Testimony of Mr. Matthew Eby,
Chief Executive Officer and Founder of the First Street Foundation
Before the Senate Committee on the Budget

March 1, 2023

“Rising Seas, Rising Costs: Climate Change and the Economic Risks to Coastal Communities”

Introduction

Good morning Chairman Whitehouse, Ranking Member Grassley, and members of the Senate Committee on the Budget. My name is Matthew Eby, and I am the Chief Executive Officer and Founder of the First Street Foundation, a nonprofit organization headquartered in Brooklyn, NY that is dedicated to making climate risk information accessible, easy to understand, and actionable by individuals, businesses, and governments. I thank you for your invitation and the opportunity to speak and describe how the First Street Foundation is quantifying and communicating climate risk for the United States - and to relate our findings to the Committee.

First Street Foundation is a 501(c)(3) nonprofit and nonpartisan organization of 40 individuals and well over 100 direct partners who are experts in climate change, data science, software engineering, communications, and marketing. To make climate change information most useful for decision making, we have focused on making this information personally relevant by creating high resolution physical climate risk models and distilling those models down to individual homes, businesses, and properties. We use deterministic computer modeling of physical processes such as flood, wildfire, extreme heat and wind, and we are able to generate very high-resolution estimates of current and future risk, which can be used both at the property-level and aggregated to the county, zip code, census tract, or other areas. We have partnered with the global engineering and consulting firm Arup to assign losses based on their expertise with damages to homes and businesses. We also have partnered with experts from the Pyregence Consortium, Rhodium Group, and dozens of top academics like Dr. Kerry Emanuel from MIT, to develop our wildfire, flood, wind and extreme heat models.

We communicate a property-specific risk today and project it up to 30 years into the future, provide an easy-to-understand 1-10 score that quantifies the risk, create a plethora of secondary exposure statistics to understand the specifics of that risk, and quantify the financial impact to each property as well - putting a price tag on that risk. We make this freely and publicly available at-Risk Factor (riskfactor.com), to democratize climate risk information, address the asymmetry that exists in the market, and to ensure that all individuals and communities have access to high quality and property-specific information. We do not advocate for any particular actions or policies to address climate change, but we work to empower all Americans to make informed decisions and actions to reduce climate risk for themselves, their families, and their communities. We truly believe that what gets measured, gets managed.

In addition to the individual climate risk information, we also make this data available in bulk and through our Applications Programming Interface (API) to Local, State, and Federal Governments along with corporations who are interested in conducting portfolio or National-scale analyses. Over 30 Federal agencies and GSEs currently have access to First Street Foundation data including FHFA, EPA, HUD, Commerce, Interior, the Federal Reserve Banks, Fannie Mae, Freddie Mac, and Treasury's Office of Financial Research. Our data is also integrated into EPA's EJSCREEN and the Council for Environmental Quality's CEJST tools where they are combined with other Federal datasets for widespread use. State level governments such as South Carolina's Office of Resilience and city and local governments such as Louisville, KY, Broward County, FL, Genesee County, NY also leverage our data to make informed decisions to address the physical impacts of climate change. Outside of governments, our data is leveraged by top institutional investors, consultants, insurance, and reinsurance, along with the largest American banks, community banks, and more. Lastly, we are especially proud of our direct integrations with residential real estate portals like Realtor.com and Redfin.com who provide our data directly to millions of users every day to ensure they are considering the impacts and financial risks associated with the purchase, sale, or rental of any property in the country.

First Street Foundation employs an open science approach to our work, meaning that we publish all of our methodologies and techniques to ensure trust in our results and to help the science community continue to make new progress, building off of our work. Through our Research Lab, we have made First Street Foundation data available to over 100 leading academic research groups for their use in socio-economic research. We are proud to have signed a Space Act agreement with NASA's Goddard Space Flight Center's Applied Sciences group with whom we collaborate on future advances on the applications of climate science and the communication of results to citizens, industry and governments. As a nonprofit, we embrace opportunities to collaborate with the science community and generate information products that benefit the Nation. We are supported both by generous philanthropic donations from groups like the 2040 Foundation, Bill and Gigi Clements Foundation, the High Tide Foundation, and the Grantham Foundation, through the commercial sales of subscriptions to our data, information and support services for industry and governments, and in-kind contributions of data and credits from Amazon Web Services and Mapbox.

Today, I will describe the highlights of First Street Foundation's findings related to climate risk that we have generated over the past 5 years, as a combination of the estimated exposure of each property in the United States to the environmental perils posed by climate change, and of the vulnerability of the buildings on those properties to that exposure in dollars and cents. We have employed models of flood, wildfire, winds, and heat to create probabilistic estimates of exposure to each of the approximately 143 million properties in the US.

Overall, we find that climate change is impacting risks today and is a demonstrable threat to personal, business, and community well-being for the future. According to NOAA, estimated economic losses from environmental perils are generally increasing across the country, and over the last 40 years have averaged around $47 billion per year aggregated across flood (including severe storms and tropical cyclones), wildfire, and wind perils[1]. These metrics are conservative in regards to the country's current risk given that they are averages over the last 40 years and we've seen substantial increases in risk over that time due to the impacts of climate change and the continued development in at-risk areas. In fact, the estimates from the First Street Foundation Flood Model finds that there is already $20 billion in average annualized loss (AAL) estimates today, specifically from direct property damage to single family (1-4 unit) homes from flooding alone, with that expected to grow to $32 billion over the next 30 years from climate change alone. Commercial properties are at risk of an additional $14 billion in property damage today, growing to $17 billion over 30 years, and account for a huge amount of indirect community economic risk through the disruption of supply chains, lost labor, and lost productivity. These indirect costs associated with commercial building flood risk are around $50 billion today, growing to $63 billion in 30 years. Along with that, the First Street Foundation Wind model finds around $18.5 billion in annualized property damage risk today, growing to around $20 billion in 30 years which we have yet to calculate the downstream economic impacts of. The results from the First Street Foundation Fire Model indicates that the Nation can expect to see an increase of 3.5 times the number of homes lost to wildfires today, resulting in 20,000 homes estimated to be lost per year in 2053 with expected losses of over $5 billion. Taken together, the annualized economic risk without those downstream economic impacts already account for about $104 billion in annualized economic loss today and growing to roughly $137 billion over the next 30 years due only to changes in the environmental conditions that drive these perils.

We hope that First Street Foundation's specific calculations of the exposure and losses to climate perils will inform actions that citizens and industry can take to reduce their risk, make their homes and businesses safer, and result in more resilient communities throughout the US. We also hope that these information products may be used by local, state and federal governments to direct available infrastructure and risk mitigation funding from the Federal government towards those communities that quantifiably have the greatest climate risk.

[1] https://www.ncei.noaa.gov/access/billions/

Climate Perils

First Street's computer models and methodologies used to resolve environmental risk for the US in a parcel-specific and climate-adjusted fashion are fully described by a combination of peer-reviewed journal articles and online documentation[2]. Below we list the most significant statistics related to each climate peril and our novel findings related to the physical and economic risks facing the Nation.

Flood - *Flood risk is the most expensive and prevalent environmental risk and many more American homes and businesses are at risk of severe flooding than previously understood by Federal estimates.*

The First Street Foundation Flood Model incorporates sea level rise, heavy precipitation, storm surge, and riverine flooding effects to produce nationwide, property-specific estimates of compound flood risk for today and 30 years into the future. At the national level, the First Street Foundation Flood Model identifies around 1.7 times the number of properties as having substantial risk (1% annual risk or greater) compared to the FEMA 1-in-100 Significant Flood Hazard Area (SFHA) designation. This equates to a total of 14.6 million properties across the country at substantial risk, of which 5.9 million properties and property owners are currently unaware of or underestimating the risk they face because they are not identified as being within the SFHA zone. As previous FEMA testimony from 2021 has shown[3] already 40% of flood claims are currently from outside the SFHAs, and FEMA is not yet including either heavy rainfall or climate change effects in their estimates of flood risk. First Street Foundation believes that by not incorporating climate change effects in estimates of current and future flood risk, that Americans are being placed at significant economic and physical peril through exposure to systematically underpredicted risk. First Street Foundation's economic analysis found that across the country, there are 4.3 million properties with *substantial* flood risk (1% annual risk or greater) that would cause economic damage to the building if that event were to take place, which results in an average estimated annual loss of $4,694 per property with identified damage risk, totaling $20.0 billion in annualized damage across the country today.

