregated skill scores commonly used to evaluate IAM hindcast experiments are likely to mask important deficiencies. (Pacific Northwest Laboratory, US Dept. of Energy, (2018)***
  - Lack of model transparency around key assumptions and model relationships lead to significant uncertainties in outcomes of IAMs
    - ***Given the challenges involved in producing IAM results and the many uncertainties underlying those results, I believe it is best to view these models as providing a good place to start in terms of basic principles and rough numbers to use in developing short-term (say through the next 5 to 10 years) policies and research priorities, but a poor place to finish in the design of specific longer-term global policies.*** **(Some Contributions of Integrated Assessment Models of Global Climate Change, John Weyant, Review of Environmental Economics and Policy, 2017).**
    - ***IAMs "are of little or no value for evaluating alternative climate change policies and estimating the SCC."*** **Pindyck, R. S. 2017. The use and misuse of models for climate policy. Review of Environmental Economics and Policy 11(1): 100–114.**

A Blueprint for Housing Finance Natural Disaster and Climate Change Risk Management

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- Ensure natural disaster and climate change risks are well defined and integrated into existing enterprise risk management frameworks for identifying, measuring, reporting and mitigating these risks
- Establish effective processes and mechanisms to disclose major natural disaster and climate change risks in public financial statements
- Focus risk assessment on measurement of direct risks
  - The use of physical and transition risk as a mechanism for assessing climate risk is ill-suited to the way risk assessment at financial institutions is conducted
- Consider developing innovative climate-specific risk management structures to transfer and distribute this risk
- Given current limitations of climate models and IAMs to produce outputs that can be integrated with financial and risk data, focus attention on:
  - Building data warehouses that combine natural disaster and climate change information with financial and risk data
  - Quantifying these linkages between natural disaster, climate change and mortgage risk

An Example of How to Directly Link Climate Events to Mortgage Risk

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- In a recent analysis[1], a large sample of Freddie Mac mortgages was combined with data from FEMA on declared disasters of hurricanes occurring between 2000-2013, and NOAA hurricane data for analysis of the incremental effects of hurricane intensity and frequency on mortgage default
- A standard statistical modeling methodology used in developing automated underwriting systems like those used by the GSEs was developed with borrower, loan, property and other traditional risk factors
- In addition, two variables depicting the intensity and frequency of hurricanes affecting the local market were included.
- The results from that analysis showed statistically significant and positive effects on mortgage default controlling for all other factors.
- Such information can be used to conduct sensitivity analysis of hurricane impacts based on NOAA hurricane forecasts over the next 5 years.

1/ ***The Connection Between Hurricanes and Mortgage Default Risk*, Clifford Rossi, GARP White Paper, 2020.**

An Example of How to Directly Link Climate Events to Mortgage Risk

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- Results from the statistical modeling were used to conduct sensitivity analysis on mortgage loan default with the results shown below.
- The percentage increase in hurricane intensity and frequency scenarios aligned with NOAA long-range hurricane forecasts and were used to quantify a forward-looking assessment of the incremental effect of hurricane risk on mortgage default.
- This type of analysis could be expanded across other climate change and natural disaster types and financial and nonfinancial risks as well as to measuring mortgage loss severity
- Moreover, such analysis could be used to simulate loss outcomes consistent with credit pricing models used by the GSEs today.

Sensitivity of D90+ Rates to Increased Hurricane Intensity and Frequency

% Increase in Intensity and Frequency	D90+ (%) Rates 3-5 Rated Hurricanes	% Change from Baseline D90+ Rates	Change in D90+ Rates (bps)	D90+ (%) Rates 3-5 Rated and 12+ Hurricanes	% Change from Baseline D90+ Rates	Change in D90+ Rates (bps)
Baseline	6.11			6.11		
10	6.14	.57	3.49	6.20	1.55	9.49
25	6.20	1.55	9.49	6.35	4.01	24.49
50	6.30	3.19	19.49	6.56	7.45	45.49
75	6.40	4.83	29.49	6.79	11.22	68.49
100	6.50	6.47	39.49	7.02	14.99	91.49

Edward Kearns

First Street Foundation

March 4 2021

FHFA Listening Session

FIRST STREET FOUNDATION

Who is First Street Foundation?

A nonprofit formed to communicate risks from climate change to individual Americans - starting with flood risk.

We provide property-level comprehensive flood risk estimates.

We recognize an urgent need for consistent, property-level, publicly-available flood risk information for the entire United States.

By democratizing this peer-reviewed flood risk data, First Street empowers Americans to protect their most valuable asset – their homes.

First Street built an expert team to develop the first comprehensive, publicly available flood risk assessment for each of 142M properties in the contiguous US.

We began by modeling every major flood type

There are four main causes of flooding events. Each is unique and each will change based on the environment.

Estimates are based on NOAA, USGS, and FEMA data, CMIP5 model outputs (RCP 4.5) and are used to estimate flood risks from 2020 to 2050.

