Assessing Maryland Homeowner Financial Vulnerability to Extreme Weather Events

CLIFFORD V. ROSSI. PHD

JANUARY 2023

Chesapeake Risk Institute

A risk management initiative of Chesapeake Risk Advisors, LLC

Executive Summary

Homeownership extends well beyond making a monthly mortgage payment. Ongoing maintenance and investment in a property help preserve and enhance home value and extend to neighborhoods and local communities as well. Owning a home also comes with the realization that every so often a costly repair can occur either unexpectedly or not, potentially placing strains on household budgets or leading to deferred maintenance over time.

Today, many Marylanders find themselves facing another costly threat to their homes that has been slowly sneaking up on them; namely the costs associated with extreme weather events. An increase in extreme weather events will negatively affect homeowners in years to come. Solutions to these problems must come from a combination of public and private investments and comprehensive strategies to build long-term resilient communities.

Understanding which communities in Maryland have higher rates of homeowner financial vulnerability to unexpected outlays either for weather-related damages or not is critical to helping target financial products and services as well as public investment in weather resiliency projects. This study leverages a variety of rich data sources for mortgage borrowers as well as natural hazards and associated risks to provide new empirical insights that can serve as a guide to inform public policy and industry investment strategy.

A newly developed **Homeowner Financial Vulnerability Index (HFVI)** is used to identify areas in Maryland with a higher likelihood of experiencing financial strain from an unexpected large out-of-pocket outlay such as repairs following a storm. The study aims to answer the following questions:

- What areas (counties and tracts) in Maryland are most at-risk from natural hazards?
- What hazards present the greatest risk to Marylanders in terms of expected annual losses (EAL)?
- What areas have the greatest homeowner financial vulnerability?
- How many areas have high homeowner financial vulnerability and are located in high hazard risk areas?
- What are the demographics; income, minority, poverty rates of these high hazard risk areas?
- Can we identify any statistically significant differences between high hazard risk census tracts and all others on the basis of borrower and other relevant characteristics?

This study provides new tools for analyzing the effects of extreme weather events and homeowner financial resiliency. Identifying areas with the greatest exposure to extreme weather and that have high homeowner financial vulnerability can help target public and private resources optimally. For example, by using tract-level measures of hazard risk combined with loan level measures of financial vulnerability, federal, state and local funding can be better allocated to support community-based resiliency projects such as investments in shoreline protection, flood control and the like as well as help facilitate the design of innovative insurance and mortgage products for individual homeowners.

For more information, please contact Dr. Clifford Rossi at crossi@criskadvisors.com.

Contents

A file containing the tract level NRI and HVFI ratings along with several other tract-level statistics may be found at https://www.criskadvisors.com/ or by contacting the author directly. Maps developed for this study may also be found at that website. The author provides these for informational purposes.

Extreme Weather in Maryland and Effects on Homeowners

Homeownership extends well beyond making a monthly mortgage payment. Ongoing maintenance and investment in a property help preserve and enhance home value and extend to neighborhoods and local communities as well. Owning a home also comes with the realization that every so often a costly repair can occur either unexpectedly or not, potentially placing strains on household budgets or leading to deferred maintenance over time.

Today, many Marylanders find themselves facing another costly threat to their homes that has been slowly sneaking up on them; namely the costs associated with extreme weather events. Residents and business owners in Ellicott City, for example, know far too well the impacts of such events. Within a two-year period, the city experienced two extreme flood events. The first of these occurred in 2016 when six inches of rain fell within a two-hour period causing significant flooding and property damage.[1] Then in 2018, another storm dropped eight inches of rain again in a two-hour period resulting in a flash flood with a height of over 10 feet resulting again in extensive property damage as well as two deaths.[2] In each instance, the amount of rainfall was reported to have had a 1-in-1,000 year chance of occurring and yet it happened twice in two years.[3]

Unfortunately, the Ellicott City floods are one of many potential natural hazards facing Marylanders. Drought, tornados, hurricanes, wind and hail storms pose significant risks each year to Maryland residents and so gaining a better understanding of the potential impact such events may have on homeowners is crucial for making homeowners and their properties more resilient to such hazards. Many parts of the 11,684 miles of shoreline of the Chesapeake Bay face ongoing threats of erosion, coastal and riverine flooding and increasing nuisance flood events.[4]

[1] National Weather Service, National Oceanic and Atmospheric Administration, Ellicott City Historic Rain and Flash Flooding of July 30th, 2016, https://www.weather.gov/lwx/EllicottCityFlood2016.

[2] National Weather Service, National Oceanic and Atmospheric Administration, May 27th 2018 Flooding, Ellicott City and Catonsville, MD, https://www.weather.gov/lwx/EllicottCityFlood2018

[3] John Bacon, USA Today, Why a 1-in-1,000 year rain event devastated Ellicott City, Maryland – again, May 28, 2018.

[4] National Park Service, Chesapeake Bay Facts,https://www.nps.gov/chba/learn/nature/facts-andformation.htm#:~:text=At%20its%20widest%20point%2C%20just,21%20feet%20(7%20m)

Residents of Maryland in areas with elevated threats from extreme weather events need to prepare for the increasing direct and indirect cost of homeownership

Parts of Annapolis and Baltimore have experienced significant increases in the number of days of nuisance flooding over the last decade.

However, Dorchester County, one of the poorest counties in the state on Maryland's eastern shore with the motto, "Water Moves Us," doesn't receive the kind of media attention that Annapolis and Baltimore receive on extreme weather events and yet its experience paints an ominous picture for what awaits county residents in the future without major changes from policymakers and private industry.

One study, for instance, found that nearly 60% of Dorchester County lies within the 100-year floodplain and that about half the population is exposed to some damage from minor storm surges not related to hurricane-like events.[5] Homeowners face a variety of potential damages to various critical components to their homes from such events including HVAC systems and ductwork, roofs, siding and windows and mold in crawlspaces among the costly repairs these homeowners can encounter.

Dorchester County faces a number of significant challenges in hardening public and private infrastructure from the ongoing threats of extreme weather events. The county ranks 19th out of 24 in terms of income with an average per capita income in 2017-2020 of $55,652; has a poverty rate of 15%; and more than a third of residents are nonwhite.[6] Still, a relatively large percentage (69%) of residents own a home with a median property value of about $190,000. Compared with a wealthier and larger county such as Anne Arundel County that has a budget of more than $1.7 billion, Dorchester County's budget of $75.7 million severely constrains the county's ability to finance urgently needed projects to address its climate-related problems. These include increased nuisance flooding in Cambridge, the county's largest city, as well as coastal erosion in a number of small communities such as Hoopers Island and failure of many bermed impervious ponds (BIPs) serving homeowners across Dorchester County as a type of community septic system. This latter problem underscores the fact that state and local governments when approving such infrastructure for residential development nearly 30 years ago did not anticipate or understand the impact of those decisions now affected by changes in weather patterns that in recent years have put many of those ponds at capacity and in dire need of mitigation.

Residents of Maryland in areas with elevated threats from extreme weather events need to prepare for the increasing direct and indirect cost of homeownership. These costs include out-of-pocket expenses that lie beyond

[5] Wanda Diane Cole, Maryland Eastern Shore Resource Conservation & Development Council, 2008.

[6] U.S. Census, QuickFacts, Dorchester County, Maryland data.

insurance payouts or show up as higher premiums and deductibles for homeowners and flood insurance policies. According to one estimate by Nationwide, two-thirds of homeowners are underinsured, exposing them to significant financial risk as well as increasing their chances of defaulting on their mortgage.[7]

Evidence of higher default risk for extreme weather events has been found over the years. Fannie Mae, for example found a substantial difference between delinquency rates following Hurricane Katrina in regions affected by that storm. The rate of mortgages 30 days past due or more was 4.24% in areas affected by the hurricane versus 1.99% for areas left unaffected.[8] This author also found that when controlling for borrower, property and loan risk factors, both the frequency and severity of hurricanes resulted in statistically significant higher default rates on mortgages.[9]

This study provides some of these answers by empirically identifying those communities in Maryland with the greatest homeowner financial vulnerability that happen to be exposed most to natural hazards

An increase in extreme weather events will negatively affect homeowners in years to come. Solutions to these problems must come from a combination of public and private investments and comprehensive strategies to build long-term resilient communities. Some of these investments will require major planning and resource commitment. An example today is the rebuilding of James and Barren Islands off the Dorchester County coast by the US Army Corps of Engineers that have all but disappeared as decades of coastal storms and rising sea levels have taken their toll on those barrier islands that serve as buffers to many homes along that shoreline. Deciding on how to optimally allocate such resources is always a challenge, however, a first step requires identifying where such resources are needed most. This study provides some of these answers by empirically identifying those communities in Maryland with the greatest homeowner financial vulnerability that happen to be exposed most to natural hazards.

Study Objectives and Approach

Understanding which communities in Maryland have higher rates of homeowner financial vulnerability to unexpected outlays either for weather-related damages or not is critical to helping target financial products and services as well as public investment in weather resiliency projects. This study leverages a variety of rich data sources for mortgage borrowers as well as natural hazards and associated risks to provide new empirical insights that can serve as a guide to inform public policy and industry investment strategy.

[7]Nationwide, "Underinsurance: Is your home covered for all it's worth?https://www.nationwide.com/lc/resources/home/articles/underinsurance.
[8]Fannie Mae Capital Markets, Historical data provides insights into past hurricane experience, November 6, 2017.

[9] Clifford Rossi, Journal of Risk Management in Financial Institutions, Volume 14 / Number 4 / Autumn/Fall 2021, pp. 426-442(17).

The study leverages a newly developed **Homeowner Financial Vulnerability Index (HFVI)** to identify areas in Maryland with a higher likelihood of experiencing financial strain from an unexpected large out-of-pocket outlay such as repairs following a storm

The study leverages a newly developed **Homeowner Financial Vulnerability Index (HFVI)** to identify areas in Maryland with borrowers having a higher likelihood of experiencing financial strain from an unexpected large out-of-pocket outlay such as repairs following a storm.[10] The HFVI is based on a multivariate statistical model trained on hundreds of thousands of historical mortgage loans originated between 2000-2016 with performance on those loans to the present and sold to Fannie Mae and Freddie Mac. This index ranks borrowers based on their financial capacity to support not just their mortgage payment but also recurring and nonrecurring expenses associated with their properties, controlling for other factors such as the borrower's credit and other loan and property characteristics.

As will be examined in more detail in a later section, the index is then paired with data from the **Federal Emergency Management Agency (FEMA) National Risk Index (NRI)** that provides a rating and score at the census tract or county level for 18 different natural hazards. While the HFVI is calculated at the loan level, **Home Mortgage Disclosure Act (HMDA) 2021 data** is used to generate a HFVI for every loan originated in Maryland for that year and then aggregated for all census tracts and counties in Maryland. While the HMDA data only highlights loans originated in 2021, it is representative of the financial profile of Maryland homeowners for that year.

The study aims to answer the following questions:

- What areas (counties and tracts) in Maryland are most at-risk from natural hazards?
- What hazards present the greatest risk to Marylanders in terms of expected annual losses (EAL)?
- What areas have the greatest homeowner financial vulnerability?
- How many areas have high homeowner financial vulnerability and are located in high hazard risk areas?
- What are the demographics; income, minority, poverty rates of these high hazard risk areas?
- Can we identify any statistically significant differences between high hazard risk census tracts and all others on the basis of borrower and other relevant characteristics?