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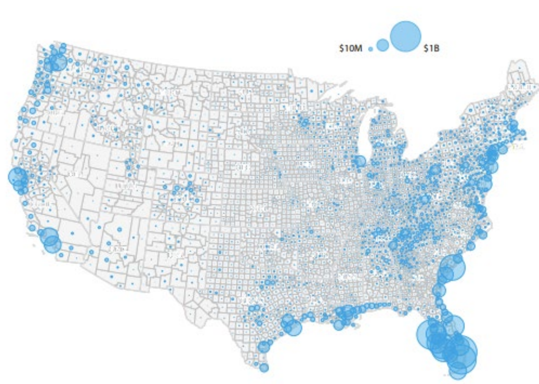
[2] https://firststreet.org/methodology/
[3] https://www.fema.gov/fact-sheet/michael-grimm-testimony-committee-science-space-and-technology

Annualized Flood Risk and Associated Economic Damage Expectations Today

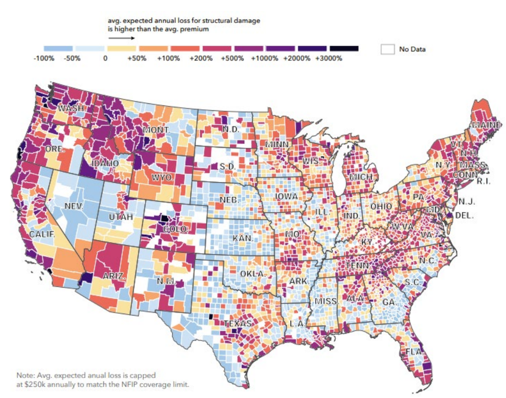
	FSF Model Used	Total Properties at Risk of Structural Damage Today	FSF Est. Avg. Annual Loss Today	
			No cap	*$250K cap*
With *Any* Flood Risk	1/500 layer	**5.71 million**	**$3,548**	**$3,343**
With *Substantial* Flood Risk	1/100 layer	**4.26 million**	**$4,694**	**$4,419**
Inside SFHAs With *Substantial* Flood Risk	1/100 layer	**1.52 million**	**$8,415**	**$7,895**
Outside SFHAs With *Substantial* Flood Risk	1/100 layer	**2.74 million**	**$2,622**	**$2,484**

These economic damage estimates are expected to grow due to climate change over the next 30 years by 61%, to an average estimated annual loss of $7,563 per property, for an estimated total loss of $32.3 billion. Those risks are also geographically clustered with the most pronounced risk occurring in the coastal states along the Gulf and Southeast Atlantic with risk especially high in the states of Florida, South Carolina, and New York. In fact, Florida alone accounts for nearly $8 billion in expected annualized losses today and growing to $14 billion by the year 2050. The economic risk in these areas far outpaced the FEMA's National Flood Insurance Program (NFIP) insurance program coverage in 2021 where the actual economic risk to flooding was found to be over 4 times as high as the NFIP rates that were being charged to cover that risk. Again, the most vulnerable areas fell along the coast in Texas, Louisiana, and Florida.

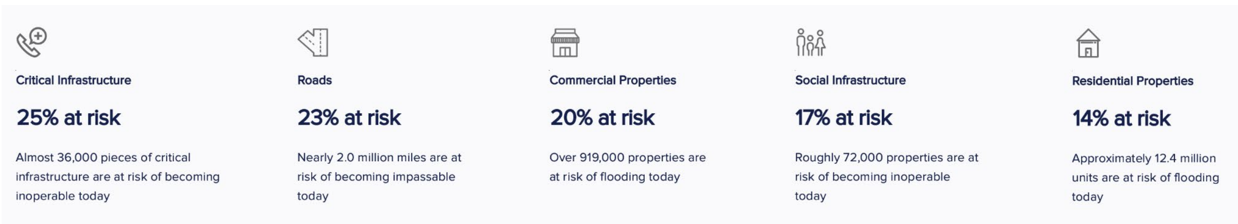
Total Estimated Structural Damage by County, 2021



NFIP Insurance Premiums Compared to Economic Risk, 2021



At the National level, we found 14% of residential properties are currently at risk which is expected to increase by 10% over the next 30 years, 17% of all social infrastructure (schools, places of worship, libraries, etc.) is currently at risk and will increase by 9% over 30 years, 20% of commercial properties are at risk and is expected to increase 7% over the next 30 years, and 25%, a quarter of all critical infrastructure facilities (utilities, hospitals, police stations) is at risk and projected to increase by 6% over the next 30 years. Additionally, 23% of all roads, roughly 2.0 million miles are at risk today of becoming impassable, which is expected to increase by 3% over the next 30 years.



At the community level, we find distinct patterns of county-level community risk significantly increasing along the Atlantic and Gulf Coasts, with large increases in risk in the Northwest. Risk concentrated along the coastal areas of the Southeastern U.S. and the Appalachian Mountain region. The highest concentration of community risk exists in Louisiana, Florida, Kentucky, and West Virginia, as 17 of the top 20 most at-risk counties in the U.S. (85%) are in those 4 states. At the city level, a large percentage of flood risk is concentrated in Louisiana and Florida. The major population centers of New Orleans, LA, Miami, FL, and Tampa/St Petersburg, FL all rank among the “most at risk” cities.

Relative Rates of Community Infrastructure at Vulnerable to Flooding

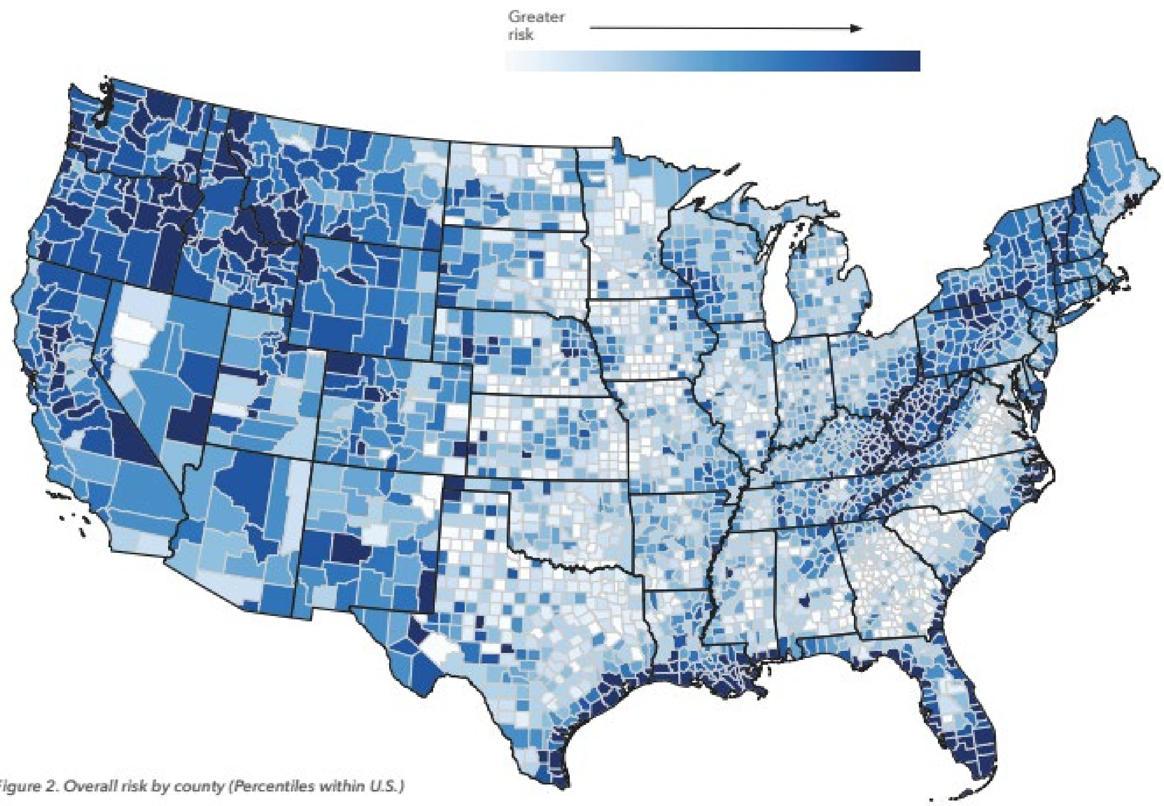


Figure 2. Overall risk by county (Percentiles within U.S.)

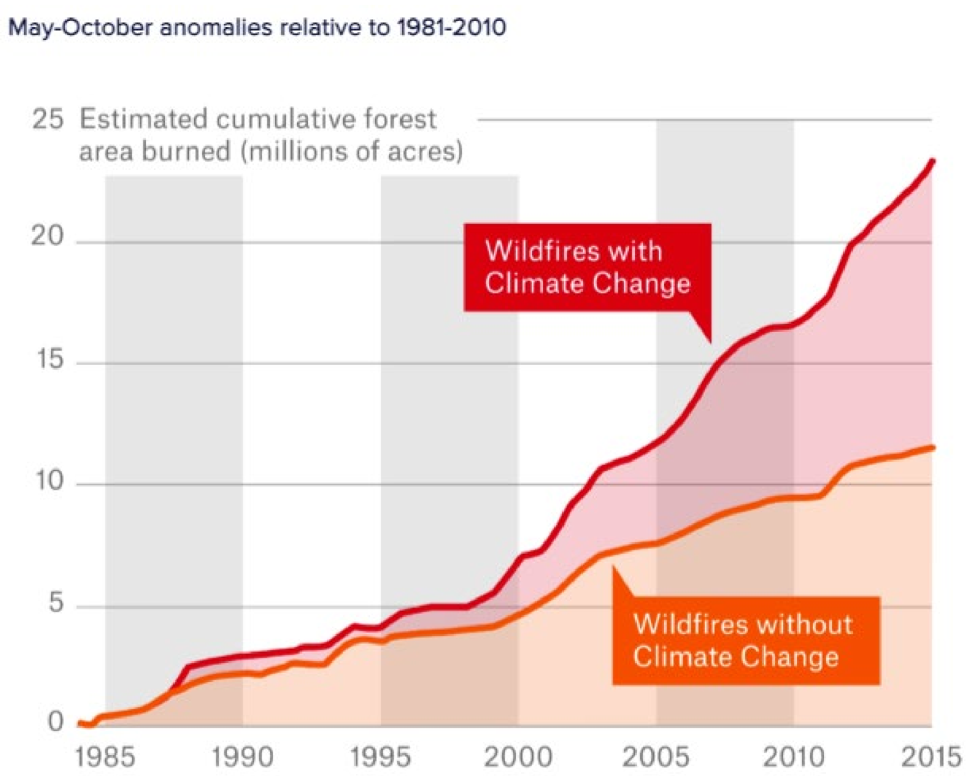
Recent guidance issued by FEMA[4] which is related to the partial implementation of the Federal Flood Risk Management Standard (FFRMS) also poses a challenge to US communities in the face of climate change. As federally-funded infrastructure projects are proposed and implemented by local governments to mitigate risk and increase resilience to flood risks, they must be built to the standards in the FFRMS guidance[5]. However, that recent guidance does not use the guidance-defined Climate Informed Science Approach that leverages the best available climate and hydrologic science, and instead prescribes a combination of 500-yr flood plain and Freeboard Value Approach for those community projects. Neglecting to take into account the best climate science available today means that not only will projects suffer from poorly defined 100-yr and 500-yr FEMA flood plains in a changing climate, but those projects using extra freeboard standards for construction are likely to be overbuilt in many areas, the extra cost of which draws valuable federal funds away from other projects that could bring significant benefits to additional US communities. First Street Foundation instead hopes that the application of the best available climate and hydrologic science may be used to inform Federal policy and enable more economical construction of climate-resilient infrastructure across the US.