Tidal

King tides

Tidal flooding in Miami

Pluvial

Precipitation

Pluvial flooding in Houston

Fluvial

Riverine

Fluvial flooding in Cincinnati

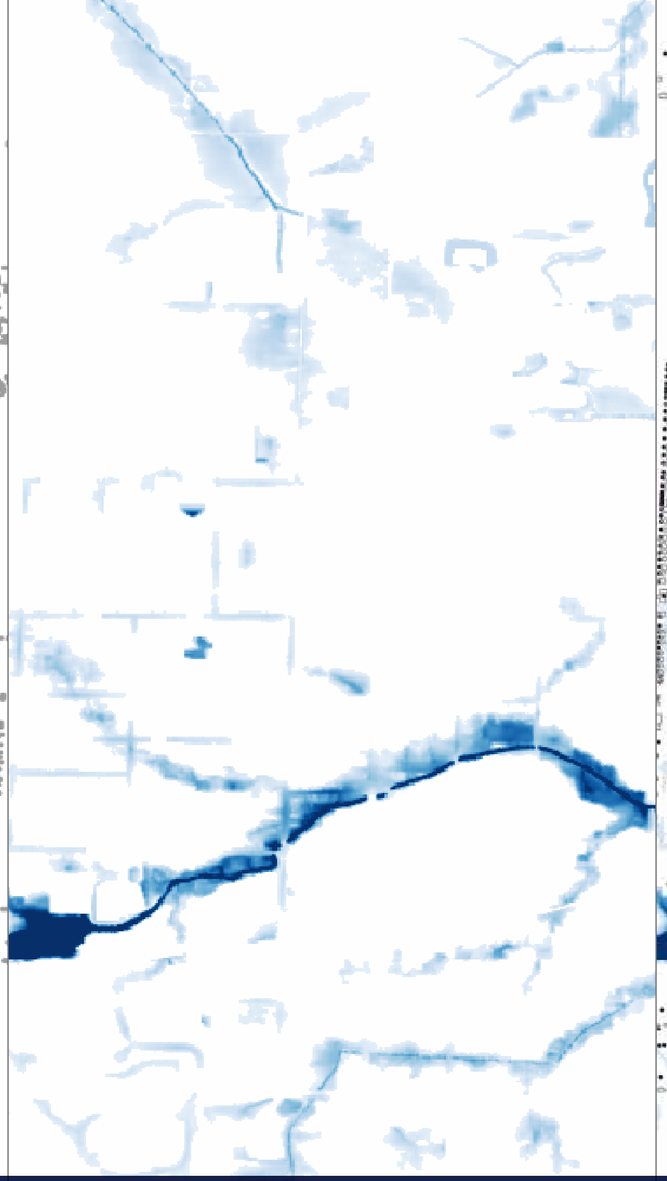
Surge

Hurricane

Surge flooding in Wilmington

Parcel data

Building footprints



Hazard layer

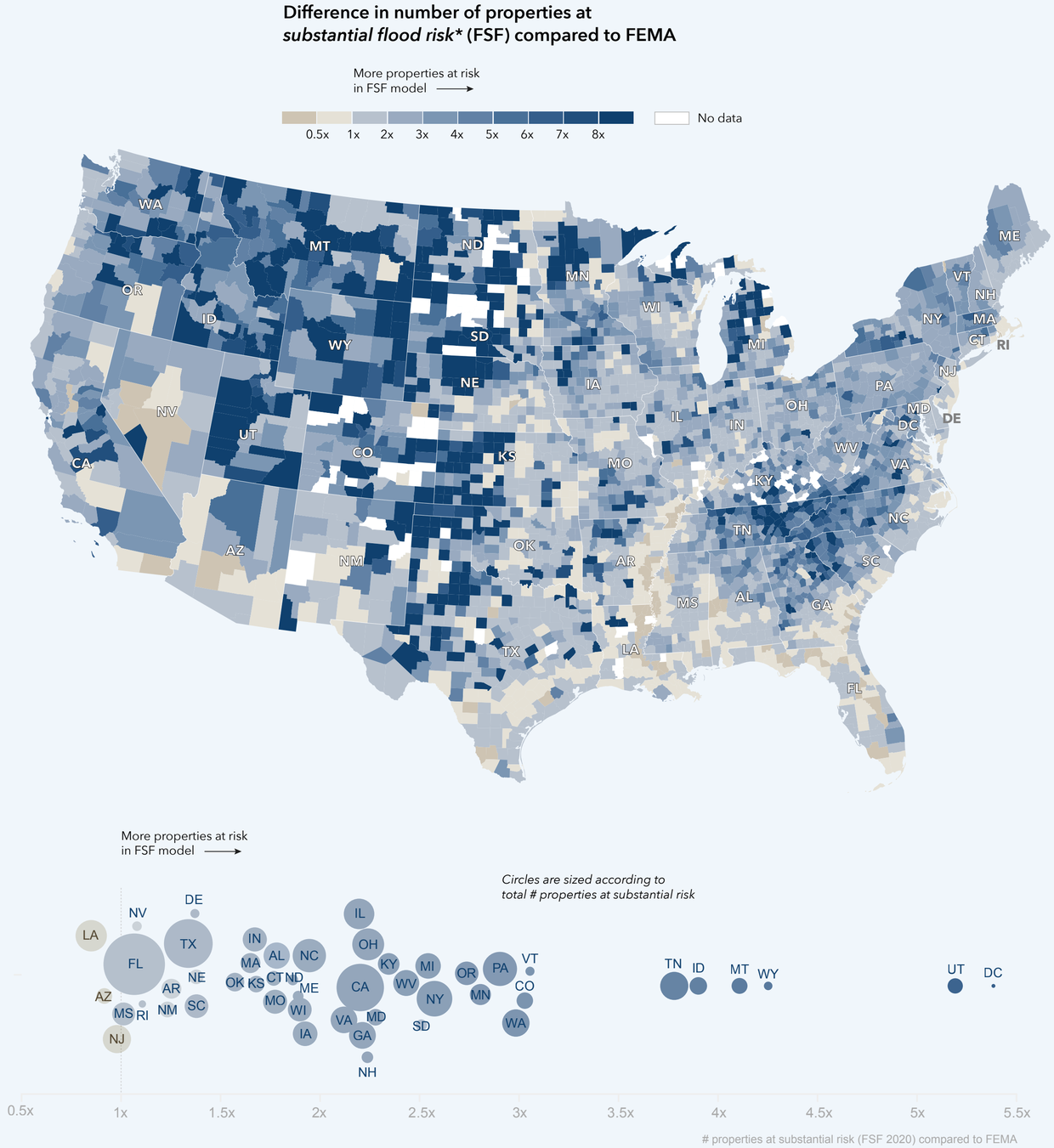
Max depth

(edge of building footprint or depth at property centroid)

Comparing our results to FEMA

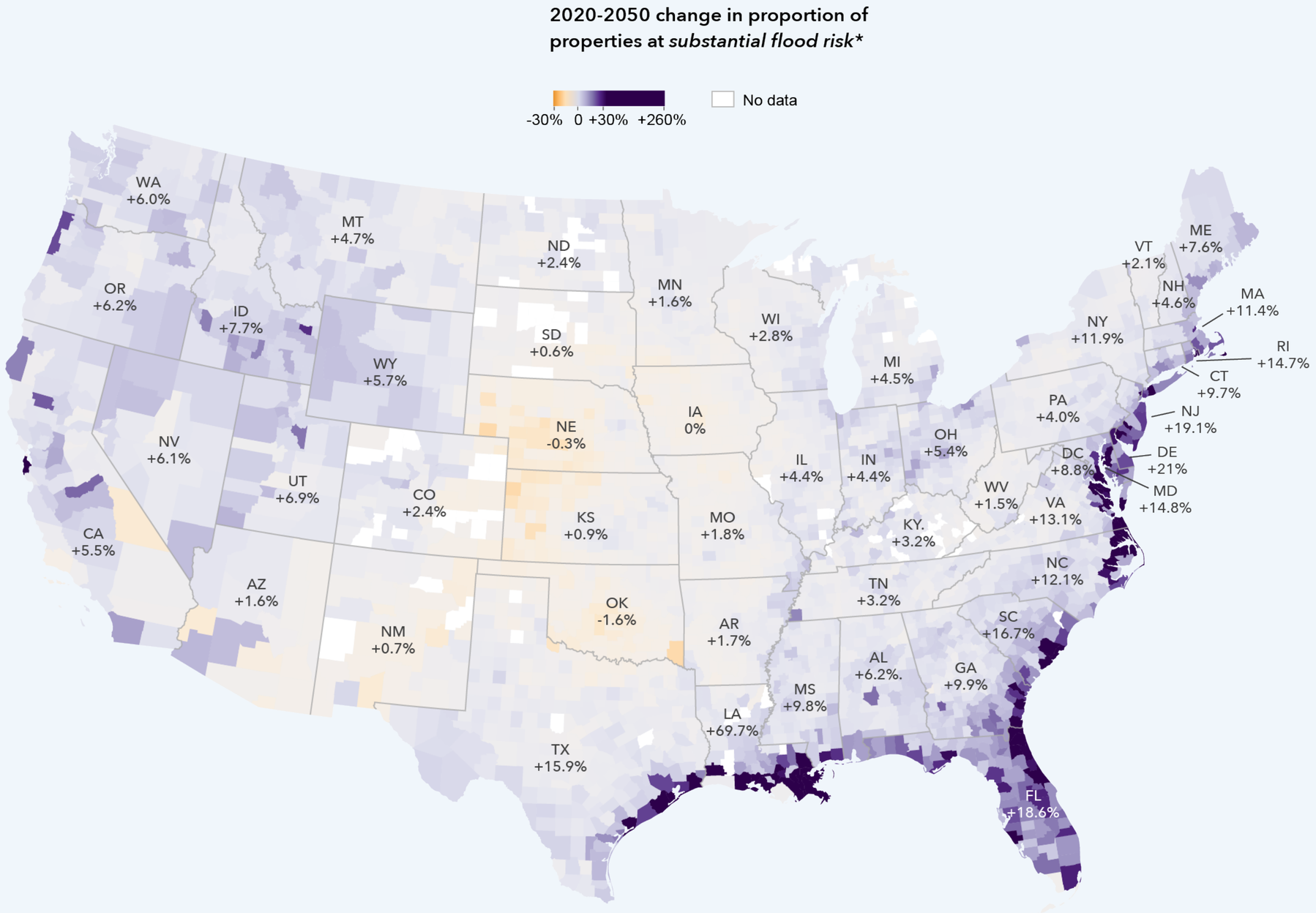
Comparing the FEMA Special Flood Hazard Area (1% annual risk) to the Foundation's same definition (1% annual risk for the median forecast in 2020), we show roughly 70% more properties as having that level than previously thought, representing an additional 5.9 million properties.

Source:
First Street Foundation



Current and future risk

Outside of the current risk calculations, the model is able to demonstrate how risk will change as the environment changes. While some portions of the country have dramatic increases in risk, others have reduction of risk. Overall, the model shows an additional 10.9% or 1.6 million properties as having that 1% or greater annual risk by 2050.



* Substantial risk is calculated as inundation 1 cm or more to the building in the 100 return period (1% annual risk)

The basis for all AAL calculations

We start with the current and future probabilities of flooding and associated depths of water to the building footprint we previously calculated as part of our release at the end of June through our peer reviewed methodology.

Annual risk today

Flooding likelihood	.2%	1%	10%	20%	50%
Water to building	36 in	30 in	25 in	18 in	12 in

Annual risk in 30 years

Flooding likelihood	.2%	1%	10%	20%	50%
Water to building	42 in	34 in	28 in	20 in	14 in

Calculated damage.

Using estimates of the house value, building characteristics, and USACE depth-damage relationships, we calculate the likely damage for each flood event based on each probability and the associated flood depth.

Damage calculations

- 0.2% chance of 36 inches of water to the building, minus 24 inches to the FFE leaves 12 inches of water inside the home which would cause 30% total structure damage to the $300,000 building = $90,000

  $90,000 In damage

- 1% chance of 30 inches of water to the building, minus 24 inches to the FFE leaves 6 inches of water inside the home which would cause 10% total structure damage to the $300,000 building = $30,000

  $30,000 In damage

- 10% chance of 25 inches of water to the building, minus 24 inches to the FFE leaves 1 inch of water in the home which would cause 5% structure damage to the $300,000 building = $15,000

  $15,000 In damage

- 20% chance of 18 inch of water to the building, minus 24 inches to the FFE leaves 0 water in the home which would cause $0 damage.

  $0 In damage

24 inches first floor elevation.
No damage inside the home below 24 inches.

Average Annual Loss.