[10] HFVI was developed by Chesapeake Risk Advisors, LLC.

Data Sources

Three publicly available data sources were used in this study; the 2021 HMDA data, the FEMA NRI data and Fannie Mae and Freddie Mac loan-level credit performance data. Some description of each of these data sources is instructive to understand the analysis that follows.

FEMA NRI Data

FEMA developed a National Risk Index comprised of three factors: expected annual loss (EAL) associated with a hazard, a community resiliency score and a social vulnerability score.[11] The relationship of these three factors in determining the NRI is as follows:

$$(1) \qquad NRI = EAL * SV * (1/CR)$$

Where SV is social vulnerability and CR is community resiliency. The social vulnerability component of the NRI reflects the the degree to which demographic groups are affected by different natural hazards. Community resiliency takes into account the ability for communities to handle various natural hazards by incorporating 49 different factors representing 6 categories of community resiliency such as community capital, social, and housing/infrastructure.

The NRI is calculated for every county and census tract in the US. The 18 hazard types in the NRI data were selected based on FEMA-approved state plans and are listed in Table 1 displaying the total EAL for each hazard in Maryland. Three hazards are not represented in the data for the state but all others sum to an EAL of $221.1 million with the hazards presenting the largest exposure to Maryland being drought, tornados and coastal flooding in that order.

EAL in dollars is defined as the following:

$$(2) \quad EAL = E_H * F_H * HLR_H$$

Where E_H is the total dollar of exposure to hazard type H from losses associated with damages to buildings, agriculture or people, F_H is the annual frequency of hazard H and HLR_H is the hazard loss ratio associated with hazard H.[12] For Maryland across all hazard types, 43 percent of the state EAL is attributed to damage and losses to buildings including residential and commercial structures.

Table 1: EAL ($) Hazard for Maryland

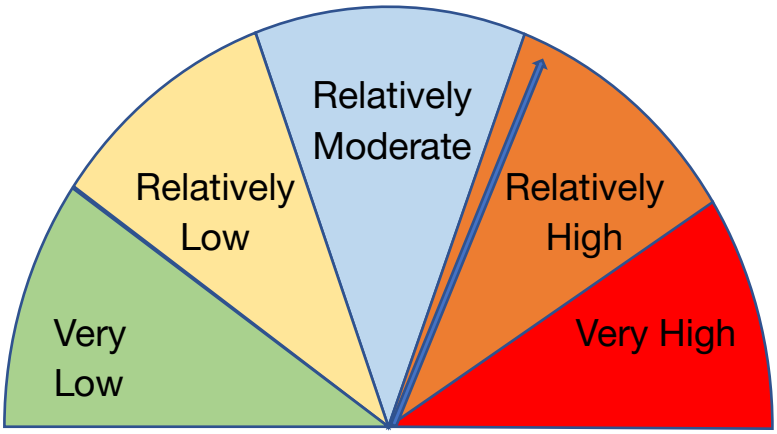
Hazard	EAL($)
Avalanche	NA
Coastal Flooding	34,626,461
Cold Wave	2,068,859
Drought	51,219,782
Earthquake	5,969,847
Hail	1,115,174
Heat Wave	13,994,782
Hurricane	14,492,073
Ice Storm	2,073,257
Landslide	1,460,897
Lightning	7,011,153
Riverine Flooding	26,314,416
Strong Wind	15,264,119
Tornado	38,100,420
Tsunami	NA
Volcanic Activity	NA
Wildfire	2,647,044
Winter Weather	4,839,674
All	221,197,958

[11] FEMA, National Risk Index, https://hazards.fema.gov/nri/.

[12] FEMA NRI Technical Documentation, November 2021.

There are only a few counties that have Very High EAL exposure: Caroline, Anne Arundel and Baltimore City

FEMA produces a risk score and rating for each hazard and for all hazards combined reflecting all three components defined in equation 1. In addition, a risk rating and score is produced based only on EAL, social vulnerability and community resiliency. The measure of hazard risk for this study is EAL in dollars for each census tract and county in Maryland as it isolates the financial costs of each hazard. Finally, this study uses the hazard EAL risk rating rather than the numeric score as the ratings provide a more convenient way of categorizing hazard risk against financial vulnerability.[13] FEMA assigns one of the five following risk ratings for each natural hazard (and for all hazards combined) by census tract or county:[14] A total of 1394 Maryland census tracts were in the NRI dataset for analysis.



Tables 2a and 2b provide more detail on the risk to Marylanders by county for each type of hazard by EAL rating and EAL exposure in dollars. Fortunately, there are only a few areas that have Very High EAL exposure. These are Caroline County for drought, Anne Arundel County for lightning and Baltimore City for winter weather. Despite the large amount of shoreline around the Chesapeake Bay and Atlantic Ocean, coastal and riverine flooding along with hurricanes do not show up as having significant EAL exposure at the county level. Some care must be taken, however, in drawing a conclusion at the county level. Exposure to various hazards tends to wash out as the level of geographic unit expands and thus the focus later on at the tract level provides a more granular view of natural hazard risk in Maryland. Likewise, these results could change over time should extreme weather events increase in frequency and intensity in the future.

[13] FEMA used a machine learning algorithm to determine each risk rating.
[14] More detail on how FEMA developed these ratings can be found in their technical documentation.

Table 2a and 2b: Maryland County NRI EAL Ratings and Dollars by Hazard

COUNTY	All Hazards	Coastal Flooding	Cold Wave	Drought	Earthquake	Hail	Heat Wave	Hurricane	Ice Storm	Landslide	Lightning	Riverine Flooding	Severe Windstorm	Tornado	Wildfire	Winter Weather
Allegany	RL	NA	RM	NA	VL	VL	RL	RL	VL	RH	RL	RM	RM	RL	VL	RM
Anne Arundel	RM	RH	RM	RL	RL	VL	RH	RM	RL	RM	VH	RM	RH	RH	RL	RH
Baltimore	RM	VL	RM	RM	RL	VL	RM	RM	RM	RL	RM	RM	RH	RH	VL	RM
Calvert	RL	RM	RL	RL	VL	VL	RM	RM	RL	RH	RM	VL	RM	RL	RL	RM
Caroline	RM	RL	NA	VH	VL	RL	RM	RL	VL	VL	RL	RL	RL	RL	VL	RL
Carroll	RL	NA	RM	RL	RL	VL	RM	RL	RL	RM	RH	RL	RH	RM	VL	RM
Cecil	RM	RM	NA	RH	RL	RL	RM	RL	RM	RM	RM	RL	RM	RM	VL	RM
Charles	RL	VL	RL	RL	RL	RL	RM	RM	VL	RM	RM	VL	RM	RL	VL	RM
Dorchester	RL	RL	NA	RL	VL	RL	RL	RL	RM	VL	RL	RM	RL	RL	RM	RL
Frederick	RM	NA	RM	RM	RL	VL	RM	RL	RL	RM	RH	RH	RH	RM	VL	RH
Garrett	VL	NA	RM	NA	VL	RL	NA	VL	VL	RM	RL	RL	RL	RL	VL	RL
Harford	RL	RL	RL	RL	RL	RL	RM	RM	RL	RM	RH	RM	RH	RM	VL	RH
Howard	RL	VL	RM	RM	RL	VL	RM	RL	RL	RM	RH	RM	RH	RM	VL	RH
Kent	RM	RM	NA	RH	VL	RL	RL	RL	RL	RL	RL	RL	RL	RL	VL	RL
Montgomery	RM	VL	RH	RM	RL	VL	RH	RM	RM	RM	RH	RM	RH	RH	VL	RH
Prince George's	RM	RL	RM	RL	RL	VL	RH	RM	RM	RM	RH	RL	RH	RH	VL	RH
Queen Anne's	RM	RM	NA	RH	VL	RL	RM	RL	RL	RL	RL	RL	RL	RL	VL	RM
St. Mary's	RL	RL	RL	RL	VL	VL	RM	RM	RL	RM	RM	RL	RM	RM	VL	RM
Somerset	RL	RM	NA	RL	VL	RL	RL	RL	VL	RL	RL	RL	RL	VL	RM	RL
Talbot	RL	RM	NA	RM	VL	RL	RM	RL	RL	VL	RL	RL	RL	RL	VL	RM
Washington	RL	NA	RM	RM	VL	VL	RM	RM	RL	RL	RL	RM	RL	RM	VL	RM
Wicomico	RL	RM	NA	RL	VL	RL	RL	RL	RM	VL	RM	VL	RL	RL	RL	RM
Worcester	RL	RM	NA	RH	VL	VL	RL	RL	RL	RL	RL	RM	RL	RL	RL	RL
Baltimore	RM	VL	RM	NA	RL	VL	RH	RH	RM	RM	RH	RM	RH	RH	NA	VH