[4] https://www.fema.gov/sites/default/files/documents/fema_policy-fp-206-21-003-0001-implementation-ffrms-hma-program_122022.pdf

[5] https://www.fema.gov/floodplain-management/intergovernmental/federal-flood-risk-management-standard

Wildfire - *Wildfire is not only a significant current and future risk across the American west, but climate change is fueling an emerging increase in fire risk in the Southeast as well.*

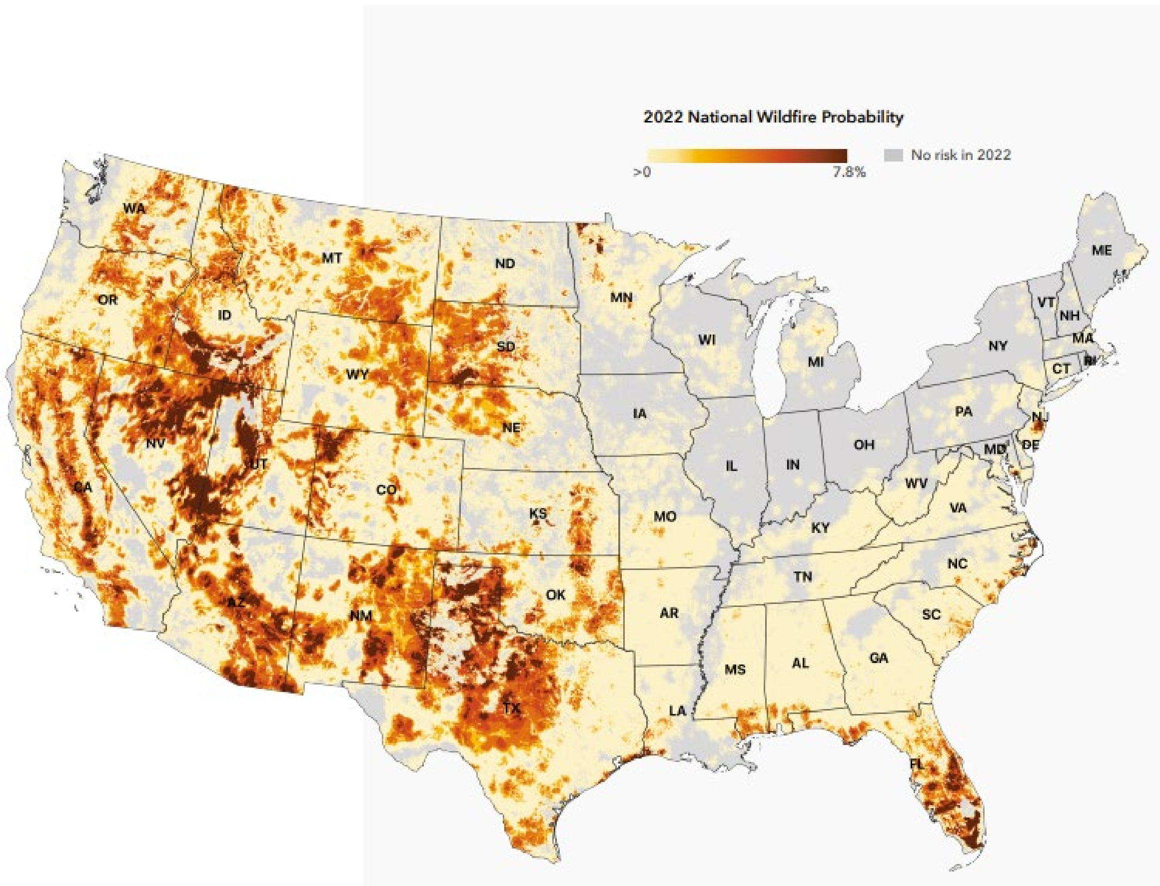
The First Street Foundation Fire Model leverages the US Forest Service's estimates of fuels, adjusted to resolve burn risk within the Wildland Urban Interface (WUI), and historical ignition locations to conduct a parcel-specific, climate adjusted investigation of possible wildfires nationwide over the next 30 years. We find that there are 49.4M properties with minor wildfire risk (with a cumulative burn probability over the next 30 years below 1%); 20.2M properties with moderate risk (1 - 6% cumulative burn probability); 6.0M with major risk (6 - 14% cumulative burn probability); 2.7M with severe risk (14 - 26% cumulative burn probability); and 1.5M properties with extreme risk (cumulative burn probabilities of 26% and up). In total, approximately 71.8 million properties, almost half the total number of properties in the US, have some level of wildfire risk in 2023, growing by 11.1% to 79.8 million by 2053, owing to the impact of a changing climate alone. The growth in wildfire exposure due explicitly to climate change now makes up about half of the total risk relative to what risk would have been in the same climate in 1985. The following figure quantifies that additional risk explicitly by illustrating that without climate change over the 30-year period, there would have been only ~12 million acres of estimated wildfire. However, with the addition of environmental changes adding to the conduciveness of wildfire conditions, there was an additional ~12 million acres of area burned by wildfire. Over that 30-year period, changes in the climate essentially doubled the area exposed to wildfire.



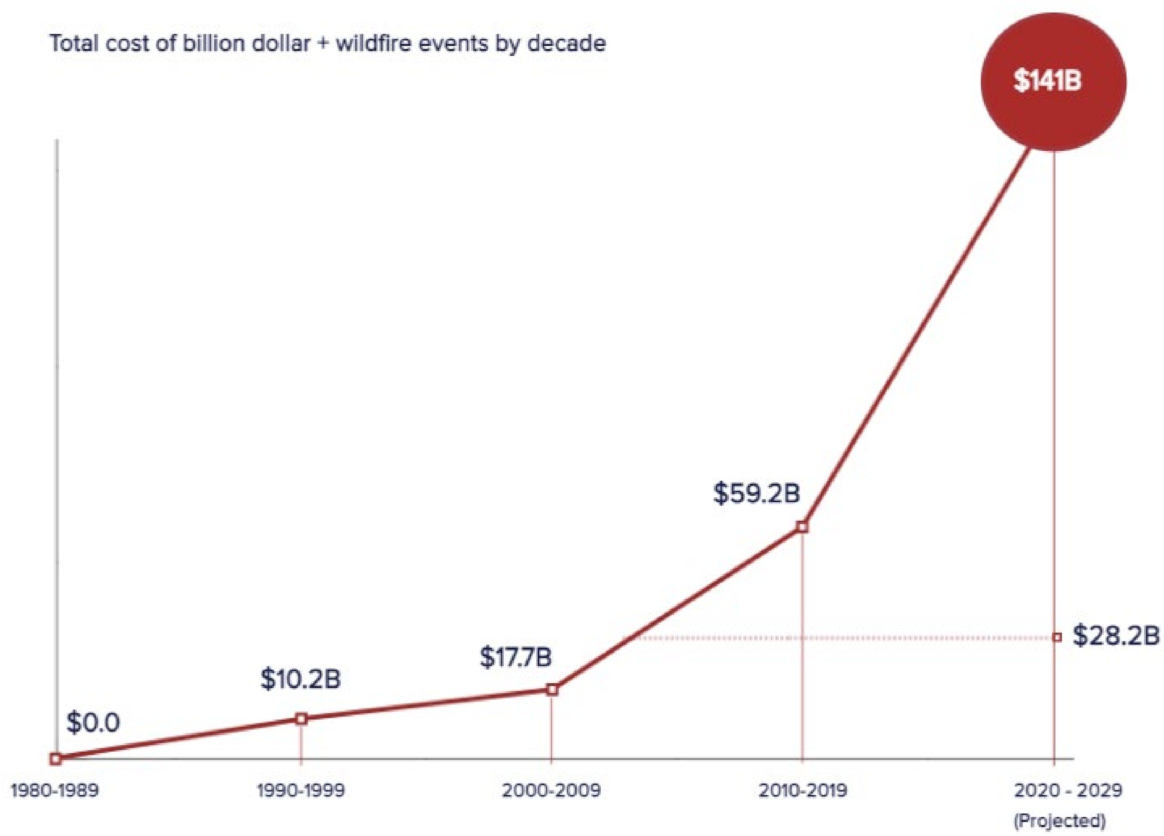
[6]

[6] https://www.pnas.org/doi/full/10.1073/pnas.1607171113

The First Street Foundation creates Fire Factor scores which range from 1-10 to describe a property's aggregate thirty-year exposure to wildfire, informed by the parcel's burn probability at a 30-meter horizontal resolution, taking into account not only the burn probability of the current time period but also how the parcel's wildfire risk changes over the next 30 years with a changing climate. We also account for the unpredictable nature of fire ember spread in our model through the use of an "ember zone" of 300 meters surrounding any modeled ember landing location, and is used as a measure of likely indirect fire exposure. The results of the development of the underlying hazard model are the first national, hyper-local, wildfire model with the ability to understand risk and economic damage at the property level.