Pulling together the damage of all the events with the probability, we can then turn the damage numbers into annual losses based on the likelihood.

Annualized calculations

- 0.2% chance of 36 inches of water to the building, minus 24 inches to the FFE leaves 12 inches of water inside the home which would cause 30% total structure damage to the $300,000 building = $90,000

  0.2% * $90,000 = $180

- 1% chance of 30 inches of water to the building, minus 24 inches to the FFE leaves 6 inches of water inside the home which would cause 10% total structure damage to the $300,000 building = $30,000

  1% * $30,000 = $300

- 10% chance of 25 inches of water to the building, minus 24 inches to the FFE leaves 1 inch of water in the home which would cause 5% structure damage to the $300,000 building = $15,000

  10% * $15,000 = $1,500

- 20% chance of 18 inch of water to the building, minus 24 inches to the FFE leaves 0 water in the home which would cause $0 damage.

  20% * $0 = $0

24 inches first floor elevation.
No damage inside the home below 24 inches.

Average annual loss

$180 + $300 + $1500 = $1,980 *Note we calculate all probabilities not just the listed ones here

Why does all of this matter to FHFA?

Increasing flooding due to climate change will impact millions of US homes. The value of homes with financial risk from flooding will be directly impacted. Valuations reflect many years of cashflow expectations so increasing annual costs coupled with growing uncertainty about new expenses will have large valuation impacts.

Current home value before rationalization

$$\text{Asset value} = \frac{\text{Net Operating Income}}{\text{Capitalization Rate}}$$

Home values after rationalization

$$\text{Asset value} = \frac{\text{NOI - Additional Cost Expectations}}{\text{CapRate + Additional Risk Premium}}$$

Demonstrating the impact to homes in Florida.

There are over 514,000 residential 1 to 4 unit properties in Florida with financial risk from flooding and in the SFHA meaning they are mandated to buy flood insurance if they have a federally backed mortgage. The average value of these homes is $620,000 and their NFIP premium is currently $2,467 a year and their AAL today is $11,865 and grows to $19,963 over the next 30 years.

Using a valuation approach of rental income allows us to understand the impact increased insurance cost will have to property values.

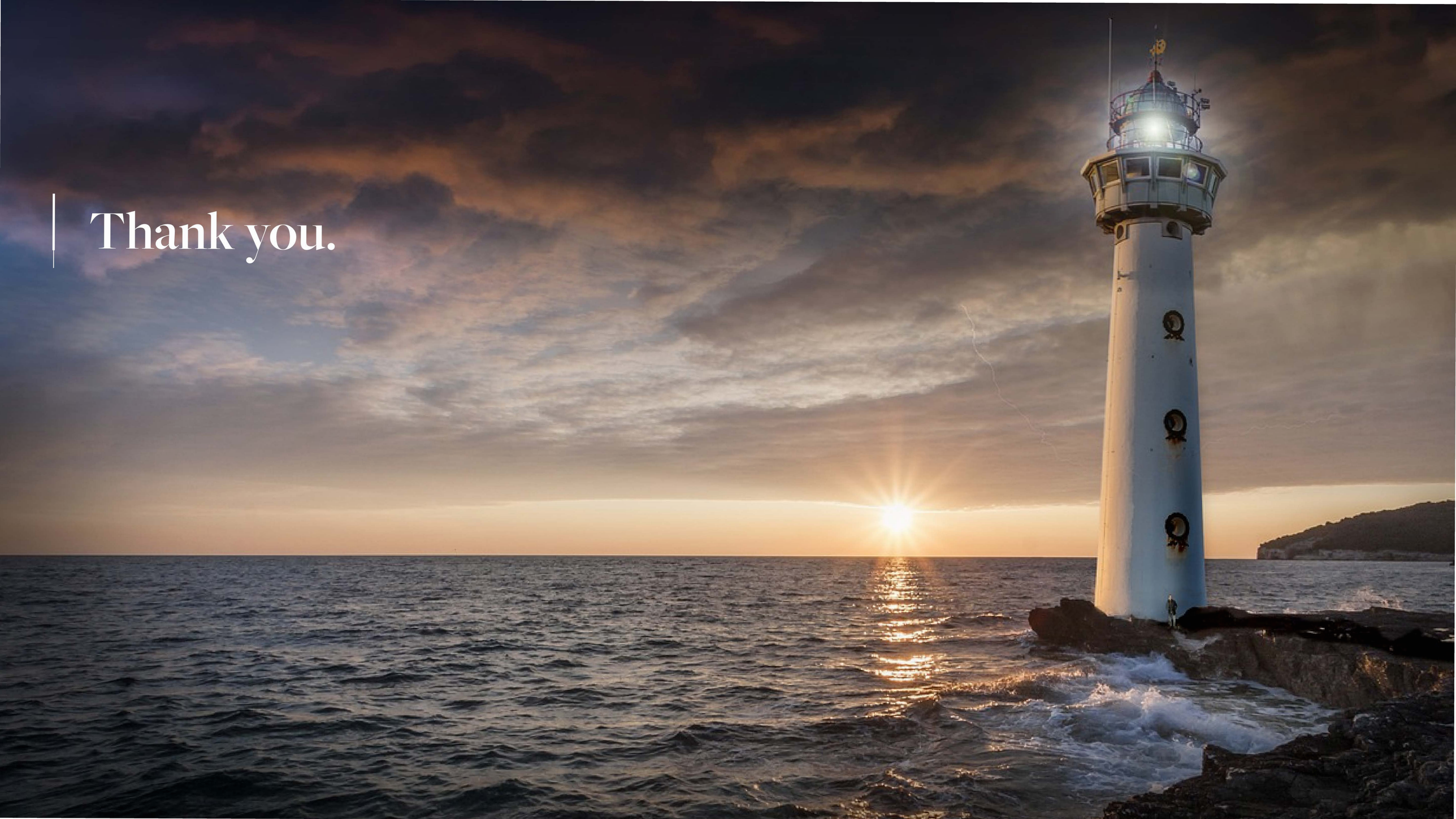
	Current	Repricing based on 2021 AAL	Repricing based on 2051 AAL
Annual rent	$35,000	$35,000	$35,000
Flood insurance cost	-$2,467	**X4.8** -$11,865	**X8.1** -$19,963
Annual costs ex flood insurance	-$7,733	-$7,733	-$7,333
Net operating income (NOI)	$24,800	$15,402	$7,304
Cap rate	4%	4%	4%
Property value (NOI ÷ Cap rate)	**$620,000**	**$385,050** (-$234,950 or -38%)	**$182,600** (-$437,400 or -71%)

Takeaways for FHFA

- First Street's models may be used to discern the current and future flood risk to individual properties and houses across the US. Open data and the science community's climate models have been used in an open and transparent fashion to estimate this risk at a reasonable precision.

- There are 4.3 million residential homes across the country with substantial (1%) flood risk that would result in financial loss. 5.7 million properties have any flood (0.2%).
- With the current National Flood Insurance Program (NFIP), rates would need to increase 4.5 times to cover the estimated risk in 2021, and 7.2 times to cover the growing risk by 2051.
- The AAL for the 5.7 million properties that have any flood risk and an expected loss from that flooding is $3,548, which totals to $20.3 billion in annualized expected losses in today's environment.
- Using climate projections for 30 years into the future yields a 67% increase in the average estimated annual loss, or $5,913 per property at risk of economic damage from flood, and an estimated $34.0 billion loss across the contiguous United States.

- The expected property losses due to flooding in the future are:
    - significant,
    - predictable, and
    - increasing with climate change.


Thank you.