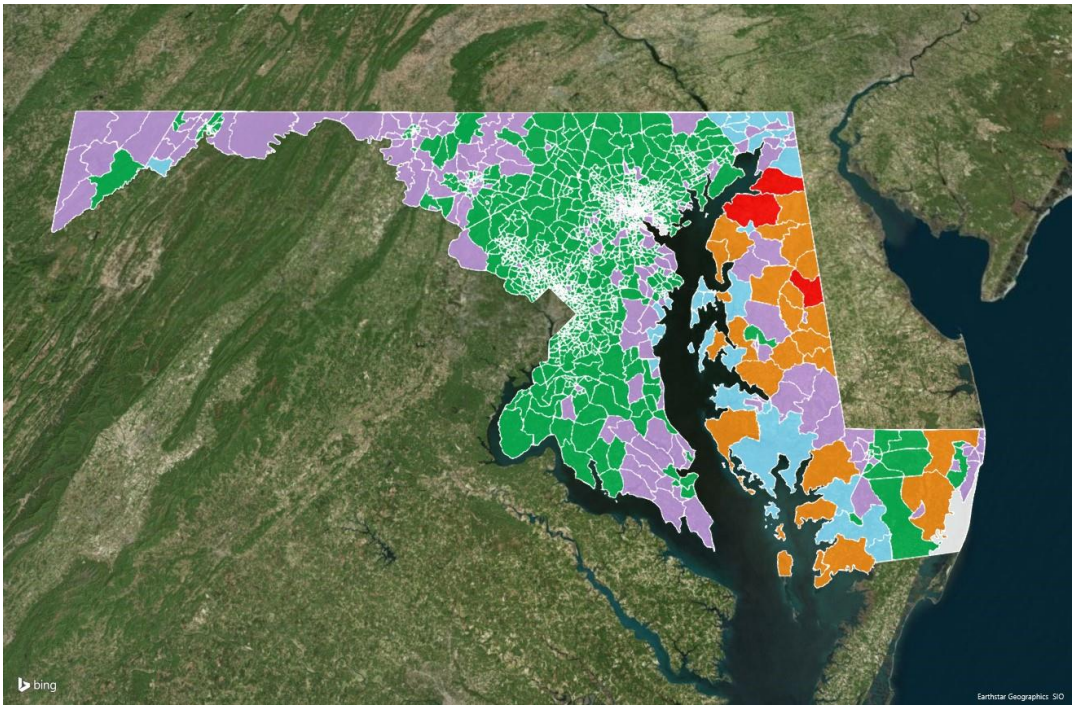
COUNTY	All Hazards	Coastal Flooding	Cold Wave	Drought	Earthquake	Hail	Heat Wave	Hurricane	Ice Storm	Landslide	Lightning	Riverine Flooding	Severe Windstorm	Tornado	Wildfire	Winter Weather
Allegany	$ 3,428,056		$ 151,651	$ -	$ 16,727	$ 4,854	$ 68,254	$ 63,910	$ 14,798	$ 170,655	$ 34,972	$ 2,165,852	$ 276,293	$ 372,431	$ 4,532	$ 83,127
Anne Arundel	$ 22,409,392	$ 10,625,966	$ 171,717	$ 202,499	$ 664,949	$ 21,487	$ 1,643,534	$ 525,224	$ 96,734	$ 51,255	$ 1,331,590	$ 953,657	$ 1,019,385	$ 4,410,061	$ 35,793	$ 655,541
Baltimore	$ 11,716,946	$ 44,460	$ 140,707	$ 362,497	$ 897,456	$ 10,990	$ 542,082	$ 3,094,337	$ 245,975	$ 28,903	$ 143,996	$ 1,273,015	$ 1,543,327	$ 3,242,812	$ 1,029	$ 145,360
Calvert	$ 5,578,921	$ 3,213,964	$ 28,439	$ 42,009	$ 81,513	$ 6,985	$ 239,325	$ 551,316	$ 42,083	$ 202,973	$ 211,182	$ 141,491	$ 339,801	$ 267,065	$ 70,549	$ 140,227
Caroline	$ 18,387,432	$ 537,424	$ -	$ 16,378,678	$ 39,119	$ 145,176	$ 172,973	$ 117,437	$ 13,202	$ 3,278	$ 39,136	$ 537,034	$ 112,055	$ 228,778	$ 23,654	$ 39,489
Carroll	$ 4,280,917		$ 106,910	$ 266,634	$ 146,234	$ 20,194	$ 365,820	$ 200,265	$ 74,267	$ 106,241	$ 359,019	$ 780,554	$ 911,739	$ 816,048	$ 147	$ 126,846
Cecil	$ 14,177,435	$ 1,807,988	$ -	$ 9,402,079	$ 123,917	$ 115,474	$ 221,443	$ 129,916	$ 137,823	$ 73,511	$ 124,578	$ 563,547	$ 553,694	$ 782,601	$ 2,851	$ 138,013
Charles	$ 3,138,061	$ 51,940	$ 46,893	$ 79,104	$ 200,764	$ 58,923	$ 364,935	$ 485,218	$ 12,187	$ 51,782	$ 253,740	$ 143,691	$ 578,199	$ 680,403	$ 8,480	$ 121,801
Dorchester	$ 4,182,049	$ 653,423	$ -	$ 49,919	$ 43,304	$ 86,306	$ 41,364	$ 131,341	$ 227,714	$ 416	$ 53,616	$ 1,315,551	$ 206,233	$ 296,654	$ 1,050,996	$ 25,210
Frederick	$ 11,802,736		$ 224,091	$ 794,754	$ 204,561	$ 4,023	$ 736,203	$ 306,668	$ 79,238	$ 84,278	$ 535,631	$ 5,667,035	$ 741,561	$ 2,154,363	$ 2,324	$ 268,007
Garrett	$ 932,194		$ 77,499	$ -	$ 12,182	$ 48,595	$ -	$ 24,699	$ 7,418	$ 125,031	$ 33,413	$ 348,393	$ 79,627	$ 159,049	$ 3,199	$ 13,090
Harford	$ 6,443,811	$ 610,206	$ 57,818	$ 264,387	$ 268,323	$ 63,061	$ 497,860	$ 583,342	$ 83,814	$ 87,742	$ 616,518	$ 1,317,471	$ 858,089	$ 796,677	$ 1,179	$ 337,323
Howard	$ 7,897,973	$ 155	$ 100,894	$ 395,225	$ 284,567	$ 5,926	$ 735,128	$ 374,121	$ 74,089	$ 84,127	$ 476,912	$ 2,773,366	$ 1,142,515	$ 1,245,918	$ 230	$ 204,799
Kent	$ 11,249,612	$ 1,680,761	$ -	$ 8,559,342	$ 37,365	$ 92,312	$ 110,572	$ 137,035	$ 22,915	$ 15,842	$ 45,775	$ 198,330	$ 130,784	$ 193,712	$ 1,368	$ 23,499
Montgomery	$ 14,181,989	$ 77	$ 312,359	$ 467,055	$ 1,038,444	$ 17,962	$ 1,643,276	$ 1,016,967	$ 140,880	$ 63,702	$ 721,971	$ 1,436,943	$ 2,191,061	$ 4,661,712	$ 1,283	$ 468,299
Prince George's	$ 15,631,784	$ 324,457	$ 276,212	$ 181,655	$ 854,973	$ 22,637	$ 2,235,865	$ 992,886	$ 118,596	$ 81,119	$ 588,214	$ 347,737	$ 1,641,821	$ 7,474,904	$ 3,692	$ 487,016
Queen Anne's	$ 14,123,914	$ 4,997,014	$ -	$ 7,068,104	$ 54,546	$ 126,783	$ 193,091	$ 279,176	$ 35,345	$ 22,104	$ 88,024	$ 457,713	$ 241,181	$ 451,575	$ 29,491	$ 79,767
St. Mary's	$ 3,596,278	$ 110,618	$ 33,716	$ 140,553	$ 97,428	$ 21,277	$ 311,677	$ 759,960	$ 64,053	$ 66,945	$ 212,340	$ 357,231	$ 391,251	$ 847,180	$ 31,270	$ 150,779
Somerset	$ 5,699,623	$ 3,733,532	$ -	$ 51,133	$ 13,898	$ 66,564	$ 31,111	$ 146,646	$ 14,250	$ 14,154	$ 37,062	$ 355,731	$ 75,812	$ 104,652	$ 1,038,298	$ 16,780
Talbot	$ 6,073,295	$ 3,574,044	$ -	$ 943,249	$ 64,117	$ 44,555	$ 145,619	$ 92,423	$ 23,214	$ 5,007	$ 89,410	$ 522,041	$ 115,803	$ 358,085	$ 26,983	$ 68,746
Washington	$ 5,392,218		$ 141,778	$ 465,421	$ 96,791	$ 3,289	$ 268,032	$ 450,454	$ 75,275	$ 35,820	$ 41,268	$ 2,155,368	$ 240,881	$ 1,286,644	$ 4,808	$ 126,388
Wicomico	$ 3,541,823	$ 1,340,882	$ -	$ 72,240	$ 90,637	$ 82,975	$ 116,052	$ 306,302	$ 236,375	$ 3,914	$ 187,262	$ 141,032	$ 197,483	$ 456,175	$ 227,815	$ 82,680
Worcester	$ 8,102,005	$ 1,315,211	$ -	$ 5,033,245	$ 45,961	$ 39,367	$ 51,669	$ 215,392	$ 31,715	$ 14,757	$ 60,504	$ 936,796	$ 97,605	$ 163,537	$ 77,075	$ 19,170
	$ 19,229,494	$ 4,340	$ 198,175	$ -	$ 592,070	$ 5,460	$ 3,258,896	$ 3,507,037	$ 201,296	$ 67,340	$ 725,019	$ 1,424,837	$ 1,577,920	$ 6,649,384	$ -	$ 1,017,718
Maryland Total	$ 221,197,958	$ 34,626,461	$ 2,068,859	$ 51,219,782	$ 5,969,847	$ 1,115,174	$ 13,994,782	$ 14,492,073	$ 2,073,257	$ 1,460,897	$ 7,011,153	$ 26,314,416	$ 15,264,119	$ 38,100,420	$ 2,647,044	$ 4,839,674

Another view of the risk of natural hazards on Maryland is seen in Figure 1. Here, the NRI rating for each census tract is shown. Taking into account all three factors; EAL, social vulnerability and community resilience, most of Maryland's higher risk tracts (i.e., Very High or Relatively High) are located on the eastern shore of the Chesapeake Bay.

Decomposing the NRI by its three factors helps provide more context on the nature of hazard risk at the tract level. First, a view on EAL exposure from all hazards is shown in Figure 2 for each census tract. The results by either overall NRI or NRI EAL rating for Maryland census tracts is skewed toward lower risk. Most tracts show up as having either Very or Relatively Low EAL risk. However, note the disproportionate share of eastern shore census tracts that are rated as either Relatively or Very High risk.

Taking into account all three factors; EAL, social vulnerability and community resilience, most of Maryland's higher risk tracts (i.e., Very High or Relatively High) are located on the eastern shore of the Chesapeake Bay

Figure 1: NRI Rating for Maryland Census Tracts



Figures 3 and 4 show the NRI social vulnerability and community resiliency ratings for each tract. Panning out on the map (which readers can do by opening up the Excel spreadsheets of each map available on the Chesapeake Risk Advisors, LLC website), areas where high social vulnerability exists are found around Baltimore City, as well as the western part of the state and eastern shore. In terms of Community Resiliency, Maryland exhibits a relatively

Areas where high social vulnerability exists are found around Baltimore City, as well as the western part of the state and eastern shore