The hyper-local resolution of our model allows for an extremely granular understanding of wildfire risk, empowering communities, states, and national government actors to take steps to mitigate wildfire risk above and beyond wildfire suppression efforts. Supporting wildfire suppression at the local, state, and federal levels is among the most expensive wildfire protection efforts, costing the federal government $2.0 billion annually across the U.S. today. Recent estimates from OMB suggest those costs could rise to $2.83 billion under conservative climate change scenarios by 2050, and perhaps to as much as $4.32 billion under higher emissions scenarios[7]). States and communities that are capable of suppressing most destructive wildfires today may find their resources stretched thinner and their capacity further challenged by climate-fueled increases in wildfire occurrence. The importance of suppression activities are made clear by looking at historic costs of wildfire events since 1980. Over that time, wildfire economic damages have grown exponentially and are projected to be $141 billion over the current decade (2020 - 2029). That estimate reflects the growing impact of climate on wildfire activity and is over 2.3 times as large as the historic estimate of $59.2 billion over the last decade (2010 - 2019) and over 5.6 times larger than the historic average since 1980.

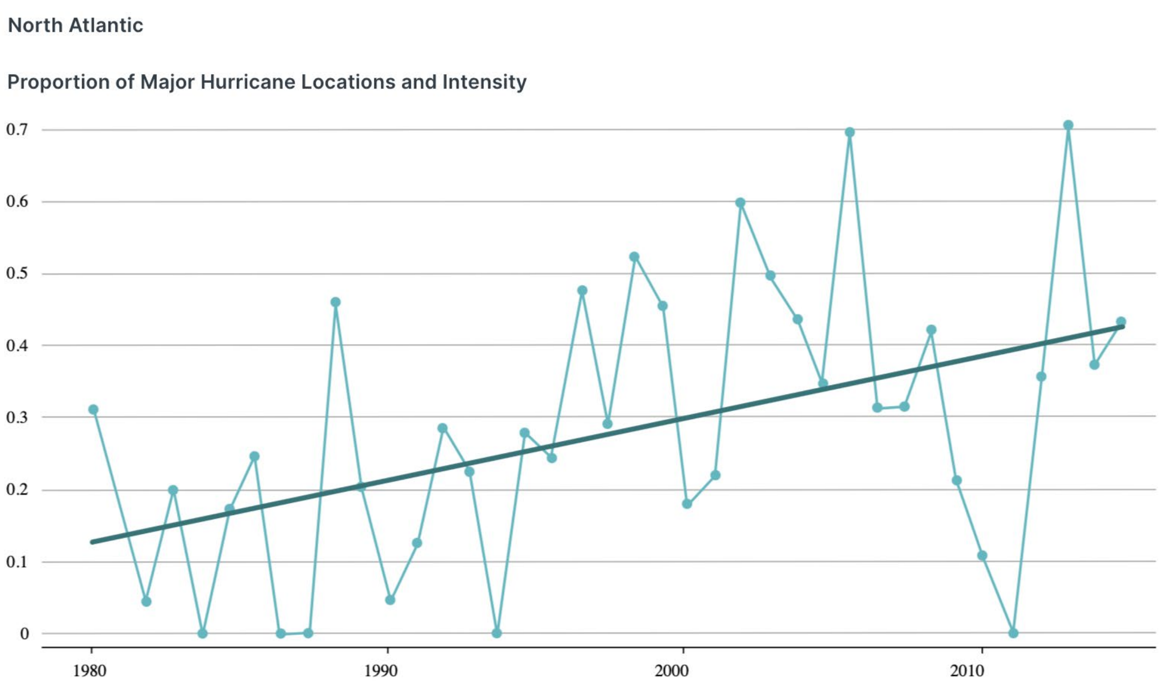


[7] https://www.whitehouse.gov/wp-content/uploads/2022/04/OMB_Climate_Risk_Exposure_2022.pdf

Wind - The *First Street Foundation Wind Model reveals extensive climate-induced tropical clone wind risk along the Gulf and Southeast Atlantic Coasts, with significant growing risk in the Mid-Atlantic and Northeast regions of the country.*

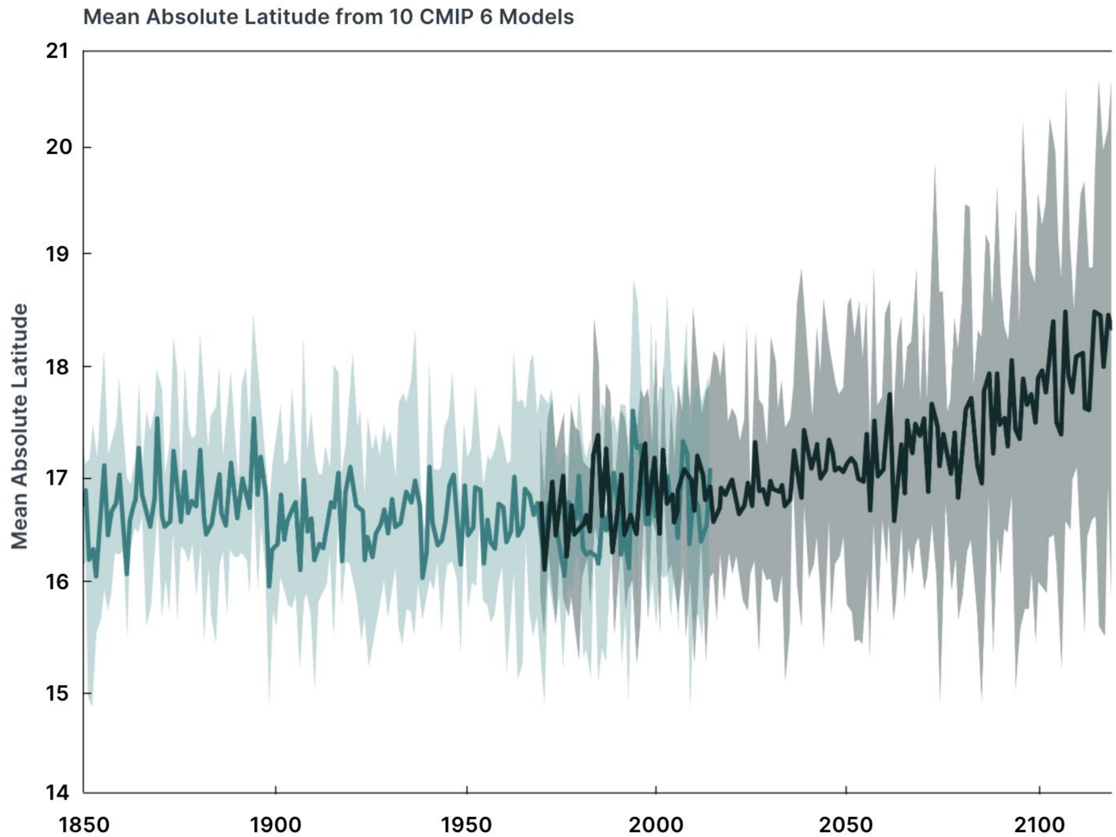
The peer-reviewed First Street Foundation Wind Model (FSF-WM) combines open data, open science, and engineering expertise to create a new tropical cyclone wind model that assesses hyper-local climate wind risk across the Nation. The FSF-WM uses high resolution topography, computer modeled hurricane tracks created by Dr. Kerry Emmanuel[8], and property data to create tropical cyclone wind hazard information for the contiguous United States, allowing a property-specific evaluation of probable wind speeds by return period, and a comparison of this wind risk between the current year and 30 years in the future. When coupled with archetype-specific damage curves developed with the global engineering firm Arup, property level losses are also estimated.

The findings of this model demonstrate that there are extensive climate-induced risks in the Gulf and Southeast Atlantic Coasts, with significant growing risk in the Mid-Atlantic and Northeast regions of the country. These effects stem from the greater proportion of storms that are likely to reach major hurricane status, and more probable northward tracks of tropical cyclones, both induced by climate change effects.



This is a triad time series (3-y bins) of the global fractional proportion of major hurricane intensities to all hurricane intensities (*Methods*).