Glenn Pomeroy

California Earthquake Authority

Residential Earthquake Insurance

- 1.1 Million Policyholders
- Publicly Managed/Privately Financed/Not for Profit
- $19 Billion in Claim Paying Capacity

Residential Earthquake Mitigation Grants

- Pre-1980 Homes/$3,000 Grant
- Retrofits to date: 13,700+
- 2021 Goal: 5,000 Retrofits

California Wildfire Fund

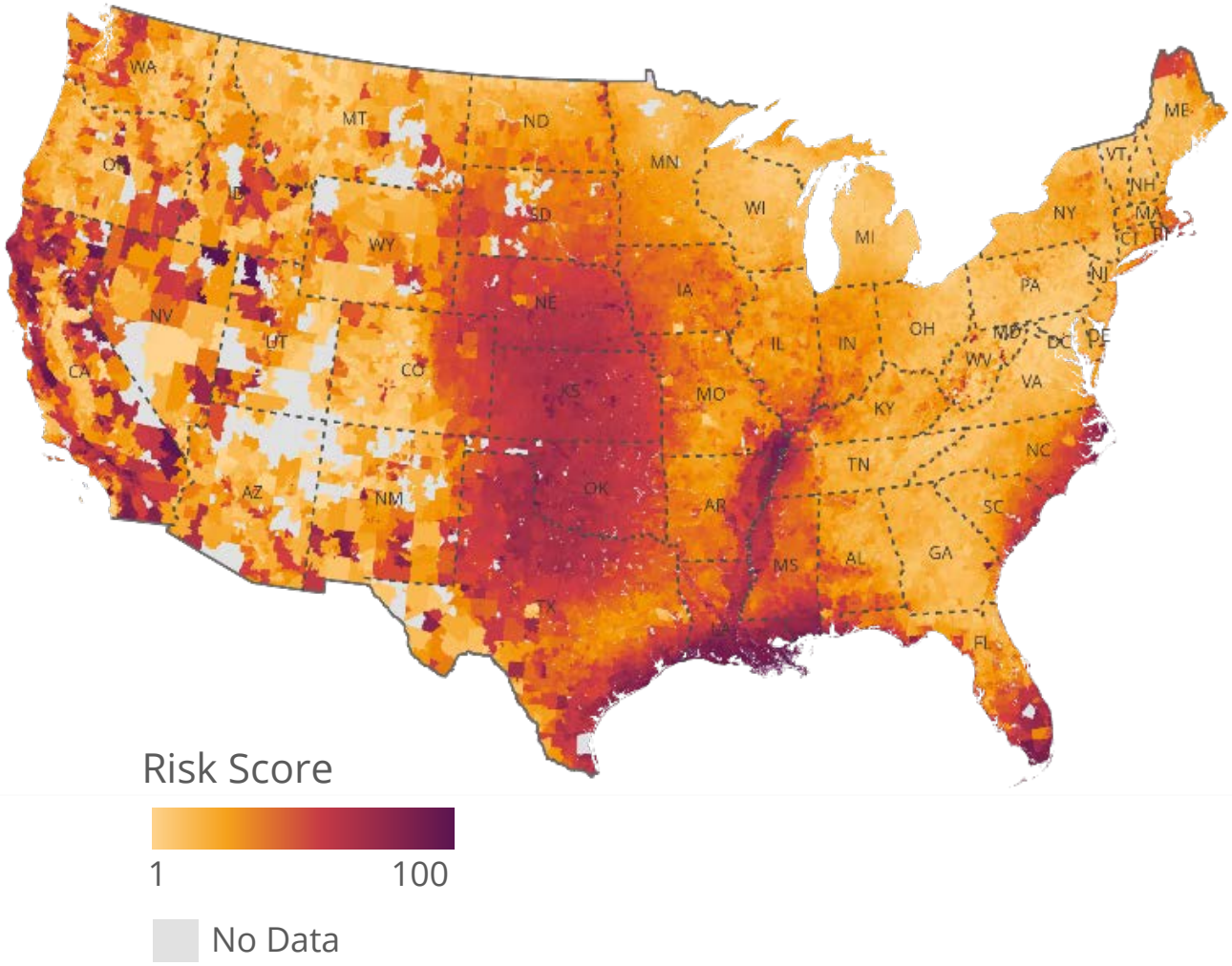
- Coverage for Wildfires Caused by Investor-Owned Utilities
- Overseen by California Catastrophe Response Council
- $21 Billion in Claim Paying Capacity