Figure 2: Overall EAL Hazard Risk for Maryland Census Tracts

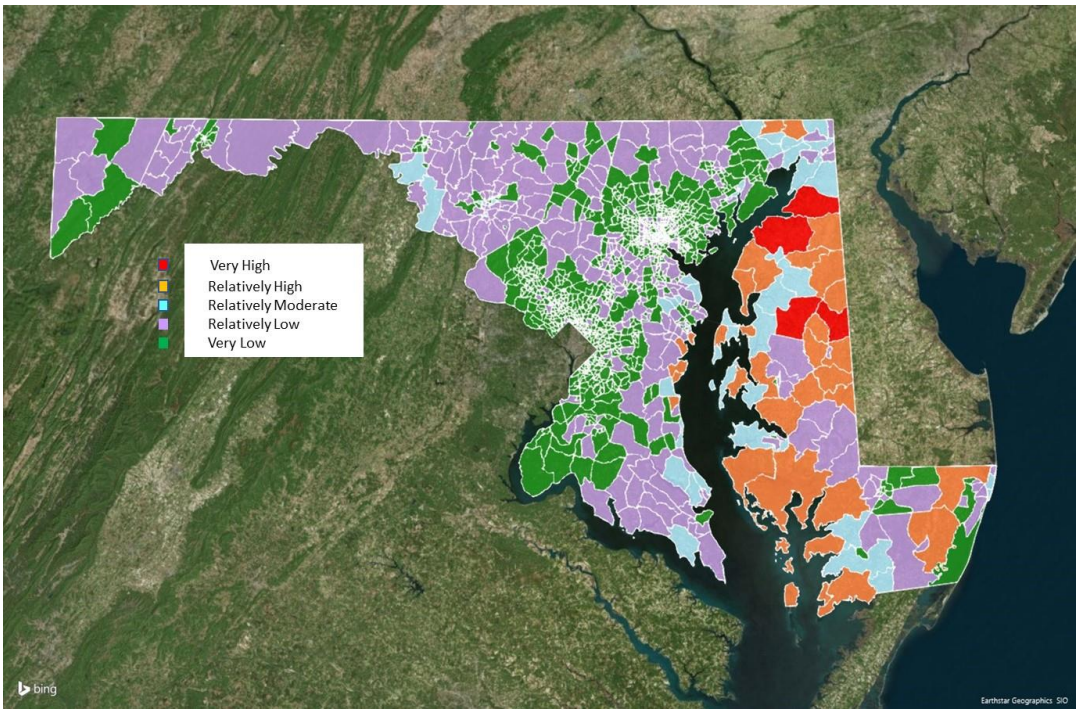
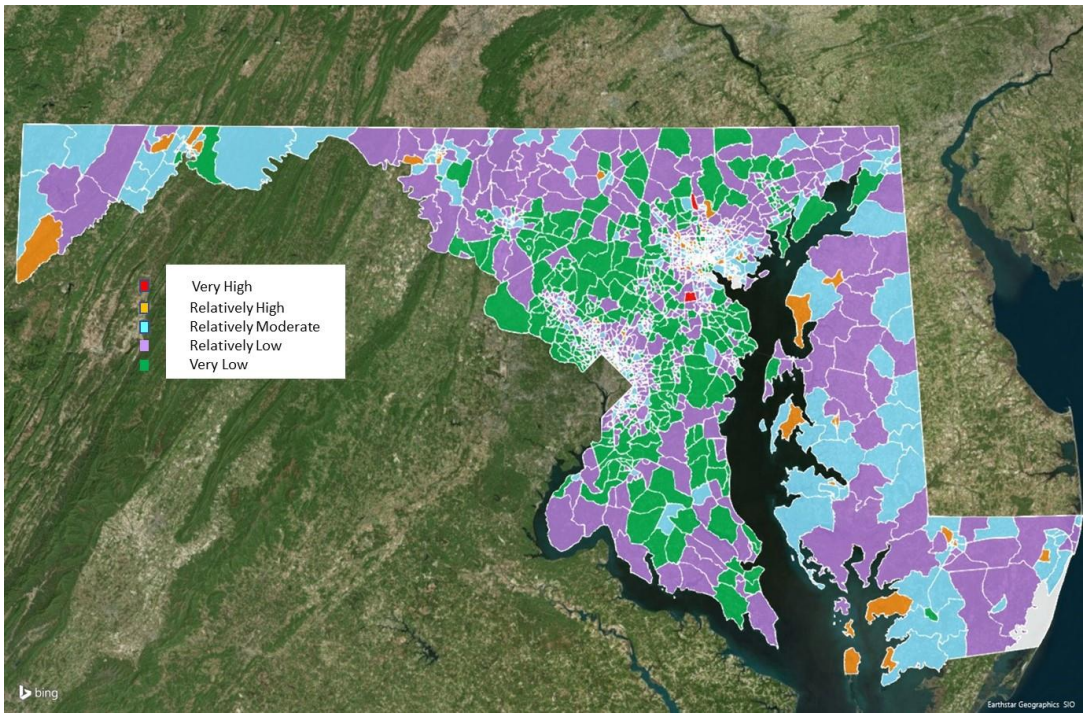


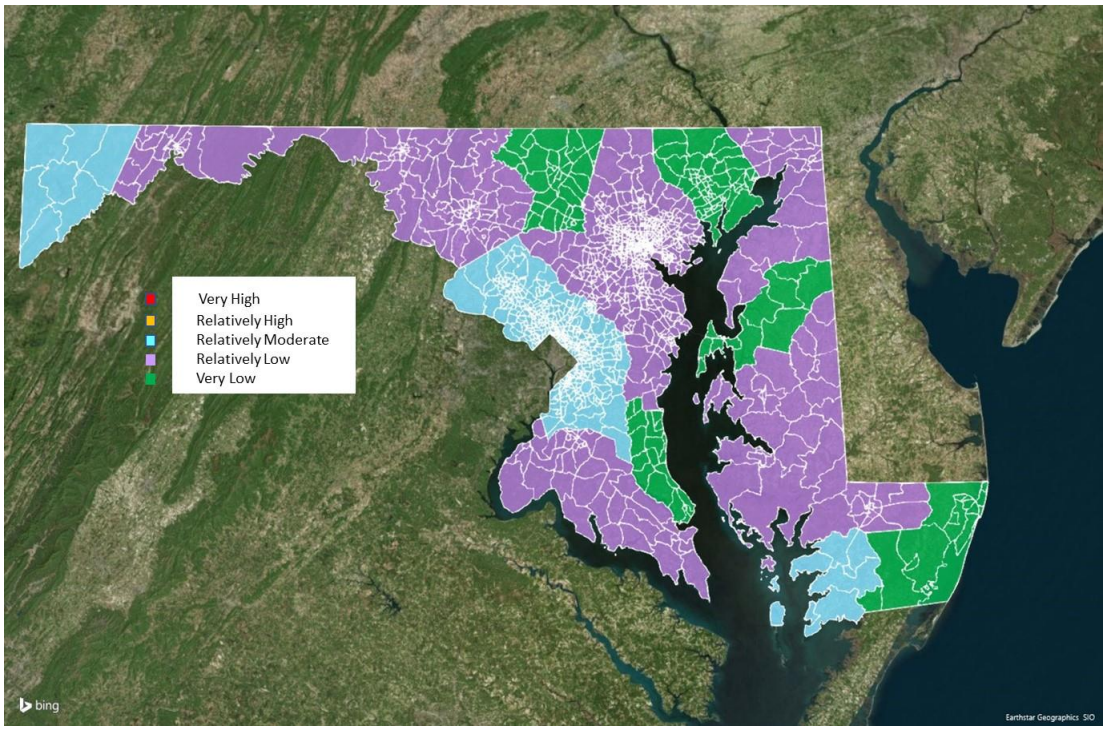
Figure 3: Social Vulnerability Rating by Maryland Census Tract



In terms of Community Resiliency, Maryland exhibits a relatively high level of community resiliency to hazard risk

high degree of community resiliency to hazard risk. It is important to keep in mind that FEMA developed these ratings not at a state level but nationally such that components, including financial resources for Maryland may, by comparison with other states, generate relatively favorable outcomes on community resiliency.

Figure 4: Community Resiliency Rating by Maryland Census Tract



HMDA Data

The 2021 HMDA data provides extensive detail on 23.3 million mortgage loan applications for that year in the US. Of these applications, 15 million loans were originated.[15] This information includes both 1st and 2nd lien mortgages as well as loans sold to Fannie Mae and Freddie Mac, FHA, VA, Rural Housing Service and privately-held mortgages making this one of the most comprehensive data sources on new mortgage loans available.

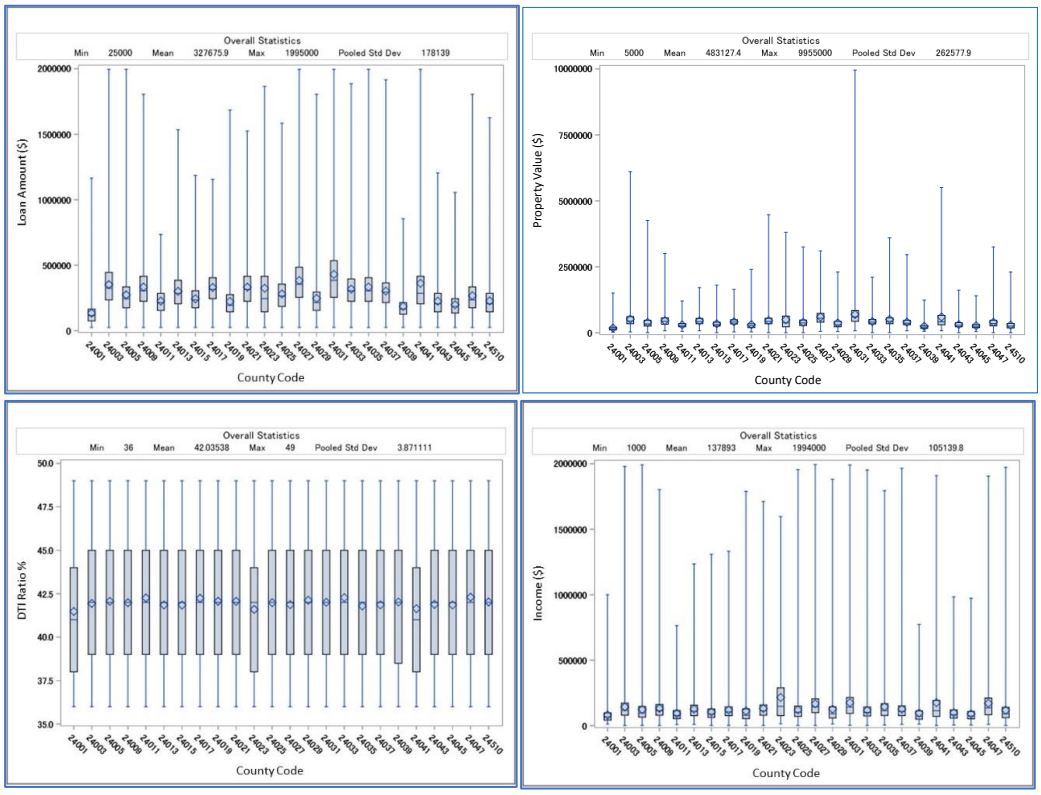
While the HMDA data does not capture any loan performance history since these reflect new loans, it does provide a great deal of information on key risk and demographic attributes useful for this study. Critical among them are such

[15] Consumer Financial Protection Bureau, Summary of 2021 Data on Mortgage Lending, June 16, 2022, https://www.consumerfinance.gov/data-research/hmda/summary-of-2021-data-on-mortgage-lending/.

COUNTY	Code
Allegany	24001
Anne Arundel	24003
Baltimore	24005
Calvert	24009
Caroline	24011
Carroll	24013
Cecil	24015
Charles	24017
Dorchester	24019
Frederick	24021
Garrett	24023
Harford	24025
Howard	24027
Kent	24029
Montgomery	24031
Prince George's	24033
Queen Anne's	24035
St. Mary's	24037
Somerset	24039
Talbot	24041
Washington	24043
Wicomico	24045
Worcester	24047
Baltimore City	24510

factors as loan-to-value (LTV) ratios, debt-to-income (DTI) ratios, loan amount, borrower income, age, race and ethnicity as well as a number of tract level statistics such as tract minority population percent. After scrubbing the HMDA data for missing data and outliers, a total of 595,874 loan applications for Maryland in 2021 remained in the sample. From these applications, 291,208 1st and 2nd lien loans were originated in Maryland. Figure 5 depicts some key statistics in boxplots for these loans across Maryland counties.

Figure 5: Borrower DTI, Income, Loan Amount and Property Value Statistics by County



Not surprising, there is little variability in DTIs of borrowers across counties. Differences emerge, however, when examining other attributes such as property values, loan amounts and borrower incomes. Here, the range in these variables is noticeable which will be important later in the analysis of hazard risk to discern any clear differences in financial and demographic characteristics across census tracts.