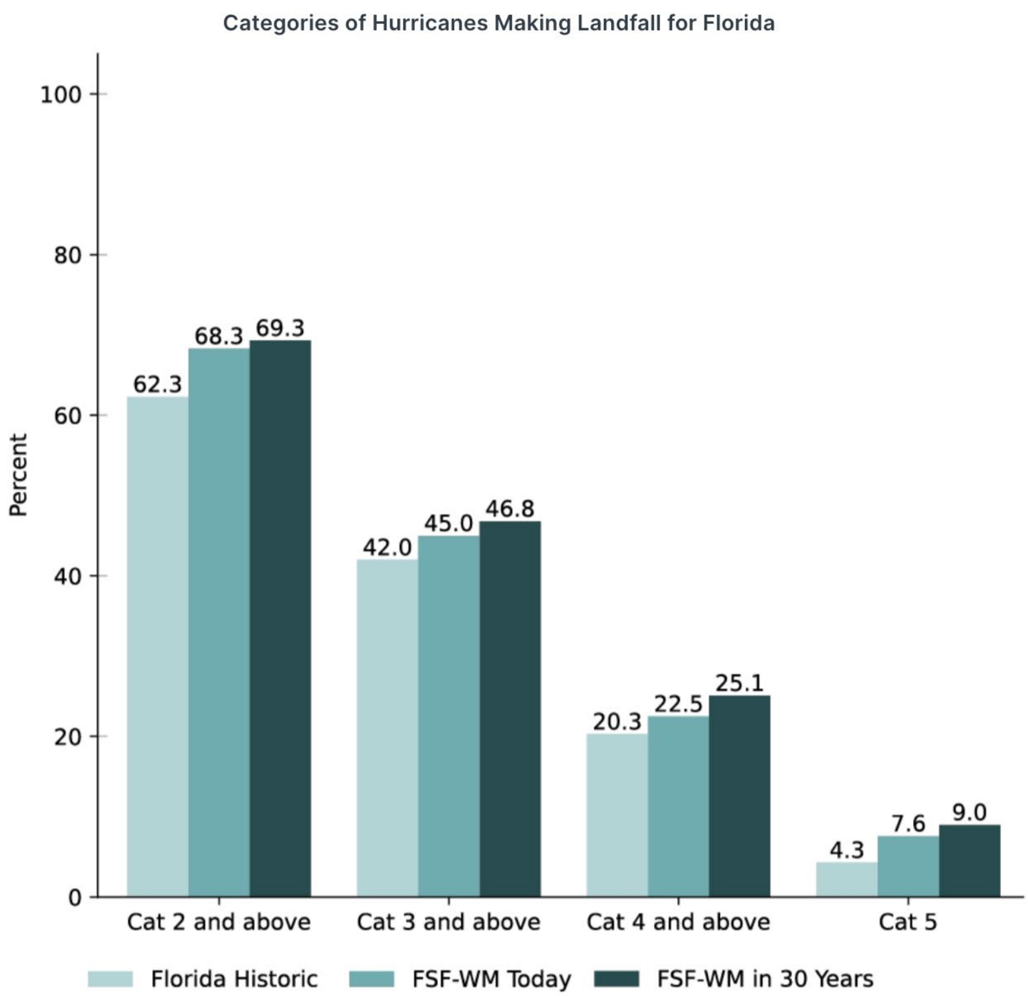
[8] Emanuel, K. A., S. Ravela, E. Vivant, and C. Risi, 2006: A statistical deterministic approach to hurricane risk assessment. *Bull. Amer. Meteor. Soc.*, **87**, 299–314, doi:10.1175/BAMS-87-3-299.



Overall, in the next 30 years, the expected National Average Annual Loss (AAL) resulting from this risk increases from $18.5 billion to $19.9 billion, and over 13.4 million US properties are likely to face tropical cyclone wind risk or greater in the future that do not currently face such risk today. Most alarming is the economic risk in the state of Florida, where current levels of expected annual losses are already over 4 times the economic risk of the rest of the Gulf Coast, and account for approximately 73% of all expected damages from tropical cyclone winds nationally.

The US counties that are expected to have the greatest absolute increases in AAL over the next 30 years are Duval, FL; Palm Beach, FL; Pinellas, FL; Brevard, FL; and Hillsborough, FL, with increases of approximately $119 million, $113 million, $104 million, $102 million, and $87 million, respectively. Other counties on the top 20 list are spread through Florida, Texas, South Carolina, North Carolina, Virginia, and Georgia. Increases in AAL appear to be primarily driven by potential future hurricane exposure moving up the Atlantic coast of Florida.

The amount of climate risk from winds in Florida is not only alarming, but the ability to resolve the changes in that risk is also hampered by the paucity of major hurricane events. Much of the research into hurricane wind risk in Florida relies on relatively sparse historical data rather than probabilistic models. When comparing the historical landfall rate of Category 5 hurricanes in Florida to the likelihoods from the probabilistic First Street Foundation Wind Model, this difference is especially dramatic – a 77% increase by 2053. The typical “catastrophe” risk models used today in Florida by the Florida Commission on Hurricane Loss Projection Methodology are unable to resolve a significant portion of the overall risk, and this blind spot will continue to grow in the future with climate change. Without explicitly including the impacts of climate change in Florida’s catastrophe modeling and risk analyses, the state faces significant financial vulnerability in the event of a major hurricane. The likelihood that a storm such as 2022’s Category 4 Hurricane Ian could impact any location in Florida, and the probable wind damages that would result from such a storm, are quantifiable and predictable using today’s climate science.



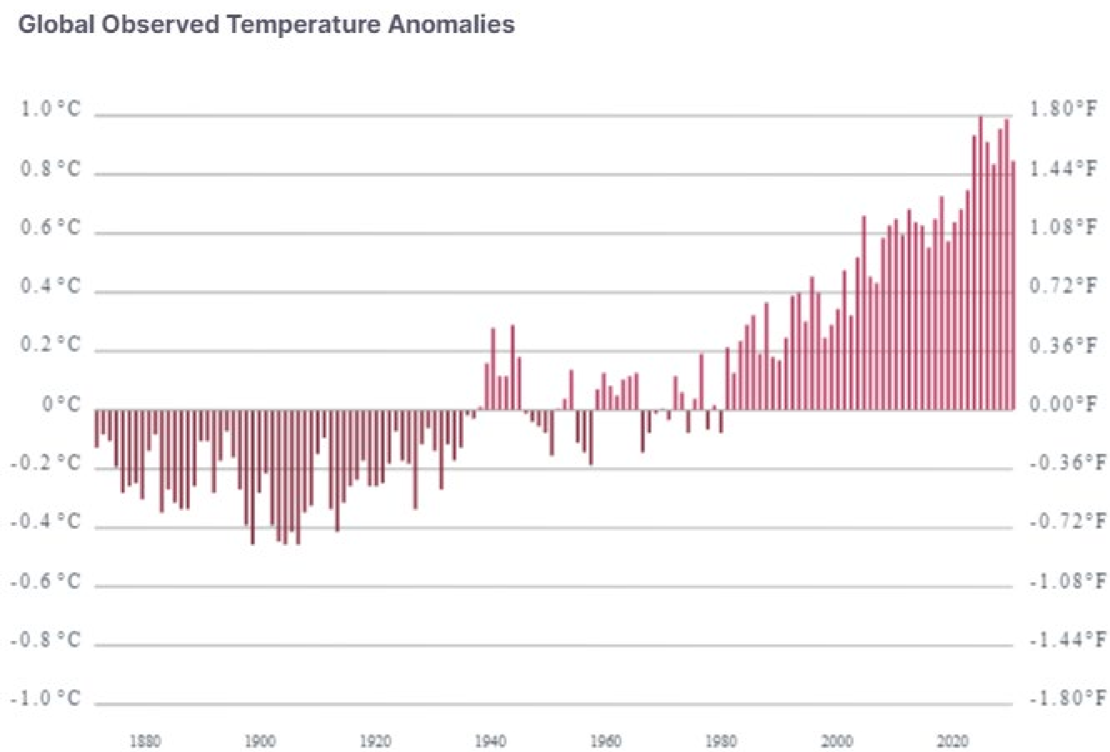
Top 20 Cities Most Likely to Face a Major Hurricane in 2023

Rank	City	Category 3 + (2023)	Likelihood Over 10 years
1	Cudjoe Key, FL	4.7%	38%
2	Big Coppitt Key, FL	4.7%	38%
3	Key West, FL	4.7%	38%
4	Big Pine Key, FL	4.7%	38%
5	Islamorada, Village of Islands, FL	4.5%	37%
6	Tavernier, FL	4.5%	37%
7	Key Largo, FL	4.4%	37%
8	Miami Beach, FL	4.4%	37%
9	Marco Island, FL	4.4%	36%
10	Miami, FL	4.4%	36%
11	Miami Shores, FL	4.4%	36%
12	North Key Largo, FL	4.3%	36%
13	Golden Glades, FL	4.3%	36%
14	North Miami, FL	4.3%	36%
15	North Miami Beach, FL	4.3%	36%
16	Marathon, FL	4.3%	35%
17	Sanibel, FL	4.3%	35%
18	Gladeview, FL	4.3%	35%
19	Pinewood, FL	4.3%	35%
20	West Little River, FL	4.3%	35%

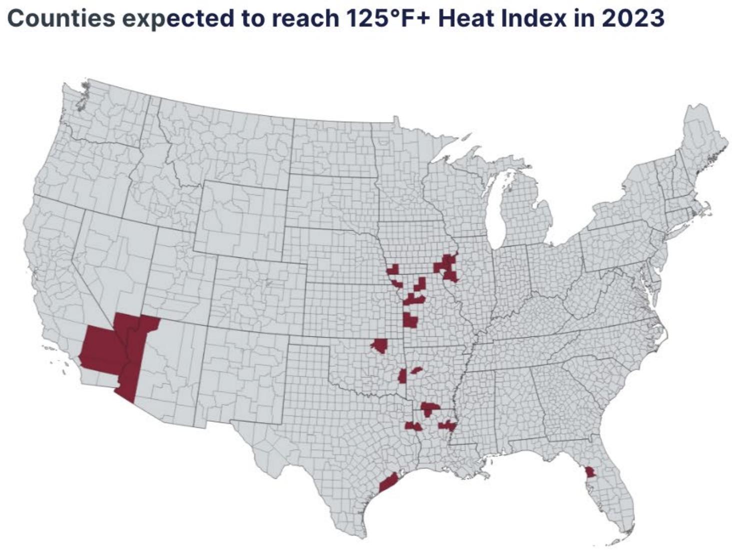
Heat - *First Street Foundation's Heat Model results estimate that by 2053 over 1,000 US counties are expected to experience air temperatures that exceed 125°F, impacting over 107 million Americans over an area equal to a quarter of the contiguous US.*