Stuart Pratt

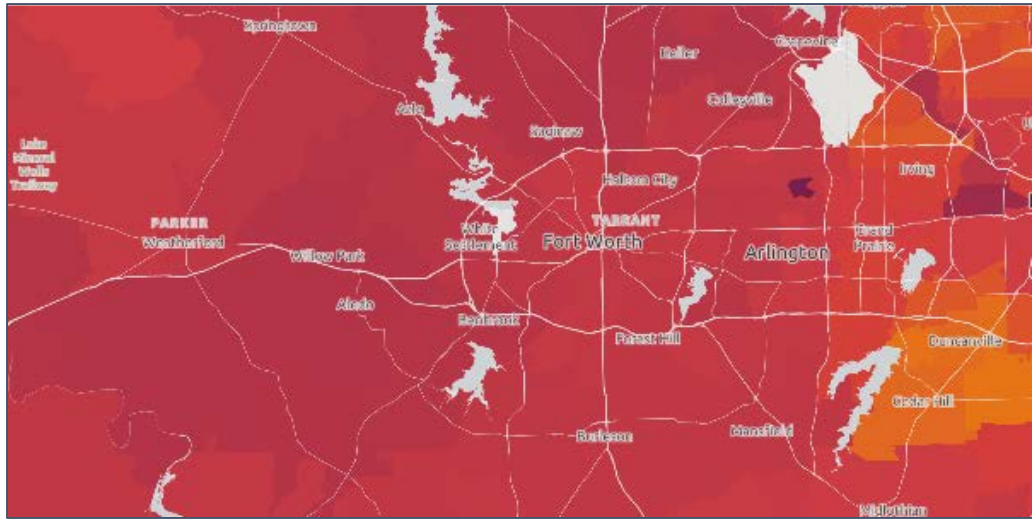
CoreLogic

Composite Risk

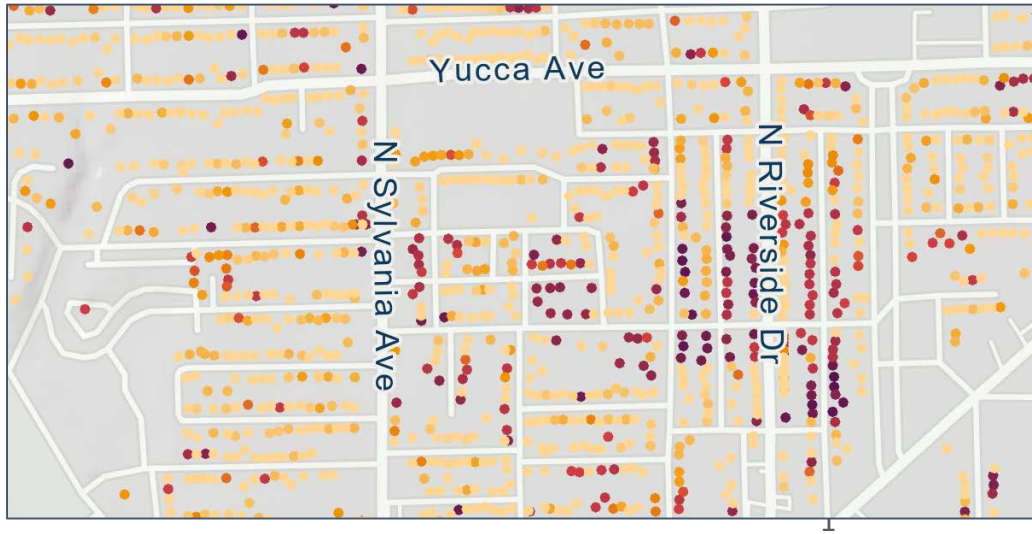
Average Risk Score by Zip Code



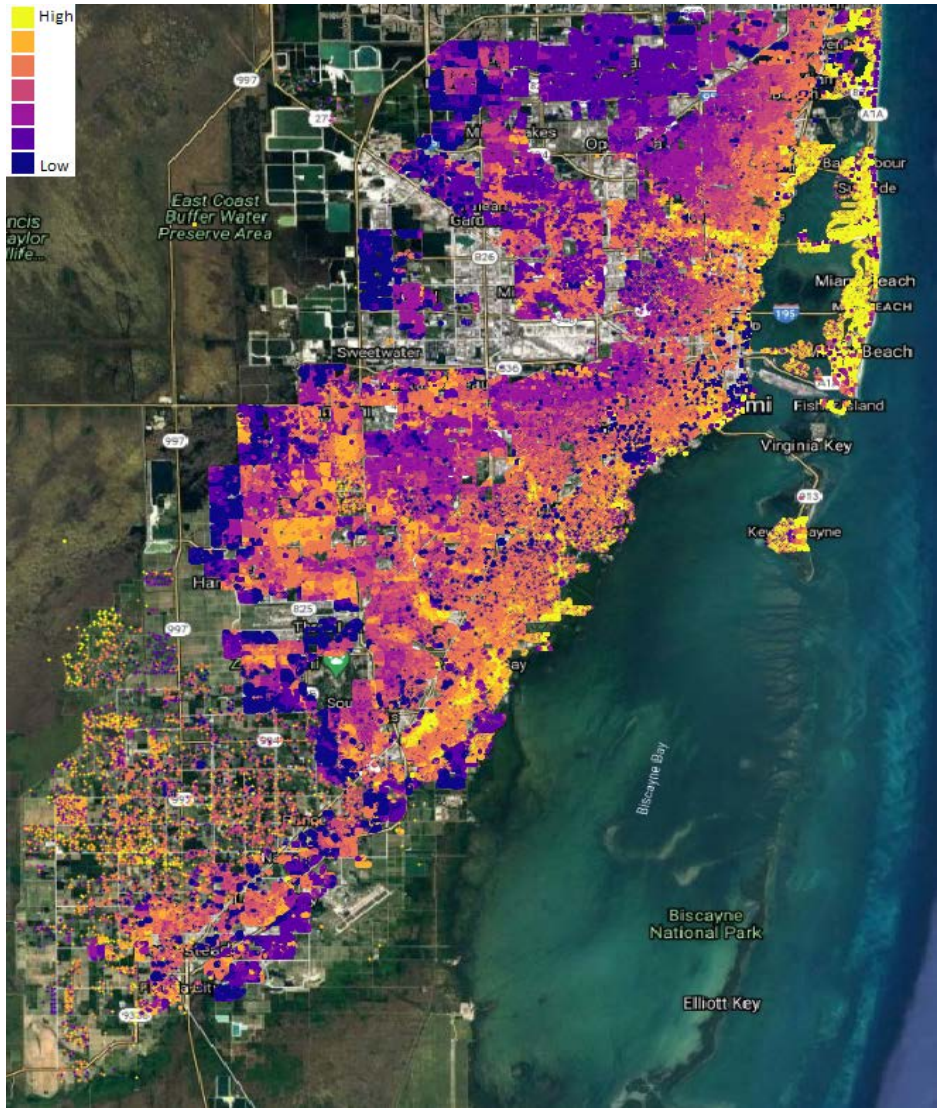
Tarrant County, TX

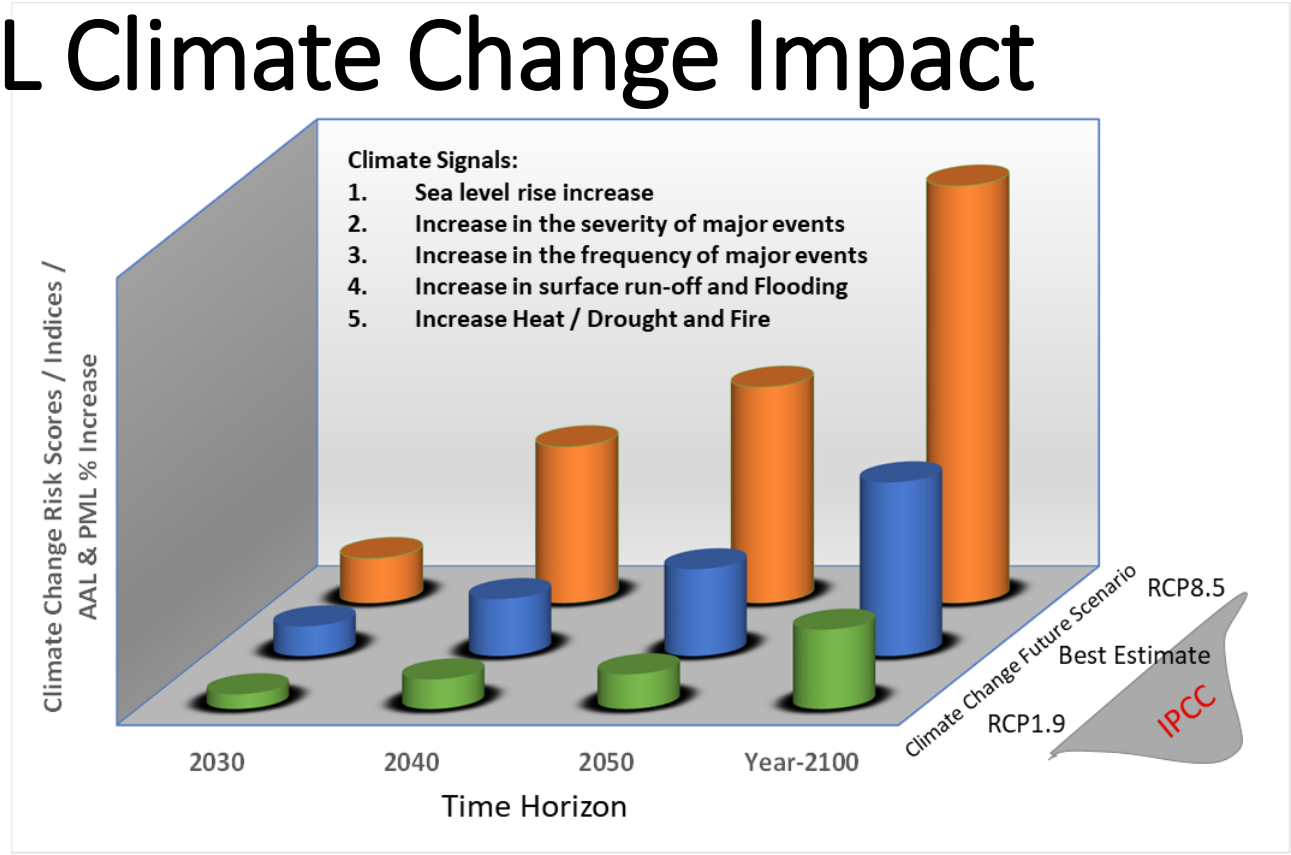


Fort Worth, TX (Property-Level Risk)



Miami-Dade County, FL Climate Change Impact





South Miami - Neighborhood

Robin Heid /Petr Zemcik

Moody's Analytics

Moody's Analytics

Better Faster Decisions

Climate Risk Assessment

Dr Juan Licari, Managing Director
Dr Petr Zemcik, Senior Director
Economics & Business Analytics

February 2021

Macroeconomic Climate Change Scenarios

Climate Risk Variables

Physical Risk

Global & regional temperature pathways
Climate-related perils (e.g. flood, subsidence)
Longevity
Agricultural productivity

Transition Risk

Carbon price pathways
Emissions pathways
Commodity & energy prices; energy mix

Macro-financial Variables

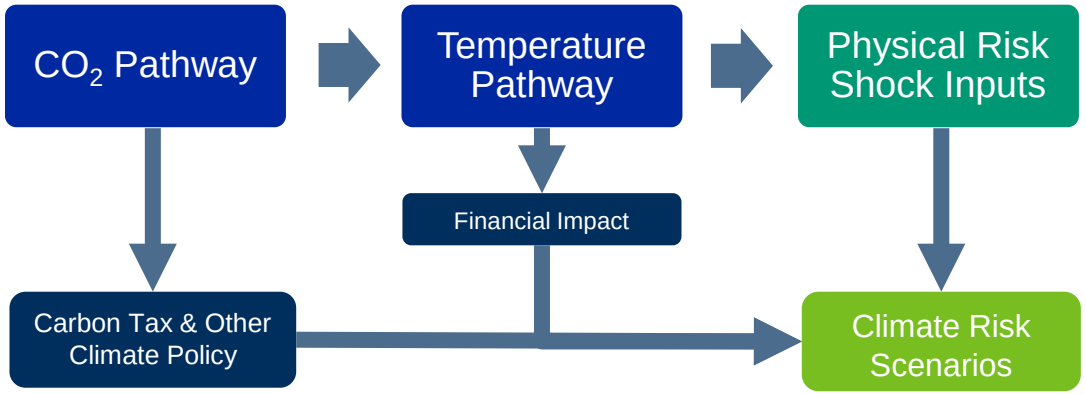
Macroeconomic Variables

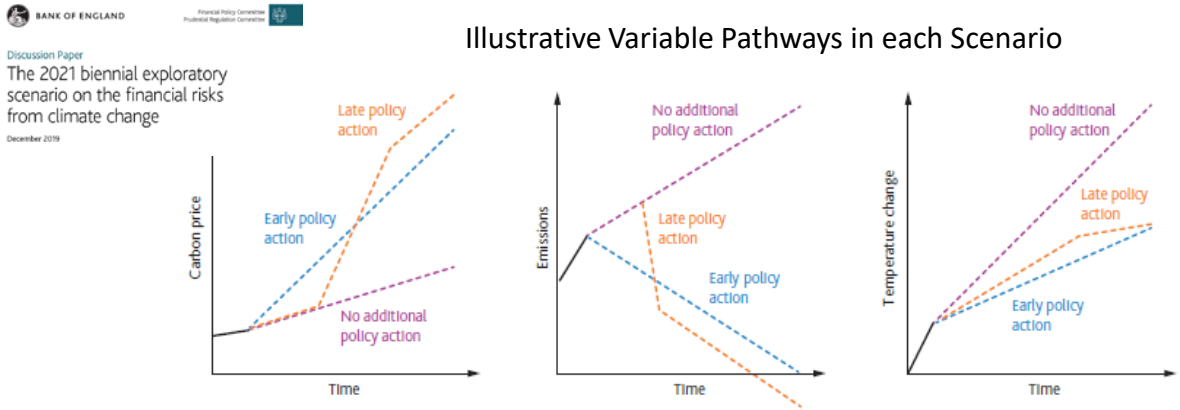
GDP & unemployment
Inflation & central bank rates
Corporate profits & household income
Residential & commercial property prices