Fannie Mae and Freddie Mac Credit Performance Data

Both Fannie Mae and Freddie Mac have as part of their credit risk transfer (CRT) initiative made publicly available the loan level data associated with the vast majority of their insured portfolios consisting of millions of loans originated from 1999 to the present.[16] The data provide both the borrower, loan, and property attributes of the borrowers such as credit scores, LTV and DTI ratios and more as well as detailed information on the performance of each loan over time. Specifically, the data enables a user to determine whether a loan remained current or prepaid, went delinquent, was modified or entered default. This data was used to develop the HFVI used in this analysis. Random samples from the Fannie Mae and Freddie Mac data were taken and combined in historical proportions to their market share. More than 250,000 loans across the US from origination years 2000-2016 were used in developing the HFVI.

Homeowner Financial Vulnerability Index (HFVI)

The HFVI leveraged for this analysis measures a borrower's financial vulnerability to unexpected housing or nonhousing costs

The HFVI leveraged for this analysis was developed by Chesapeake Risk Advisors, LLC in a separate initiative to measure a borrower's financial vulnerability to unexpected housing or nonhousing costs. As mentioned earlier, over the course of a loan's life, borrowers' invariably encounter any number of unexpected expenses, small and large. In the case of housing, such unexpected large expenses would include major system breakdowns such as HVAC, appliances, windows, roofs, sewer and waterline replacement and repair, among others. While substantial academic literature exists relating to mortgage default, less is known about the degree of financial frailty of borrowers as it relates to unexpected outlays. However, the insurance company Hippo recently conducted a survey of new homeowners and found that within the first year of owning their home, a significant repair costing more than $1,000 happened for two-thirds of the homeowners in that sample.[17]

[16] Details on the Fannie Mae and Freddie Mac datasets are found at the following links: https://capitalmarkets.fanniemae.com/credit-risk-transfer/single-family-credit-risk-transfer/fannie-mae-single-family-loan-performance-data. https://www.freddiemac.com/research/datasets/sf-loanlevel-dataset

[17] Sarah O'Brien, "Many homebuyers face surprise repair costs soon after moving in, survey shows, CNBC, March 31, 2022, https://www.cnbc.com/2022/03/31/many-homebuyers-face-surprise-repair-costs-soon-after-moving-in.html.

Hippo found that within the first year of owning their home, a significant repair costing more than $1,000 happened for 2/3rds of the homeowners in their survey

Factors that are predicted to affect financial vulnerability include debt burden, borrower income diversification, relative capital costs of equipment and component replacement to borrower income, the age and type of property (e.g., single family vs condo), equity stake in the property by the borrower, relative income and occupancy status, among others.

Taking each of these in turn, clearly a borrower's debt burden, defined as total monthly housing and nonhousing obligations divided by monthly income is expected to be positively related to financial vulnerability. Moreover, multiple borrowers with incomes tend to be more insulated from a financial stress event due to income diversification. A variety of property-related features are considered to factor into the cost of repairs or replacement to important components in a home. These include the age and condition of the structure and its critical components, structure size and building materials, among others. The HFVI model takes into account the idea that these factors are embodied within the property value and that borrowers with lower incomes will have a greater financial shock from an unexpected home repair the larger that property happens to be.

Extreme weather events could affect homeowner financial vulnerability as stated earlier. Costs associated with such events include the impact on property insurance premiums and out-of-pocket costs for protecting property against natural disasters, as well as higher deductibles and any expenses not otherwise covered by insurance after an event occurs. Homeowner insurance costs, for example, rose more than 12 percent between 2021 and 2022 according to one study.[18] And those in states more susceptible to disasters not surprisingly are seeing significant increases in premiums. Ominously in some areas, obtaining a homeowners policy is becoming increasingly difficult as underwriters assess the insurability of these homes. For instance, Florida's homeowners insurance market is under extraordinary financial pressure, with homeowners in at-risk areas facing non-renewal notices or much higher premiums and deductibles.[19]

The release of FEMA's new risk-based pricing for flood insurance called Risk Rating 2.0 has greatly improved the flood insurance program in a number of important ways including taking into account a property's cost of construction premiums for lower-valued homes.[20] In Maryland, the premium impact on

[18] Kate Dore, "As climate change threatens more homes, some properties are getting too costly to insure," CNBC, August 9, 2022, https://www.cnbc.com/2022/08/07/climate-change-is-making-some-homes-too-costly-to-insure.html

[19] Ed Leefeldt, Why is Homeowners Insurance in Florida Such a Disaster? Forbes Advisor, November 22, 2022.

[20] FEMA, Risk Rating 2.0: Equity in Action, https://www.fema.gov/flood-insurance/risk-rating

Ninety-seven percent of Maryland policyholders under the FEMA NFIP 2.0 program experienced an annual premium increase no more than $10

homeowners from Risk Rating 2.0 has been negligible. Ninety-seven percent of policyholders under the FEMA NFIP 2.0 program experienced an annual premium increase no more than $10 and more than 61% realized lower premiums.[21]

The HFVI is a proprietary statistically-based model that predicts the likelihood of borrower financial vulnerability. Financial vulnerability is marked by an event of such significance that it places the homeowner in a state of financial distress. Events triggering financial distress could include a major unexpected outlay or loss of income or employment, death or illness or divorce. Typically proxies of these trigger events are used in modeling mortgage default, and similar approaches can be leveraged to examine financial vulnerability. HFVI controls for and strips away those elements not directly related to financial vulnerability. The multivariate statistical model was validated on a large sample of mortgage loans and found to have a high degree of discriminatory power in distinguishing between borrowers that came into financial distress versus all others over time.[22]

For this analysis, the HFVI model was applied to all 2021 HMDA loans in Maryland and a predicted probability of financial distress computed. The average predicted probability of financial distress for the sample was 9% with a range of 0 to 19% and a standard deviation of 1.8%. From there, the probabilities were transformed into the HFVI score using an industry standard credit scoring algorithm. Scores for HFVI range from 0 to 400 with 50 points doubling the odds of a borrower becoming financially distressed. The average HFVI in the 2021 Maryland HMDA sample was 168. Lower scores are indicative of greater financial distress and vice versa.

For each Maryland census tract a weighted (based on each loan's unpaid principal balance) HFVI score was produced from HMDA loans in that tract. Then a rule was applied to establish an HFVI risk rating for each tract. The definitions for each HFVI rating are shown in **Table 3** along with the number and percentage of tracts for each category. Within this sample, 13.7 percent of Maryland tracts are designated as either Relatively High or Very High homeowner financial vulnerability. Borrowers in these two risk categories are 2-3 times more likely to enter financial distress sometime in the life of their loan than Relatively Moderate borrowers.

[21] Association of State Floodplain Managers and The Pew Charitable Trusts, Risk Rating 2.0 Interactive Map, https://www.arcgis.com/apps/dashboards/44d08581aaf14f39bc0da5d02f378007.

[22] For example, one diagnostic measure used to test the validity of HFVI is the Kolmogorov-Smirnov (KS) test. The out-of-sample KS score was 47 for the HFVI model, indicative of a relatively high level of discriminatory power.

13.7 percent of Maryland tracts are designated as either Relatively High or Very High homeowner financial vulnerability

To provide some insight into important differences between groups, the percentage of homeowners with a Very High financial vulnerability rating having DTIs above 40% is 63.7% of that rating category versus less than 1% for the other rating groups. Moreover, the ratio of borrower income to median income for all Maryland borrowers averaged .79 for borrowers in the Very High financial vulnerability category versus an average of 1.14 for all others. Similarly, the ratio of property value to borrower income averages 4.85 for borrowers in the Very High financial vulnerability category versus 3.86 for all other borrowers. These statistics individually are indicative of borrowers with greater vulnerability to unexpected financial events such as an extreme weather due to the potential relative costs of repairs to financial resources available to these borrowers.

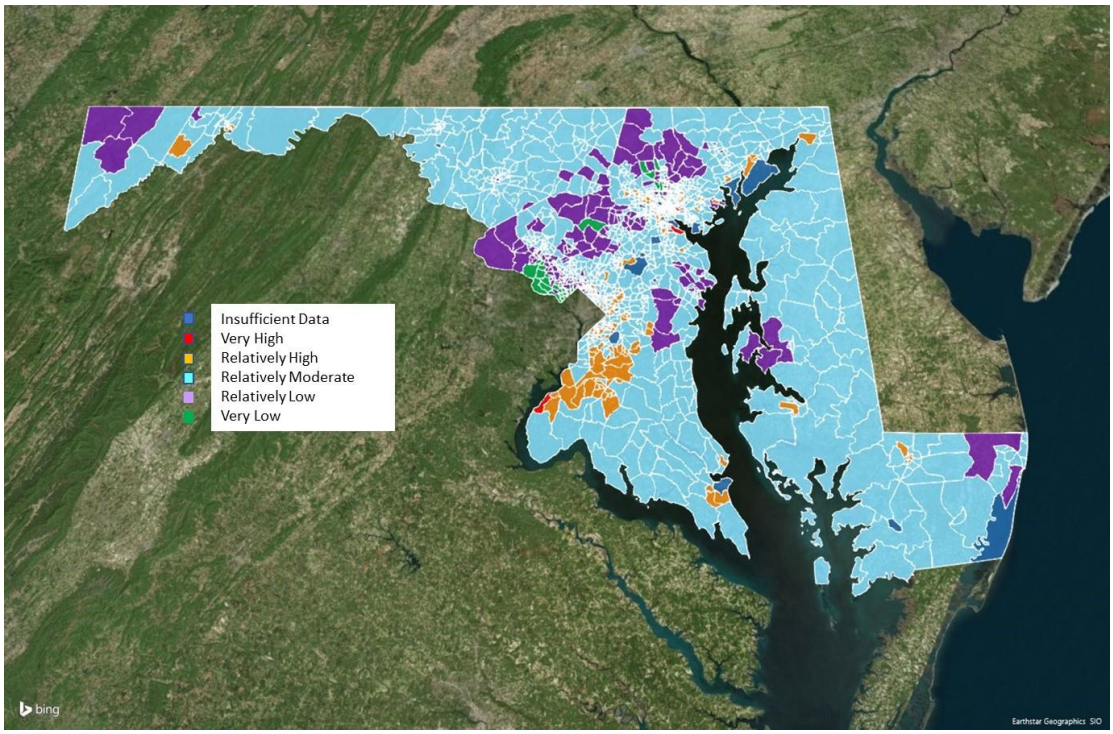
Table 3: HFVI Rating Definitions and Tract Counts for Maryland[23]

HFVI Rating	HFVI Score	Risk Multiple	Number of Tracts	% of Tracts
Very Low	>375	.25Xs	32	2.41
Relatively Low	>325-375	.50Xs	180	13.57
Relatively Moderate	>275-325	1.00Xs	933	70.36
Relatively High	>225-275	2.00Xs	170	12.82
Very High	<=225	3.00Xs	11	0.83

Figure 9 provides more insight into where borrowers with the greatest financial vulnerability are located. The majority of Maryland census tracts are located in Relatively Moderate or Very Low HFVI tracts. In terms of population density, we see portions of Prince Georges County, Baltimore City and County and Charles County as having Relatively and Very High homeowner financial vulnerability tracts, however, there are pockets of higher risk tracts in each corner of the state.

[23] Note: this total of 1,326 tracts excludes 69 that reported an insufficient number of loans in the tract for analysis. To preserve statistical integrity, each census tract had to have at least 50 mortgage loan observations.