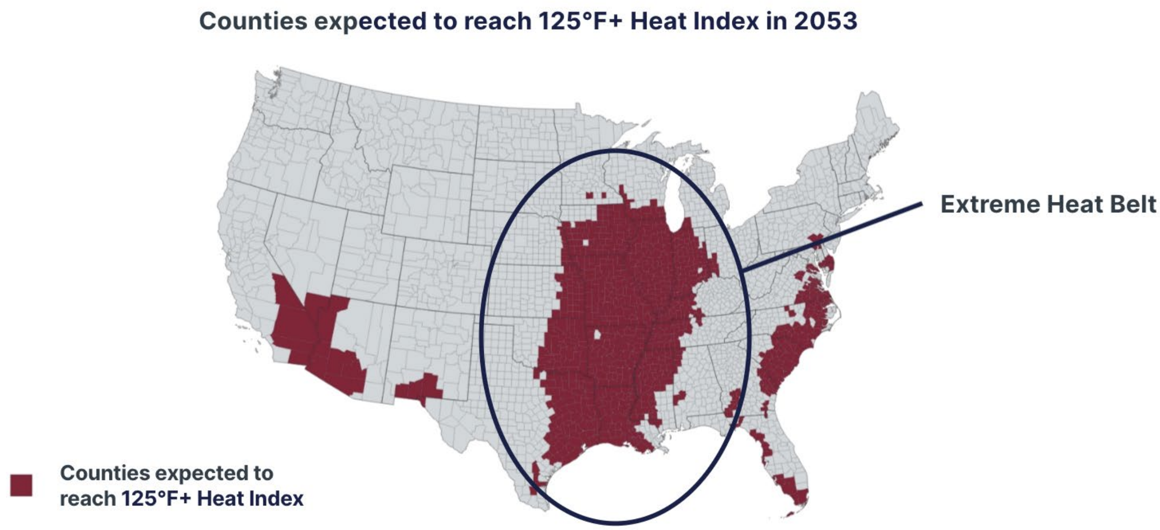
The First Street Foundation's Heat Model (FSFHM) uses satellite observations of land surface temperature, government open data from weather stations, and land surface characteristics to create local, probabilistic estimates of heat impacts today and for 30 years into the future. Global observed temperatures have risen by about 1.8 degrees Fahrenheit since the mid 1900's. The nearly 2-degree difference is small as an average, but brings with it increased occurrence of heat waves, dangerous heat days, and an increasing occurrence of extreme heat days. The mid-century comparison further underscores the observable warming climate evidenced by the fact that temperatures in the early 1900's were as much as 2.5°F less than they are today. The steady increases in temperatures are the clearest observable evidence of our warming planet and the trends serve as the underlying reasons for many of the increases in other climate perils highlighted in this testimony.

1°C or 2°F Warmer Than Pre-industrial Era

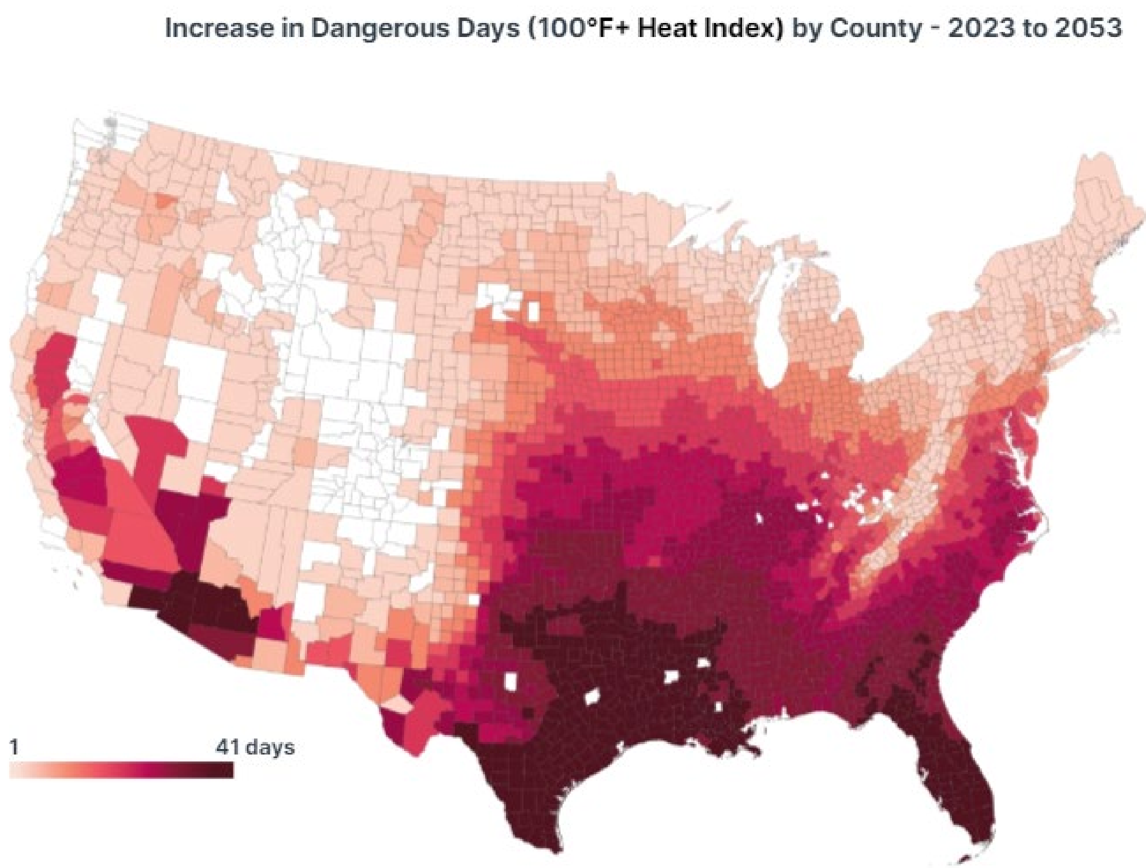


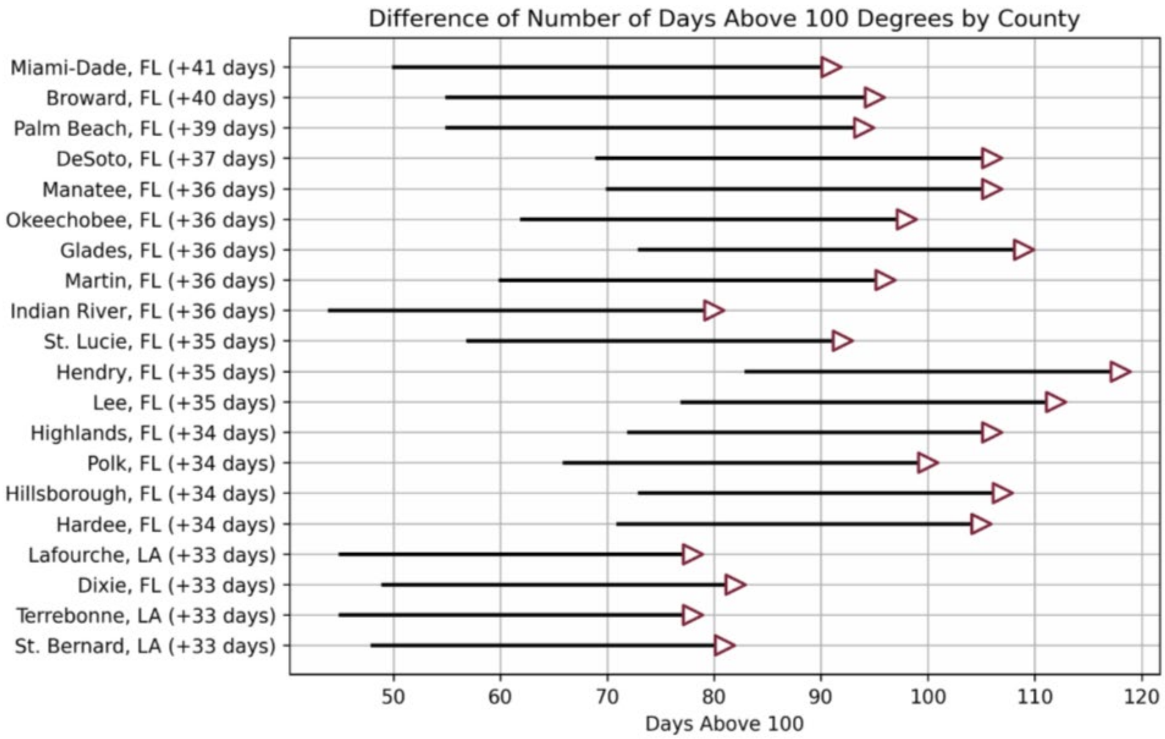
The FSFHM highlights the local impacts of climate change by identifying the seven hottest days expected for any property this year, and calculates how many of those days would be experienced in 30 years. The most severe shift in local temperatures is found in Miami-Dade County, FL where the 7 hottest days, currently at 103°F, will increase to 34 days at that same temperature by 2053. Across the country, on average, the local hottest 7 days are expected to become the hottest 18 days by 2053. In the case of extreme heat, the model finds 50 counties, home to 8.1 million residents, that are expected to experience temperatures above 125°F in 2023, the highest level of the National Weather Services' heat index. By 2053, 1,023 counties in the US are expected to exceed this temperature, an area that is home to 107.6 million Americans and covers a quarter of the US land area. This emerging area, concentrated in a geographic region the Foundation calls the "Extreme Heat Belt," stretches from the Northern Texas and Louisiana borders to Illinois, Indiana, and even into Wisconsin. This means that within the next 30 years, there will be nearly ⅓ of the entire US population living in an area where at least one day out of the year is so hot that the National Weather Service categorizes the day as "Extreme Danger" and notes that "Heat Stroke or Sunstroke are Highly Likely".