Financial Market Variables

Government & corporate bond yields
Equity indexes
Exchange rates & bank rates

Start with parameters from regulators or clients and expand scenarios to populate additional variables using our Global Macro Model with climate risk components

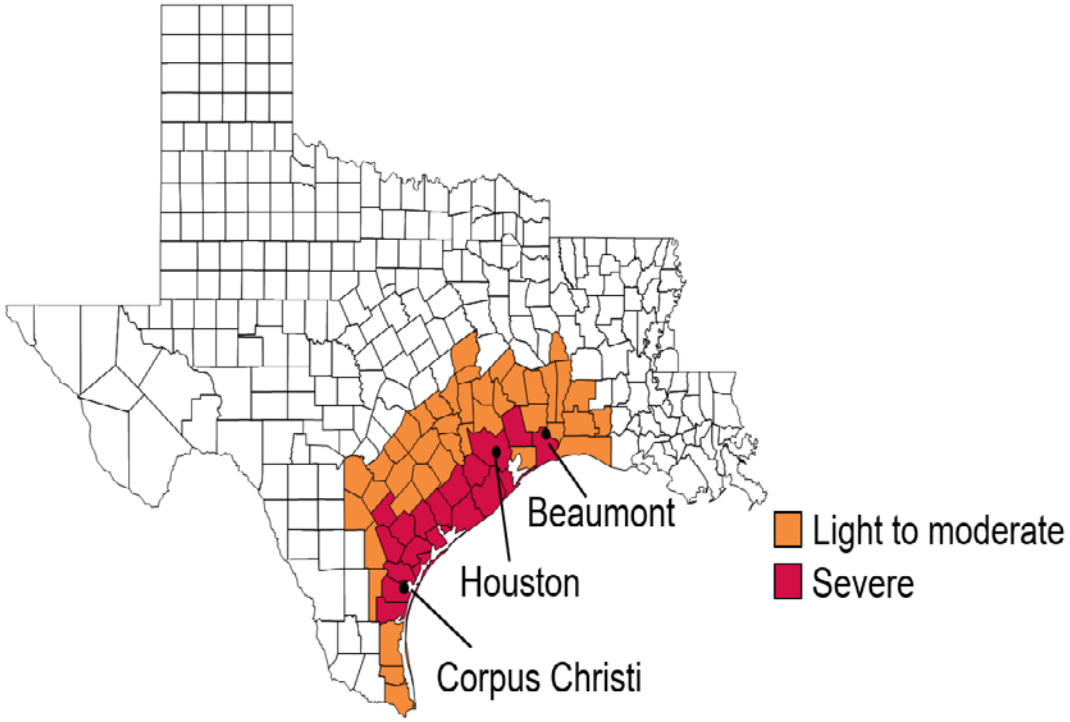




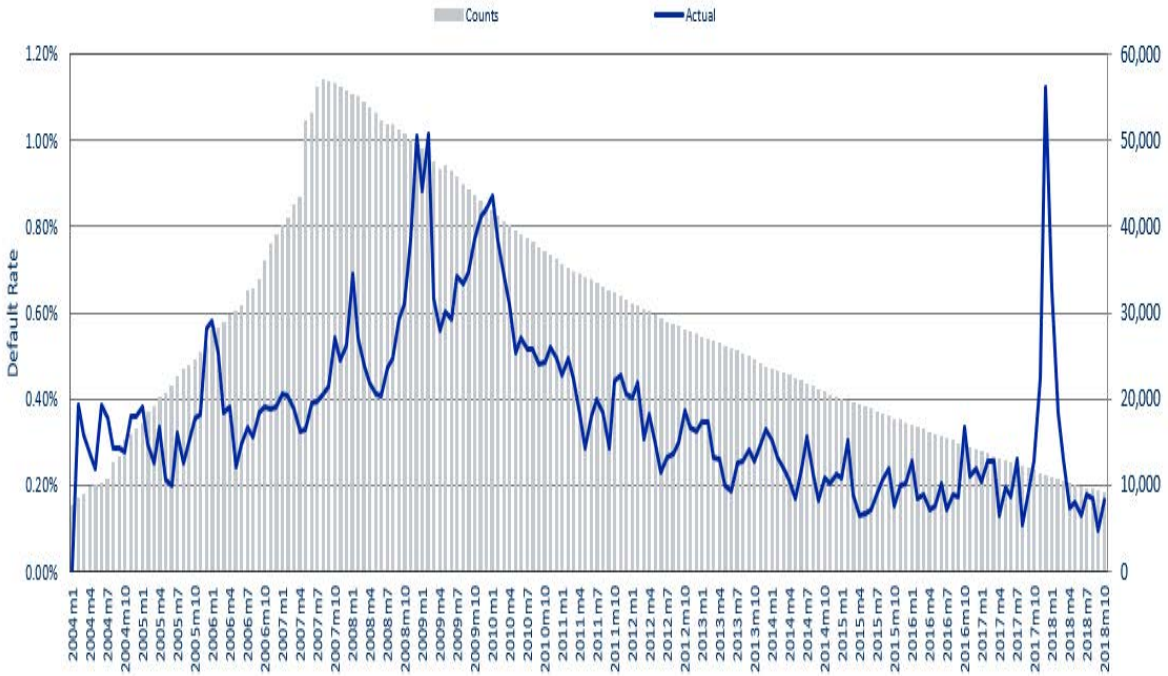
Acute Physical Risk

Harvey Leaves a Trail of Destruction

Economic Impact

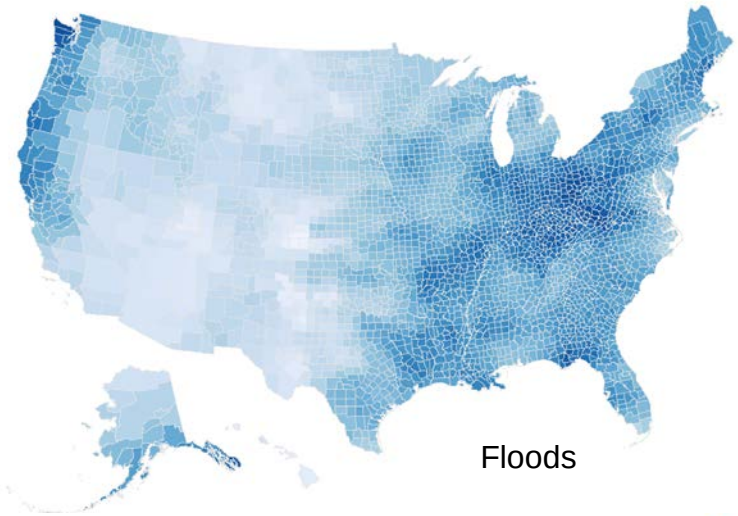


Default Model, Texas

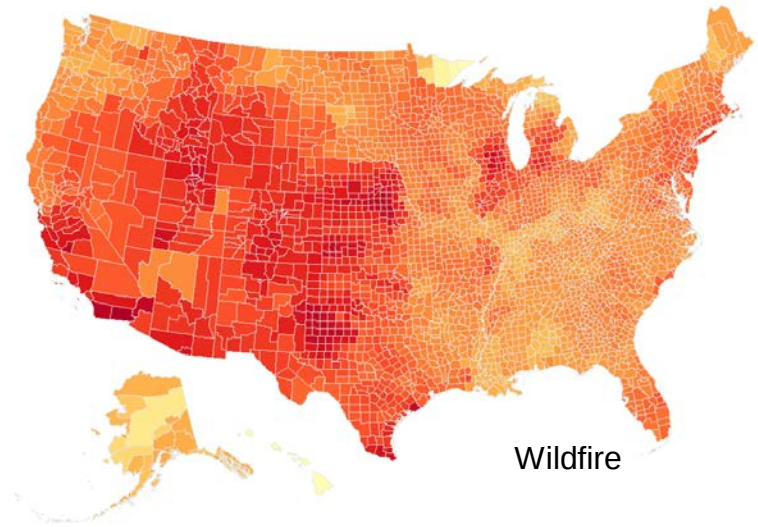


Chronic Physical Risk

Location-specific: 427 Scores



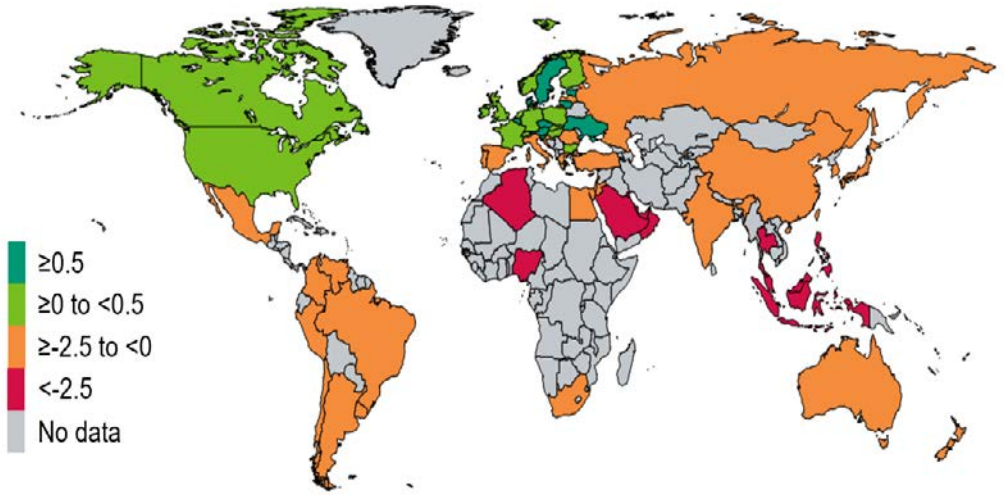
Floods



Wildfire

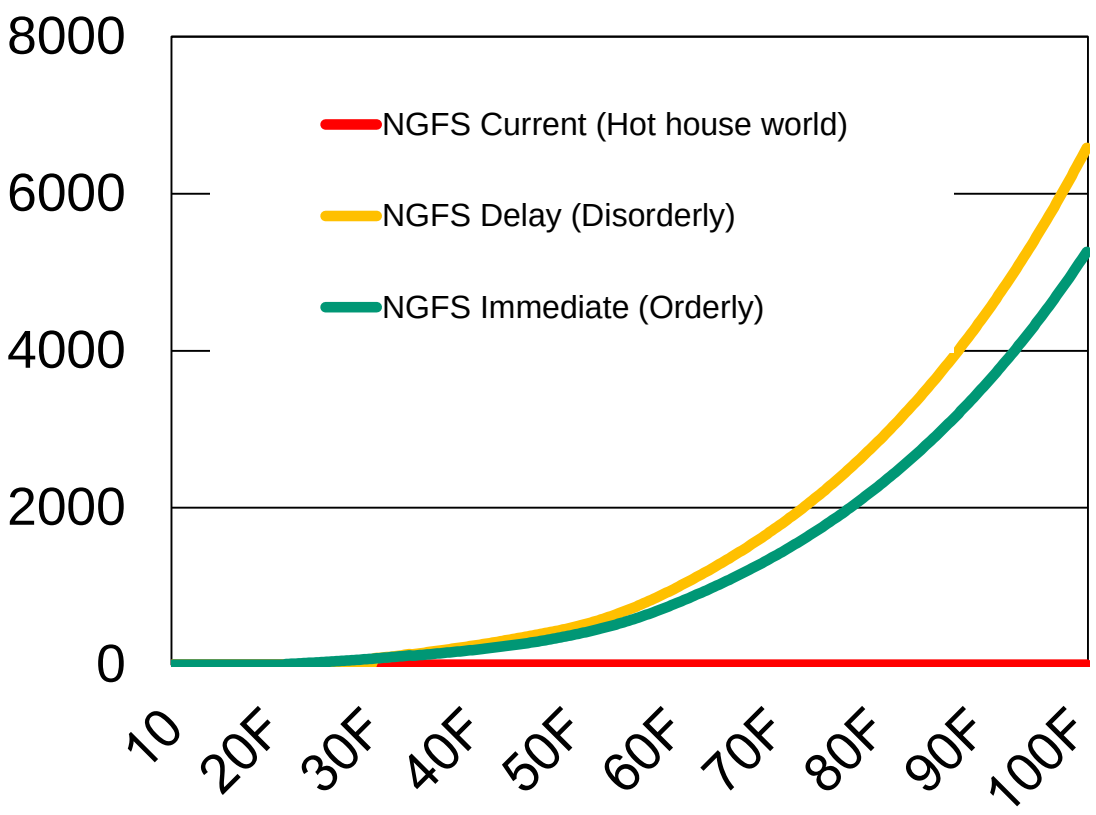
Global: Some Winners, More Losers

GDP, %change, 3º C temperature increase, RCP 8.5

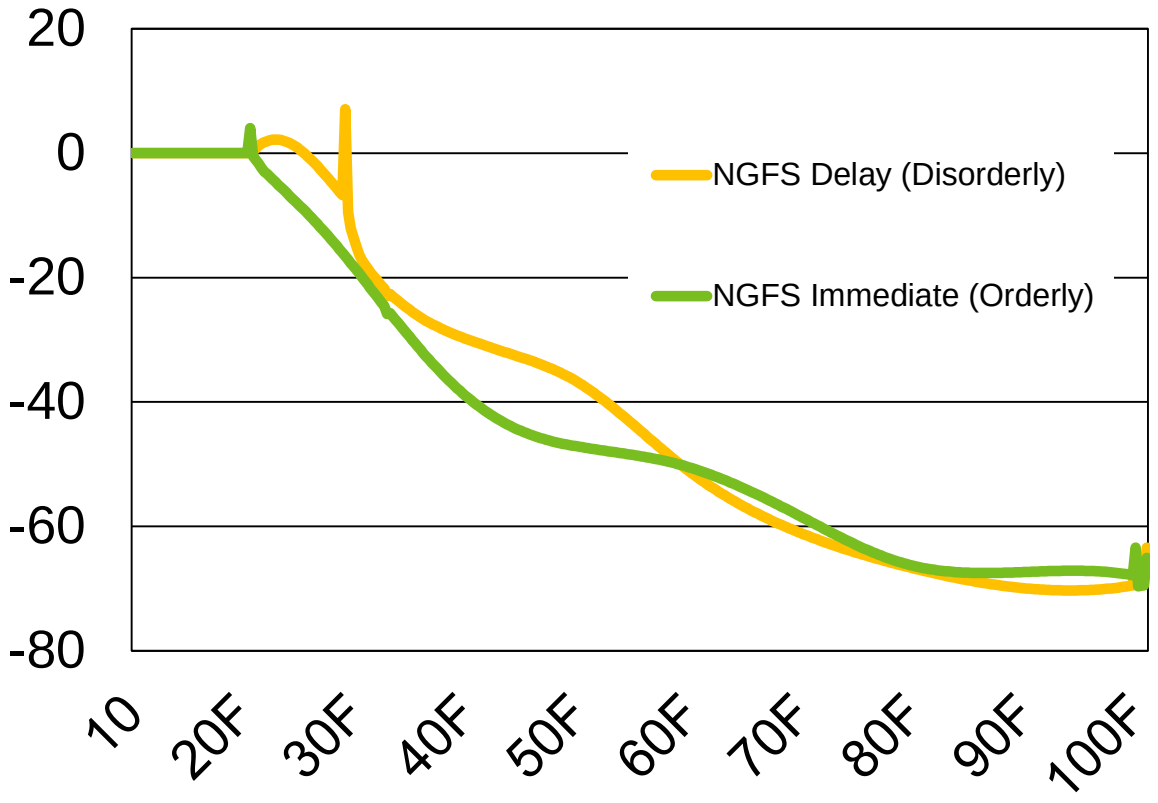


Transition Risk

Carbon tax, USD per metric ton, NSA



U.S. GPO – Mining Industry, % Deviation from Current



Climate Risk Adjustment for PD/LGD