Figure 9: HFVI Rating by Maryland Census Tract



The majority of Maryland census tracts are in Relatively Moderate to Very Low HFVI tracts

Maryland Natural Hazard Risk & Financial Vulnerability

So far, the NRI risk ratings and homeowner financial vulnerability ratings have been examined in isolation from each other. Putting these ratings together presents a clearer picture of where extreme weather events have the greatest impact to homeowners in Maryland. Based on these ratings, only 4 tracts in Maryland are designated as having very high combined hazard risk and financial vulnerability as shown in Table 4 (orange cells). An additional 30 tracts fall into the next highest combined risk category (yellow cells). The vast majority of tracts thus fall into Relatively Moderate to Low Risk. Greater geographic detail on combined hazard risk and financial vulnerability is provided in Figure 10. We find the vast majority of the highest risk tracts are found on the eastern shore and to a lesser extent in tracts along the western shore of the Chesapeake Bay. These areas are some of the least densely populated areas in the state where agriculture and fishing are major industries.

Additional perspectives on the various groups are provided in Tables 5 and 6. Table 5 displays the median income for each rating combination. While there is some variation in income across rating combinations (e.g., VL EAL Ratings and RH and VH HFVI), no clear pattern emerges suggesting that homeowners living in high hazard areas have significantly lower incomes than other lower risk areas.

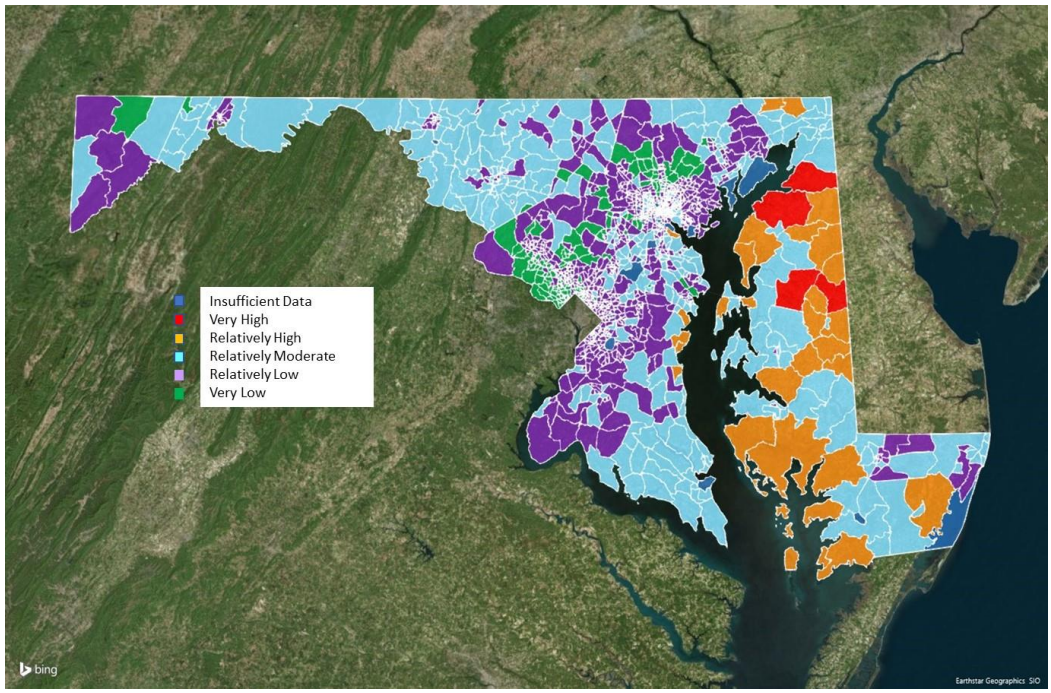
Only 4 tracts in Maryland are designated as having very high combined hazard risk and financial vulnerability

Table 4: Combined NRI (EAL) and HFVI Ratings for Maryland Census Tracts

	HFVI Rating						
NRI EAL Rating	VL	RL	RM	RH	VH	Totals	NRI*HFVI Legend
VL	29	125	614	143	9	920	Very Low
RL	2	47	247	27	2	325	Relatively Low
RM	1	4	40	0	0	45	Relatively Moderate
RH	0	4	28	0	0	32	Relatively High
VH	0	0	4	0	0	4	Very High
Totals	32	180	933	170	11	1326	

Looking at the minority percentages in these areas, Table 6 suggests that overall minority populations are considerably lower in higher hazard, financially vulnerable areas. Once again, it is important to point out that individual tracts in certain high hazard risk areas have much higher minority percentages and lower income and as a result the utility of these ratings is found in examining their characteristics at the individual tract level for public policy.[24]

Figure 10: Map of Combined NRI (EAL) and HFVI Ratings for Maryland Census Tracts



[24]Making the HFVI and NRI ratings available at the tract level provides policymakers with that level of detail.

Overall minority populations are considerably lower in higher hazard, financially vulnerable areas

Table 5: Median Income ($) by Hazard and Homeowner Financial Vulnerability Rating

	HFVI Rating				
NRI (EAL) Rating	VL	RL	RM	RH	VH
VL	202,645	176,987	118,510	98,877	93,094
RL	111,233	156,799	124,747	136,492	-
RM	-	170,487	142,722	157,468	-
RH	-	-	127,835	141,816	-
VH	-	-	119,283	-	-

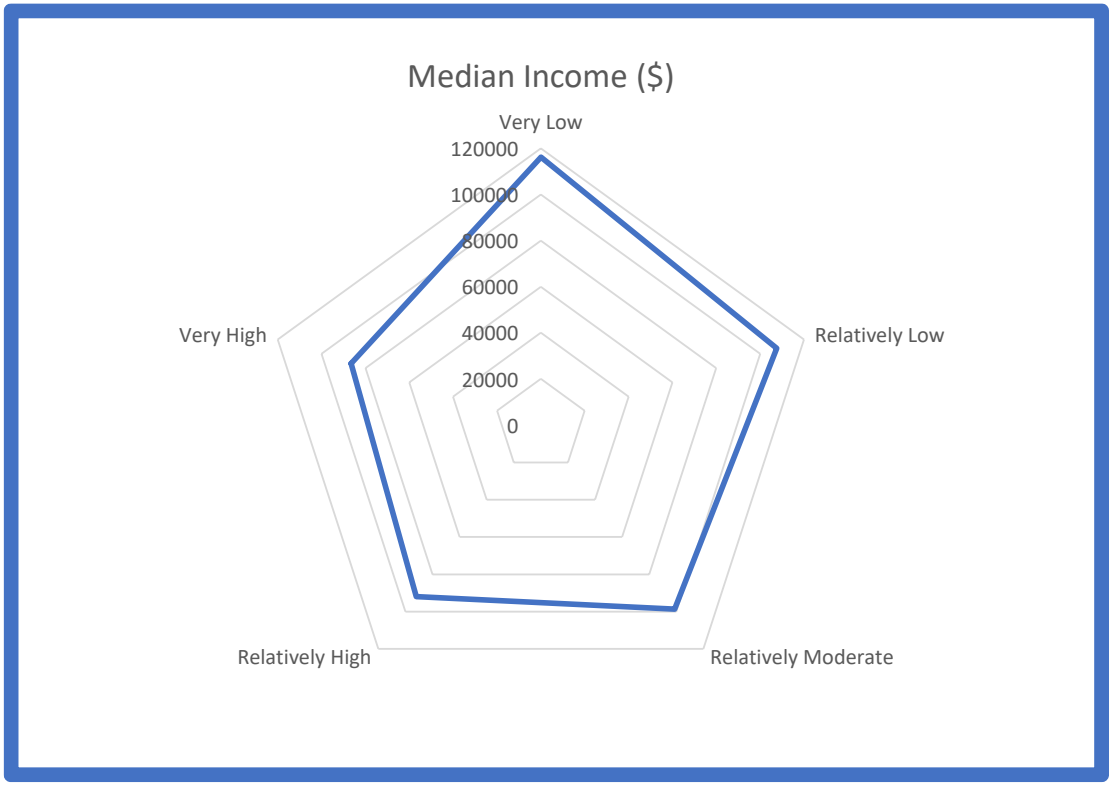
Table 6: Average Minority Share of Population (%) for Tracts by Hazard and Homeowner Financial Vulnerability Rating

	HFVI Rating				
NRI EAL Rating	VL	RL	RM	RH	VH
VL	39.0	38.2	50.3	83.6	60.0
RL	14.4	30.0	31.4	35.0	NA
RM	NA	34.0	17.4	9.5	NA
RH	NA	NA	18.3	16.8	NA
VH	NA	NA	13.2	NA	NA

Another way to examine differences in median income is by the radar plot in Figure 11. The pattern that emerges seems to suggest that median incomes in the VH and RH EAL rating categories tend to be a bit lower than the other categories. Further assessment of any differences in income by hazard risk rating is performed in a multivariate analysis.

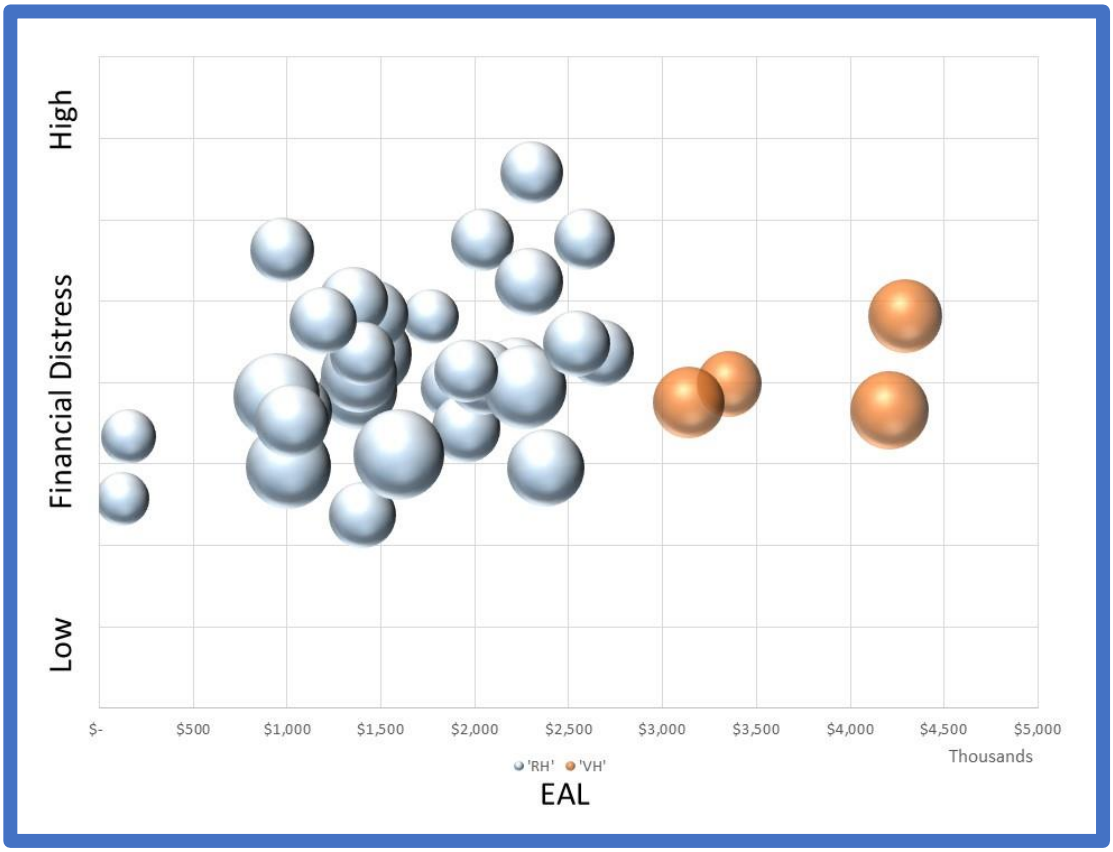
Figure 12 presents additional insight on the relationship of median income for the highest risk EAL categories taking financial distress into account. Here we tend to see higher median income tracts (larger bubbles) oriented toward the lower end of the EAL axis and again not surprising also at the lower end of the financial distress axis.