At a lower threshold, the National Weather Service categorizes “Dangerous Days” as days where “Sunstroke, Muscle Cramps, and Heat Exhaustion are Likely”. Across the country, “Dangerous Days” – days exceeding the 100°F threshold from the National Weather Service – occur more commonly in the southern half of Contiguous United States and impact a greater number of properties in Florida and Texas. Currently, the top 20 counties across the United States expected to experience the greatest number of Dangerous Days annually are located in Texas, California, Arizona, and Florida. Topping the list this year with 109 days above the heat index temperature of 100°F is Starr County, TX. The other top four counties with over 100 Dangerous Days are in Texas and California. Dangerous days are particularly important at this level of occurrence due to the increased likelihood of adverse health complications (heat stroke, heat exhaustion, etc.), dangerous conditions for outdoor laborers, and the increased burden on local power grids due to increased air conditioning usage.





<u>Impact of a Changing Climate on the Real-Estate Market</u> - While *the changing climate is increasing our exposure to many perils, the symptoms of increased flooding have been the most obvious in regards to their already observable impact on the real estate market.*

According to NOAA, flooding (including tropical cyclone events) is the costliest climate hazard since 1980. The unique exposure of real-estate to flooding is a marker of this risk and the costs associated with its occurrence.

NOAA's Billion Dollar Disaster Cost Estimates[9]

Disaster Type	Events	Events/ Year	Percent Frequency	Total Costs
Drought	30	0.7	8.8%	$327.7B CI
Flooding	37	0.9	10.9%	$177.9B CI
Freeze	9	0.2	2.6%	$35.3B CI
Severe Storm	163	3.8	47.8%	$383.7B CI
Tropical Cyclone	60	1.4	17.6%	$1,333.6B CI
Wildfire	21	0.5	6.2%	$133.1B CI
Winter Storm	21	0.5	6.2%	$84.9B‡ CI
All Disasters	**341**	**7.9**	**100.0%**	**$2,476.2B‡** CI

9 https://www.ncdc.noaa.gov/billions/

The increasing exposure in the US to flood perils has had an observable impact on property value, appreciation, and cost of ownership in the real estate market. By looking at the universe of available real estate transactions from the years of 2005 - 2017 from Texas to Maine, there was a quantifiable $15.9 billion in losses directly attributable to property value decreases and slowing rates of property appreciation lost in properties exposed to mere tidal flooding. The largest losses over this time period were in the state of Florida ($5.4 billion), followed by New Jersey ($4.5 billion), New York ($1.3 billion), and South Carolina ($1.1 billion). These losses were directly attributable to increased exposure to coastal flooding, and in particular, increasing rates of tidal flooding. The increased rates of tidal flooding reflect the growing exposure of communities to frequent, yet low impact, flooding events that eventually cause economic stress on communities due to the persistence of their occurrence. In related research, the phenomenon of “climate gentrification” has been observed, described as the movement of home buyers out of low-elevation neighborhoods and into higher-elevation neighborhoods in the same housing market. While single family home owners are generally a little slower to adapt to the increasing climate hazard exposure due to lack of information, institutional investors have already begun taking advantage of this information by investing in less risky properties and directly contributing to as much as a 7% discount on real estate in risky flood zones.

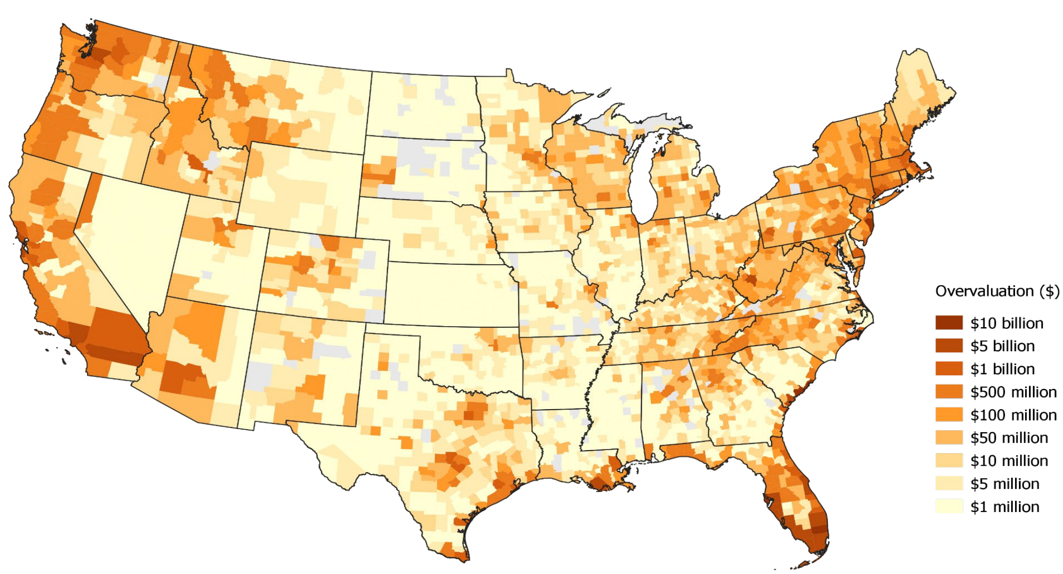
Property Value Loss Due to High Frequency Flooding (2005-2017)

Rank	State	Loss
1	Florida	-$5,422,165,140
2	New Jersey	-$4,522,798,463
3	New York	-$1,301,333,910
4	South Carolina	-$1,111,154,304
5	Connecticut	-$915,873,888
6	North Carolina	-$582,251,970
7	Maryland	-$555,725,150
8	Delaware	-$299,530,473
9	Virginia	-$280,290,183
10	Massachusetts	-$273,392,732
11	Mississippi	-$263,764,081
12	Alabama	-$157,868,992
13	Texas	-$76,390,582
14	Maine	-$69,865,575
15	Rhode Island	-$44,715,623
16	Georgia	-$15,268,577
17	New Hampshire	-$15,166,359
18	Pennsylvania	-$10,148,959

On top of the direct property value losses, the misidentification of properties by flood zone classification also builds a cumulative cost of ownership bubble where properties with flood risk are estimated to be overvalued by an order of ~3%. The overvaluation of these properties is further exacerbated by the economic damage associated with unknown flood risk and ultimately amounts to approximately $200 billion in current real-estate market overvaluation.

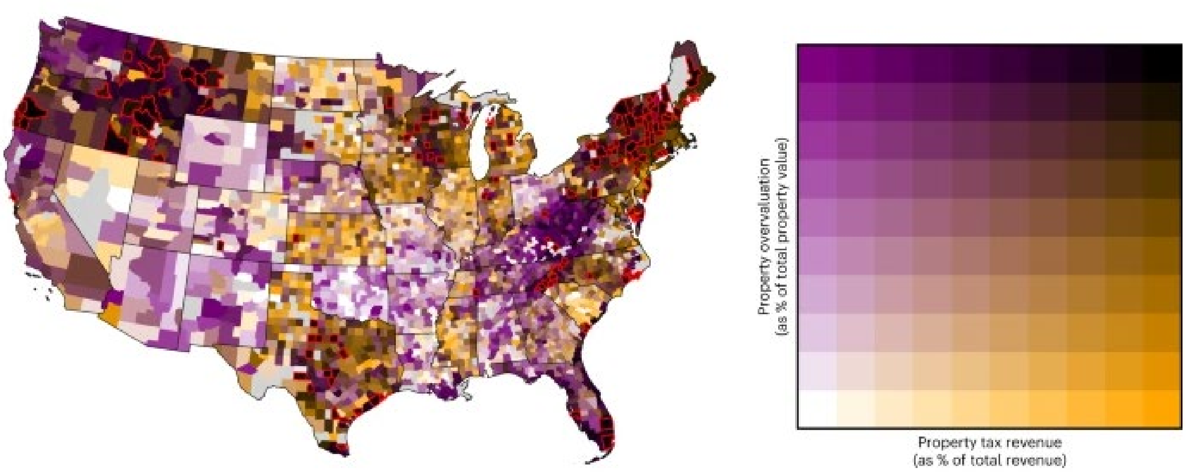
This overvaluation is driven by two primary components. First there is a significant amount of “unknown” flood risk in which property owners are unaware of their own actual risk due to methodological approaches taken in the creation of the authoritative standard in flood risk assessment, FEMA’s Special Flood Hazard Area (SHFA, or 1-in-100-year flood zone). Specifically, heavy precipitation, flooding from small waterways (creeks, tributaries, streams), and the inclusion of climate change impacts are not taken into account in the creation of FEMA’s SFHAs (all of which are included in the First Street Foundation Flood Model). Given these methodological differences, there are roughly 6 million more properties (for a total of over 14 million properties across the country) at risk of a 1-in-100-year flood than the ~8 million properties in FEMA’s flood zones identified today. This unknown flood risk decreases home buyer awareness around risk, which in turn causes that risk not to be capitalized into the cost of ownership. If those properties were to be zoned properly with respect to actual risk, they would likely see an immediate decrease in property values. Of note, much of this risk is in inland areas where precipitation and small water way flooding are the predominant type of flooding, but there is a significant amount of “unknown” risk in coastal areas as well due to the rising sea-levels (among other contributors) associated with our warming atmosphere.