Based on Physical Risk and Climate Change Scenarios

Mortgage Portfolio Analyser → Mortgage Portfolio Characteristics

Moody's Climate Change Forecast → Unemployment

427 Data, Physical Risk Scores → Location / Climate Hazards for a specific counterparty *in high risk area*

Model Factors

Panel logit model of the form

$$\Pr(Default) = \frac{e^{\alpha+\sum_{i=1}^{N_i}\beta_i x_i+\sum_{j=1}^{N_j}\mu_j x_{j,t}+\sum_{k=1}^{N_k}\gamma_k x_t}}{1+e^{\alpha+\sum_{i=1}^{N_i}\beta_i x_i+\sum_{j=1}^{N_j}\mu_j x_{j,t}+\sum_{k=1}^{N_k}\gamma_k x_t}}$$

16 28 24 22 16 12

Model Structure

Panel logit model of the form

$$\Pr(Default) = \frac{e^{\alpha+\sum_{i=1}^{N_i}\beta_i x_i+\sum_{j=1}^{N_j}\mu_j x_{j,t}+\sum_{k=1}^{N_k}\gamma_k x_t}}{1+e^{\alpha+\sum_{i=1}^{N_i}\beta_i x_i+\sum_{j=1}^{N_j}\mu_j x_{j,t}+\sum_{k=1}^{N_k}\gamma_k x_t}}$$

A country/regional-hazard damage variable is **introduced and calibrated** to amplify/reduce the impact of the climate-adjusted macro scenario