Figure 11: Median Income by EAL Hazard Rating Radar Plot



Median incomes in the VH and RH EAL rating categories tend to be a bit lower than the other risk categories

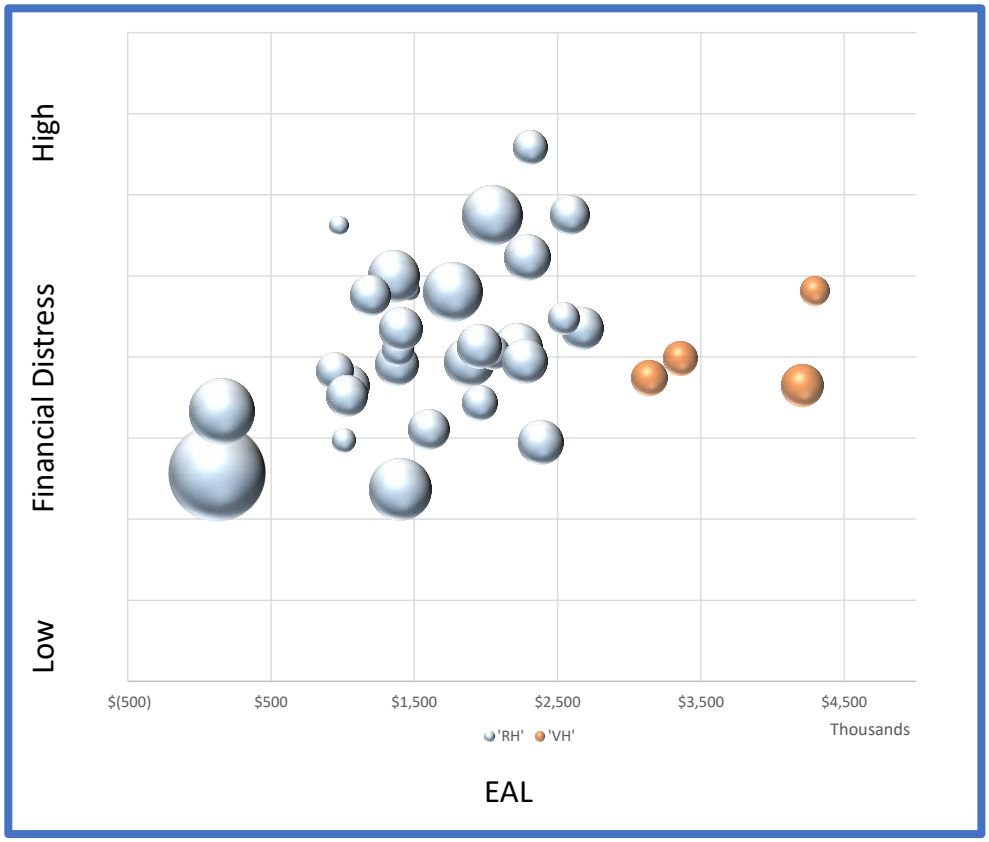
Figure 12: Median Income by EAL Hazard Rating and Financial Distress Radar Plot



Tracts with Very Low EAL risk have the highest tract-level minority percentage

Figure 13 presents a multilayered view of minority presence in high hazard risk areas. For just the Relatively High and Very High tracts, there appears to be some relationship between tracts with higher EAL and financial distress though less of a clear relationship emerges between higher minority percentages (larger bubbles) and EAL or HFVI. Figure 14 provides another view of the relationship between minority percentage and combined EAL and HFVI rating. What this figure shows is that tracts with Very Low EAL and HFVI risk have the highest tract-level minority percentage while the highest two combined EAL and HFVI rating categories show the lowest minority percentages.

Figure 13: Tract Minority Percent by EAL



Finally, an examination of the age of housing stock of borrowers by EAL risk ratings from Figure 15 can provide some insight into the potential costs for homeowners should an extreme weather event occur. Damage to newer homes, particularly stick-built structures, could be more costly due to restoration and or repair costs for these structures as compared with older homes. Many factors beyond age factor into the cost of repair such as composition and materials used in construction, for example. But on this one dimension, no clear pattern emerges on the radar plot. Tracts with Very Low

Figure 14: Minority Percent by EAL Hazard Rating and Financial Distress Radar Plot

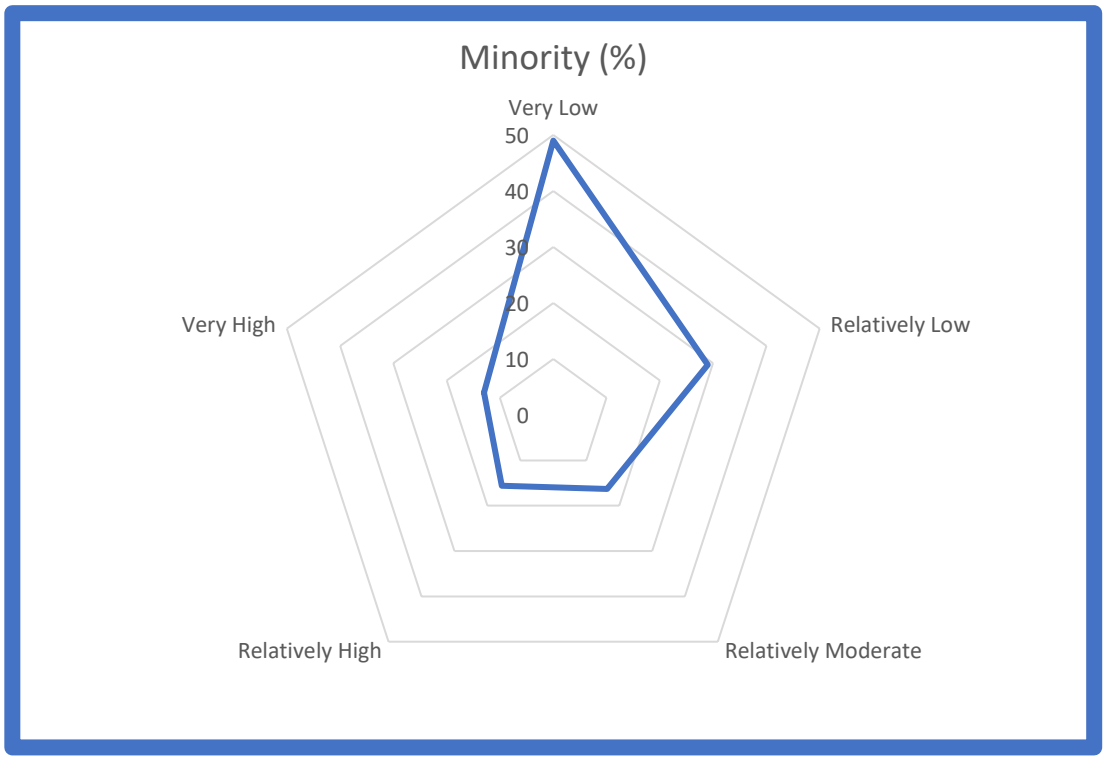
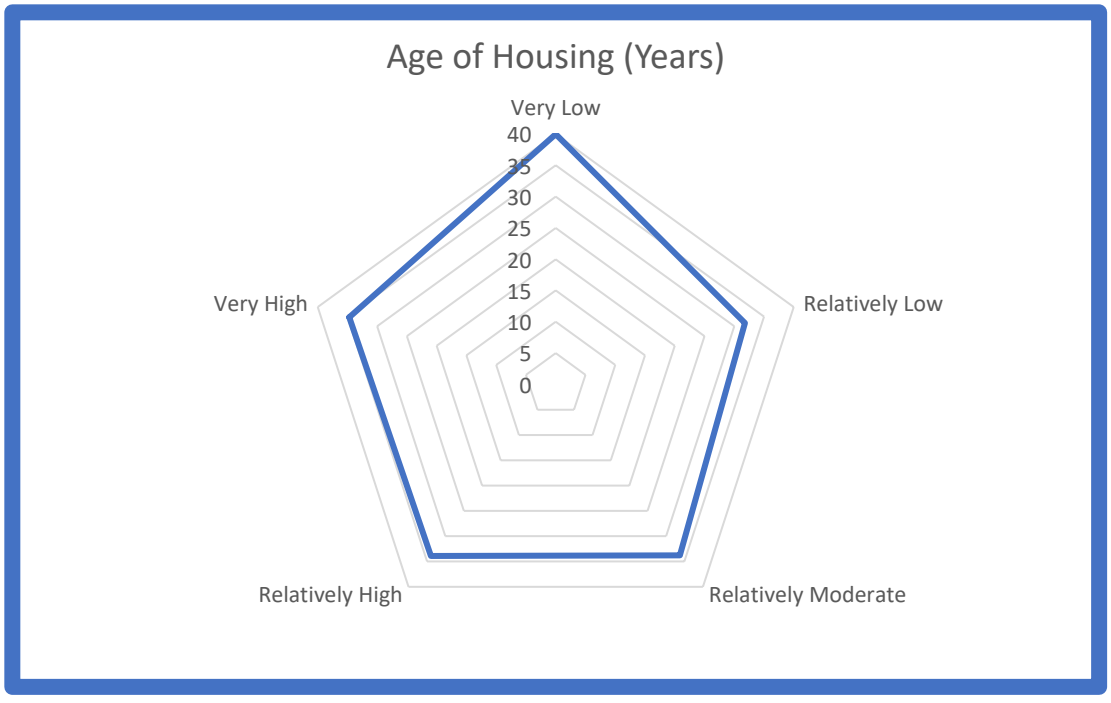