Property Overvaluation by County



Secondly, and in addition to the “unknown” or unresolved flood risk, the mispricing of insurance through the federal NFIP program has created a system in which development in risky climate areas has been incentivized through the public subsidization of that risk. The in accurately cheap rates of NFIP flood insurance reduce the burden of cost and the implications of exposure to a flood event, in which case the economic consequences of living in a risky area are, again, not fully capitalized into the cost of ownership. This overvaluation ranges between 0-25% as a percentage of property value across the country, but the impact is much farther reaching than the individual property itself. If this overvaluation is ever realized, the impact would be dramatic. Driving this impact is the fact that in many communities a significant proportion of the tax revenues are derived from property values as an assessment of the property values, and just as we saw revenues decrease in the 2008 recession after the housing bubble popped, a downturn in property values due to the realization of overvaluation in the housing market will undoubtedly lead to lower tax revenues. The local governments most at risk are those with high levels of “unknown” risk, high levels of flood exposure, and where rates of local government revenue is closely tied to property tax revenue (those areas appear in the darkest shade in the map below). Decreases in these revenues would directly hinder the community’s ability to provide social services, fund public education, build protective adaptation, and a whole host of other initiatives dependent on these resources. First Street Foundation is encouraged by FEMA’s recent attempts to bring actuarial rigor to the NFIP and correct some of this mis-pricing of risk at the property level through its implementation of the Risk Rating 2.0 program, but we note that without the explicit inclusion of climate change impacts the program is still likely to fall short of its otherwise laudable goals. In addition, we regret that the methodologies employed by FEMA in determining Risk Rating 2.0 insurance rates are not fully transparent and discoverable, which inhibits any outside analysis of the efficacy of this new approach.

Local Government Vulnerability to Loss Revenue Due to Overvaluation



Closing

The First Street Foundation is grateful to the Senate Budget Committee for the opportunity to present our findings related to climate change risks and their economic impacts on the Nation, including our coastal communities. By creating property-specific, climate-adjusted estimates of physical climate risk exposure and related economic losses across the entire United States, First Street Foundation hopes to inspire informed action by citizens, businesses, and governments. We are proud to make our results publicly and freely available to individual Americans and democratize access to key risk information that will support informed decision-making that can result in communities that are more resilient in the face of climate change. Using the latest science and computing technologies, we have shown that climate change risks are quantifiable, they are predictable, and their estimated economic impacts today and over the next 30 years are alarming, to say the least. At First Street Foundation we truly believe what gets measured gets managed, and that is exactly what we hope this testimony and our data will help us do over the coming years while we still have the option to manage the risk posed by climate change to outcomes that don't result in complete financial destruction.

We remain optimistic, that by continuing to be informed by science that we, as a Nation, can find ways to address climate change and create more resilient communities today and for the future.

List of Relevant First Street Foundation Peer-Reviewed Research

Heat Model	High-Resolution Estimation of Monthly Air Temperature from Joint Modeling of In Situ Measurements and Gridded Temperature Data. Bradley Wilson, Jeremy R Porter, Edward J Kearns, Jeremy S Hoffman, Evelyn Shu, Kelvin Lai, Mark Bauer, Mariah Pope. Climate 10 (3), 47.
Flood Model	Combined modeling of US fluvial, pluvial, and coastal flood hazard under current and future climates.Oliver Wing, Niall Quinn, Christopher Sampson, Andrew Smith, Jeison Sosa, Mike Amodeo, Edward Joseph Kearns, Sharai Lewis-Gruss, Jeremy R Porter, Paul D Bates, Jeffrey C Neal, Guy Schumann. Water Resources Research 57 (2), e2020WR028673.
Flood Model	Simulating historical flood events at the continental scale: observational validation of a large-scale hydrodynamic model.Oliver EJ Wing, Andrew M Smith, Michael L Marston, Jeremy R Porter, Mike F Amodeo, Christopher C Sampson, Paul D Bates. Natural Hazards and Earth System Sciences 21 (2), 559-575.
Flood Model	A natural language processing approach to understanding context in the extraction and geocoding of historical floods, storms, and adaptation measures. K Lai, JR Porter, M Amodeo, D Miller, M Marston, S Armal. Information Processing & Management 59 (1), 102735.
Precipitation Model	Assessment of the standard precipitation frequency estimates in the United States. J Kim, E Shu, K Lai, M Amodeo, J Porter, E Kearns. Journal of Hydrology: Regional Studies 44, 101276
Wildfire Model	The construction of probabilistic wildfire risk estimates for individual real estate parcels for the contiguous United States.Edward J Kearns, David Saah, Carrie R Levine, Chris Lautenberger, Owen M Doherty, Jeremy R Porter, Michael Amodeo, Carl Rudeen, Kyle D Woodward, Gary W Johnson, Kel Markert, Evelyn Shu, Neil Freeman, Mark Bauer, Kelvin Lai, Ho Hsieh, Bradley Wilson, Beth McClenny, Andrea McMahon, Farrukh Chishtie. Fire 5 (4), 117.

Ozone Model	Characterizing changes in extreme ozone levels under 2050s climate conditions: An extreme-value analysis in California. B Wilson, M Pope, JR Porter, E Kearns, E Shu, M Bauer, N Freeman, M Amodeo, D Melecio-Vazquez, H Hsieh, M Tarasovitch. Atmospheric Environment: X 16, 100195
Economic Damage	Estimating Pluvial Depth–Damage Functions for Areas within the United States Using Historical Claims Data. JR Porter, ML Marston, E Shu, M Bauer, K Lai, B Wilson, M Pope. Natural Hazards Review 24 (1), 04022048.
Economic Damage	Commercial Real-Estate at Risk: An Examination of Commercial Building and Economic Impacts in the United States Using a High-Precision Flood Risk Assessment Tool. Jeremy Porter, Evelyn G Shu, Mike F Amodeo, Neil Freeman, Mark Bauer, Ibrahim Almufti, Meg Ackerson, Jinal Mehta. Frontiers in Water, 50.
Economic Damage	Assessing property level economic impacts of climate in the US, new insights and evidence from a comprehensive flood risk assessment tool. S Armal, JR Porter, B Lingle, Z Chu, ML Marston, OEJ Wing. Climate 8 (10), 116.
Economic Damage	Climate change, riverine flood risk and adaptation for the conterminous United States. C Wobus, J Porter, M Lorie, J Martinich, R Bash. Environmental Research Letters 16 (9), 094034.
Community Flooding	Community flood impacts and infrastructure: Examining national flood impacts using a high precision assessment tool in the united states. JR Porter, E Shu, M Amodeo, H Hsieh, Z Chu, N Freeman. Water 13 (21), 3125.
Climate Implications	The Economic Impact of Flood Zone Designations on Residential Property Valuation in Miami-Dade County. EG Shu, JR Porter, B Wilson, M Bauer, ML Pope. Journal of Risk and Financial Management 15 (10), 434.
Climate Implications	Federally Overlooked Flood Risk Inequities in Houston, Texas: Novel Insights Based on Dasymetric Mapping and State-of-the-Art Flood Modeling. Aaron B Flores, Timothy W Collins, Sara E Grineski, Mike Amodeo, Jeremy R Porter, Christopher C Sampson, Oliver Wing. Annals of the American Association of Geographers, 1-21.
Climate Implications	Inequitable patterns of US flood risk in the Anthropocene. Oliver EJ Wing, William Lehman, Paul D Bates, Christopher C Sampson, Niall Quinn, Andrew M Smith, Jeffrey C Neal, Jeremy R Porter, Carolyn Kousky. Nature Climate Change 12 (2), 156-162.
Climate Implications	Exposure of real estate properties to the 2018 Hurricane Florence flooding. M Tedesco, S McAlpine, JR Porter. Natural Hazards and Earth System Sciences 20 (3), 907-920.
Climate Implications	Estimating recent local impacts of sea-level rise on current real-estate losses: A housing market case study in Miami-Dade, Florida. SA McAlpine, JR Porter. Population Research and Policy Review 37, 871-895.
Climate Implications	Flood recovery outcomes and disaster assistance barriers for vulnerable populations. B Wilson, E Tate, CT Emrich. Frontiers in water, 159
Climate Implications	Unpriced climate risk and the potential consequences of overvaluation in US housing markets. Jesse D. Gourevitch, Carolyn Kousky, Yanjun (Penny) Liao, Christoph Nolte, Adam B. Pollack, Jeremy R. Porter, Joakim A. Weill. Nature Climate Change 13 (2).