UK Sample	
Climate hazards	Scores
Average of Heat Stress Score	18.0
StdDevp of Heat Stress Score	5.6
Average of Water Stress Score	29.4
StdDevp of Water Stress Score	6.9
Average of Floods Score	18.1
StdDevp of Floods Score	17.0
Average of Hurricanes & Typhoons Sco	21.6
StdDevp of Hurricanes & Typhoons Sco	3.1
Average of Sea Level Rise Score	6.4
StdDevp of Sea Level Rise Score	13.6
Average of Socioeconomic Risk Score	10.6
StdDevp of Socioeconomic Risk Score	3.8

→ **Hazard damage factors**

Example

PD/LGD Adjustment

f^{-1}(PD 09-2020) = f^{-1}(**6.5%**)

+

△ Macro V.* shock = **2,5**

✖

Climate damage factor** = **1.54**

=

C-PD 09-202 = f(3.85) = **7.8%**

* Weighted average of the macroeconomic variables shocks by associated weights
** Weighted average of *Hazard damage factors* and *427 Climate Hazards scores* – those factors have an indicative value as they will be estimated during the project over the relevant sample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Prof. Ken Klein

California Western School of Law

Possible Ways to Improve Homeowner Outcomes after Natural Disasters ©

Ken Klein, Louis & Hermione Brown
Professor of Law

FHFA's Climate and Natural Disaster Risk Management at the Regulated Entities Public Listening session – Mar. 4, 2021

I bring to the table today perhaps a unique constellation of perspectives:

- I lost my own home to natural disaster in 2003.
- I worked as a business litigation defense lawyer defending, among others, insurers and mortgage lenders.
- I now am a law professor who teaches, researches, publishes, and presents on insurance, natural disasters, and mortgages.
- I have counseled hundreds of disaster survivors on the implications of their mortgages and insurance.
- I am a Consumer Representative to NAIC.
- I have presented by invitation to insurers, regulators, and financial institutions on these subjects.

I am starting from the following premises:

- As a policy matter, both the Mortgage Industry and the Federal Government want to promote homeownership.
- If a home is damaged or destroyed, then both the Mortgage Industry and the Federal Government prefer it to be rebuilt.
- The worst possible outcome is that the homeowner neither can rebuild nor pay off the mortgage, and so defaults.
- With increasing frequency, natural disasters either are destroying homes or at least so damaging homes as to make the home uninhabitable.
- If mortgage instruments can be revised to reduce the frequency of homeowners unable to get back home, then they should be.

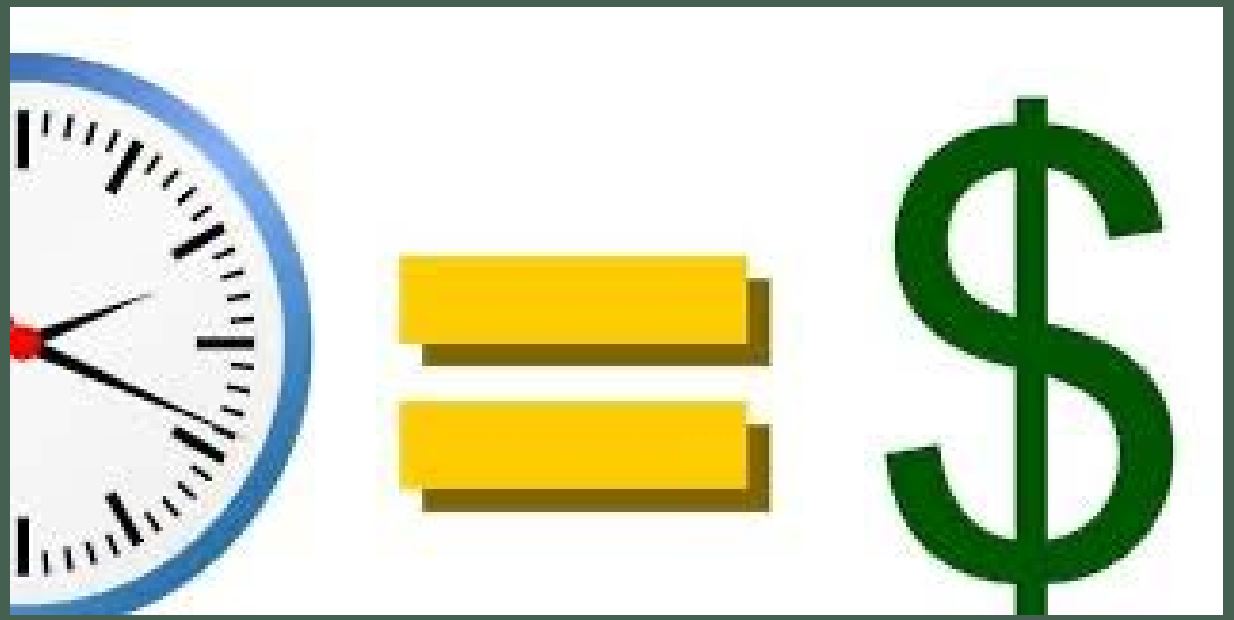
The two dominant impediments to a homeowner reconstructing are time and money

- **Time** – insurance typically allows one year to rebuild (insurance coverages such as personal property inventories and alternative living expenses are capped at one year). In some jurisdictions, in a federally- or state- declared disaster, this is two or three years. Increasingly, post-disaster the time to rebuild is on average more than two years, and often more than three years, especially in locations where even normal weather patterns shorten normal construction season (think: Winter in Colorado).
- **Money** – Many perils are not insured. When the peril is insured, the proceeds available from insurance are insufficient for the homeowner to complete reconstruction ("underinsurance"). And the proceeds are not generating return for the homeowner during the years the lender/servicer holds the proceeds.

Today I will very briefly explain how by revising Uniform Covenant 5 of the FNMA/FHLMC Template Deed of Trust (NOTE: the covenant is not exactly the same in all States), these impacts could be ameliorated


TIME

Multiple Causes of Delay



- Time to settle claim
- Access to funds
- Time to construct

ONE PIECE OF A POSSIBLE SOLUTION: Modify Covenant 5 to provide that mortgage-compliant insurance, when loss occurs in a state- or federally- declared disaster, must provide that all coverages must be open a minimum of three years.

Covered Peril

Voluntary take up rates for flood insurance or Earthquake insurance are low:

- Flood:
  - 13% - 15% of homes are insured for flood
    - 40% of flood-insured homes are required to have flood insurance
    - Meaning only 9% - 10% of homeowners in U.S. who have a choice choose to have flood insurance
- Earthquake:
  - Only 7% - 8% of homes are insured for earthquake
    - Essentially none of which is mandatory
    - Even in California, only 10% of homes are insured for earthquake

Voluntary take up rates for hazard insurance are high:

- Fire:
  - 91% of homes have ‘standard’ home insurance
    - 59% - 66% of homes have a mortgage
    - Meaning 74% - 78% of homeowners in U.S. who have a choice choose to have fire insurance

POSSIBLE SOLUTION: Modify Covenant 5 so that mortgage-compliant insurance is an HO-3 with no excluded peril.

Underinsurance

The underinsurance problem, boiled down to its essentials, is that the data suggests:

Most people *think* they are fully insured.

Most people are underinsured.

Most people are underinsured by a lot.

There isn’t precise data on how many, how often, or by how much.

No one tells homeowners about any of this.

When mortgages or refi's are in escrow, lenders do not check.

POSSIBLE SOLUTION: Modify Covenant 5 to require that mortgage-compliant insurance provides that an insurer must make an an estimate of the home's full replacement value, an if a homeowner accepts the insurer's estimate of full replacement value, then if the the actual reconstruction cost is insufficient by more than 5%, the coverage will be modified to bring it up to 95% of actual reconstruction cost.

Interest

Multiple problems:

- Accounts are non-interest bearing
- Accounts are not federally-insured
- Money is not required to be dispersed as a construction loan would be dispersed

POSSIBLE SOLUTION: Consider providing explicit directives to lenders/loan servicers that without regard to the space given to financial institutions in extant or future FNMA/FHMLC loans, lenders and loan servicers will be required to:

Release	Do not hold insurance proceeds in excess of the outstanding balance of the loan.
Pay Interest	Pay interest on held proceeds at the greater of the 2% simple or whatever return the financial institution is making on the funds.
Disburse	Fund control release of proceeds on no slower schedule than the same schedule as a construction loan funds would disburse.
Insure	Hold funds in a federally-insured account. And federally insure the entire balance without regard to FDIC limits on voluntary deposits.
Enable	Confirm that it is the borrowers' option whether to use the funds to rebuild or to pay off the loan.
Support	Provide a direct contact with authority within the financial institution rather than through a third-party vendor.

What next?

- Obviously, all these possible solutions have nuance, pros, and cons.
- A nine-minute speaking slot does not allow for that discussion.
- I will submit detailed written comments by the April 19, 2021 deadline.
- Thank you for the invitation to introduce you to these matters today.