Figure 15: Age of Housing by EAL Hazard Risk and Financial Distress Radar Plot



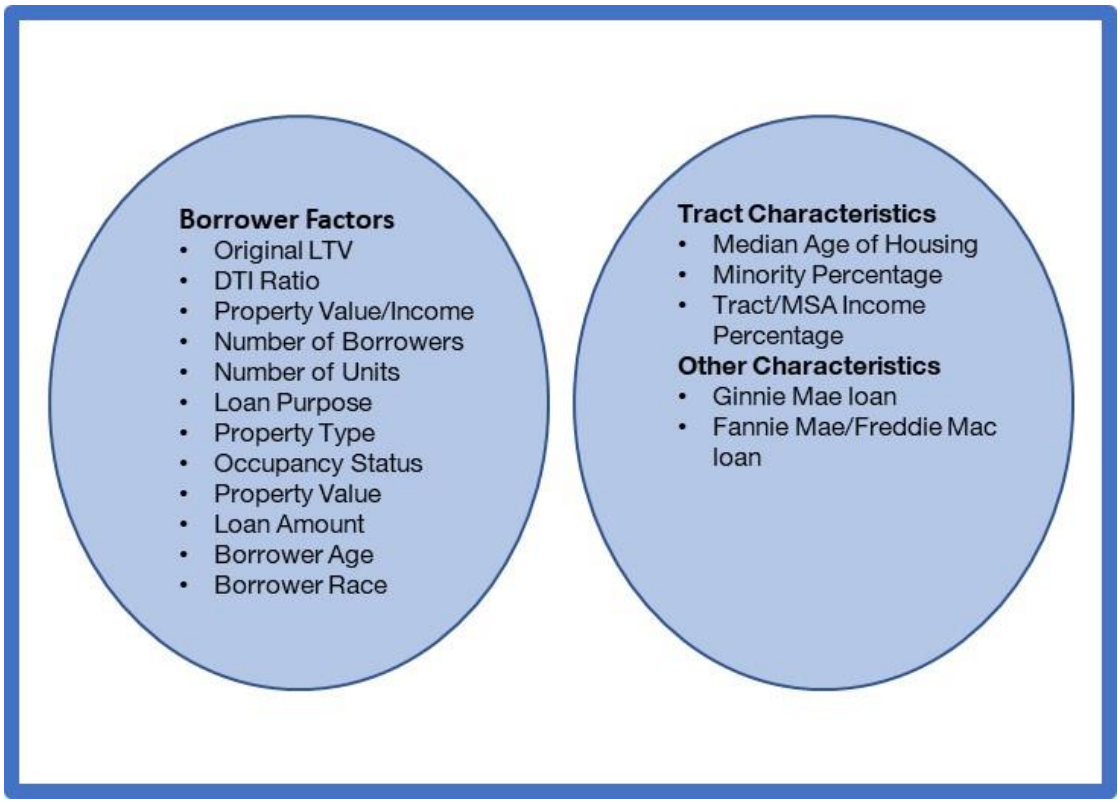
Tract minority percentages are lowest for the two highest combined EAL and HFVI rating groups

combined risk show a somewhat older housing stock than the other categories but beyond that very little difference in age across risk ratings is observed.

While examining individual borrower and tract characteristics can shed light on homeowner vulnerability to extreme weather events, a more robust approach requires a multivariate analysis where individual attributes can be controlled for against other characteristics. For this purpose, a logistic regression model was estimated using the Maryland 2021 loan level data combined with the NRI data. This type of model is commonly used when examining differences between groups. The variable of interest, or dependent variable was whether the property underlying the loan was located in a high hazard risk area (i.e., Relatively High or Very High) as designated by the EAL Rating. High EAL risk loans are designated as 1 in the data and 0 for all others. A number of other borrower, tract and housing market factors were identified as candidate explanatory variables. A list of candidate variables for the analysis are found in Figure 16.

A statistical analysis of MD loans identified several factors distinguishing high hazard risk areas from others

Figure 16: Candidate Variables for Multivariate Analysis



The idea was to discern whether some combination of these variables would have statistical significance in distinguishing between loans in high EAL risk areas and all others. While a hypothesis for each variable regarding its relationship with the dependent variable could be drawn, some relationships

One implication from these results is that government loans such as FHA, VA and Rural Housing are more likely to be in high hazard risk areas

are not readily apparent and so using this type of analysis can help identify important patterns in the data in this case.

After estimating a large number of models with different specifications, the set of variables leading to the model with the most discriminatory power among all alternatives is shown in Figure 16 along with the odds ratios for each variable.[25] All variables were significant at the 1% level. The variable with the largest odds ratio was the dummy variable for Ginnie Mae loans. The variable was designated as a 1 if the loan was a Ginnie Mae loan or 0 otherwise. The odds ratio for that variable of 1.31 implies that properties associated with Ginnie Mae loans are 1.31 times more likely to be in high EAL risk areas than other loans. Several specifications tested whether there was any difference between GSE (Fannie Mae and Freddie Mac) and nonGSE loans and in all instances that variable was not significant. One implication from these results is that government loans such as FHA, VA and Rural Housing are more likely to be in high risk areas. This result begs the question of whether these agencies are being adversely selected by loan originators. Agencies insuring the credit risk on these loans then from this analysis would be well-served to understand the risk to borrowers from extreme weather events as they could pose higher default risk over time. Conversely, there does not seem to be any adverse selection with GSE loans given the lack of significance between GSE and nonGSE loans by EAL risk rating.

Factors also associated with a higher likelihood of a property being in a high EAL risk area were borrower relative income defined as the ratio of a borrower's income to median income for the HMDA sample and loan purpose defined as whether the loan was a cashout refinance (=1) or not (=0). While this variable is an important predictor of mortgage default, it was hypothesized that there might be a positive relationship between taking equity out of the property and its hazard exposure. The effect in this case was moderate, based on the odds ratio of 1.2. All other factors in the table were negatively related to the dependent variable.

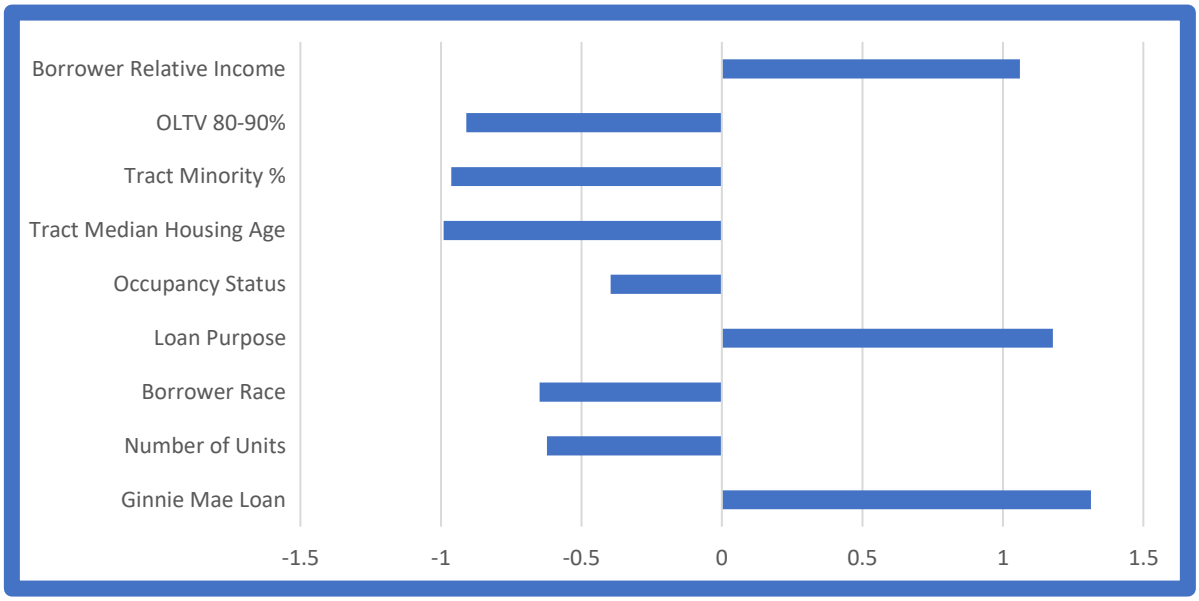
The odds ratio for instance of the housing age variable was statistically significant and implies that for every 1 year increase in the age of a house, the likelihood of being in a high EAL risk area falls by 1%. Other significant factors are that the higher the percentage of minorities in a tract, the lower the liklihood that tract would be in a high EAL risk area. Borrower race is consistent with that tract-level effect as well.

What this analysis shows is that there is variation among tracts on the basis of their EAL risk rating from borrower, tract and other characteristics. The

[25] An odds ratio is defined as e^b where b represents an explanatory variable's estimated coefficient in the model. The final model reported a KS of 66.7 and an AUC of .89.

analysis sheds new light on the characteristics of homeowners in high hazard risk areas and information such as this can help guide policymakers in developing programs aimed at helping borrowers mitigate risk from extreme weather events.

Figure 16: Odds Ratios Differentiating High Hazard Risk Tracts



By using tract-level measures of hazard risk combined with loan level measures of financial vulnerability, federal, state and local funding can be better allocated to support community-based resiliency projects

Summary and Conclusions

Homeownership remains of the most important financial achievements for individuals in this country and has significant public policy implications for the economy and social welfare. More than two-thirds of Marylanders own their home and for most, it is the most valuable asset that they own. Protecting this asset against loss from extreme weather events now and in the future is critical. Policymakers as well as the insurance and mortgage industry need to improve the tools available to assess the risk to homeowners from such events.

This study provides new tools for analyzing the effects of extreme weather events and homeowner financial resiliency. Identifying areas with the greatest exposure to extreme weather and that have high homeowner financial vulnerability can help target public and private resources optimally. For example, by using tract-level measures of hazard risk combined with loan level measures of financial vulnerability, federal, state and local funding can be better allocated to support community-based resiliency projects such as investments in shoreline protection, flood control and the like as well as help facilitate the design of innovative

Tools such as the HFVI when combined with FEMA's NRI data can provide the kind of information needed to better insulate homeowners from the unexpected

insurance and mortgage products for individual homeowners.

Current and prospective homeowners living in high hazard risk areas will need new products and services to help them understand and manage the physical and financial risks they face from extreme weather events now and in the future. For new homeowners, having tools that help identify the physical risks of their area is critical before making a purchase. Today there are tools available for prospective homeowners to obtain estimates of a property's value and also its flood risk. While these are certainly valuable at the property level, assessing this risk along a broader set of hazards and at the tract level can provide potential homeowners with a sense of the risks of not just living in the home but also the effects extreme weather might have on the community, local infrastructure and commerce over time.

Current homeowners can likewise benefit from these tools, especially forward-looking tools that can provide them with perspectives on hazards happening not just this year but 5-10 years and more down the road. Today, in Maryland about 42% of residential properties considered to be at-risk have flood insurance.[26] Further, as the frequency and severity of extreme weather events increases, today's seemingly low-risk property might become tomorrow's high risk home, making the need to obtain insurance more critical. And with flood risk being just one of many potential hazards to a home over the life of a mortgage, providing homeowners with better information is imperative.

In addition, financial products that cater toward proactive investment by homeowners in weather resiliency projects should be developed. This could include adjustable balance mortgages that incent homeowners to invest in qualifying remediation/resiliency projects that add value to the home and spread those investment costs flexibly over time at a lower rate, thus making such investments more feasible. Other products post-disaster could be imagined that provide similar financial relief to homeowners for renovation and repair costs not otherwise covered by insurance. Ideas such as extreme weather/climate banks could be established for instance from guarantee fees charged by credit investors such as the GSEs and FHA and allocated based on need.

Ultimately, the first step in developing these capabilities, products and programs is to identify those homeowners most in need of help. Tools such as the Homeowner Financial Vulnerability Index when combined with FEMA's NRI data can provide the kind of information needed to better insulate homeowners from the unexpected costs of extreme weather events.

[16] Meg Stefanac, Maryland Flood Insurance, Trusted Choice, February 18, 2022.