

Flood Insurance Coverage of Federal Housing Administration Single-Family Homes



Multidisciplinary Research Team: Task Order 7

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March 30, 2020

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2M Research

ACKNOWLEDGMENTS

Several individuals contributed to the successful completion of this research. Ransford Osafo-Danso of the U.S. Department of Housing and Urban Development's (HUD) Office of Policy Development & Research (PD&R) served as our contracting officer's representative. Dr. Osafo-Danso helped ensure that our work proceeded in a timely fashion, facilitated our communication with subject matter experts (SMEs) at HUD, and generally helped guide the development of this study. SMEs at HUD PD&R—Mr. Christopher Narducci, Ms. Katrina Durbak, and Dr. Maria Chelo De Venecia—provided timely feedback and guidance to help the study team understand relevant issues and refine our research. Dr. Kevin Park at HUD PD&R also provided helpful background on the Federal Housing Administration single-family property database. Within the 2M Research (2M) study team, Dr. Jim Murdoch served as project director; Dr. Dennis Kwadwo Okyere was project manager; and Dr. James Murdoch, Dr. Meghna Brahmachari, and Dr. Arpita Chakravorty led the analysis and reporting. 2M's research staff, including Shane Smith, Lan Hu, MacKenzie Regier, Cindy Romero, and Joshua Townley provided invaluable support throughout the study and assisted in the preparation of the final document. The analysis was made possible only with National Flood Insurance Program policy data made available by the Federal Insurance and Mitigation Administration within the Federal Emergency Management Agency (FEMA) under an interagency sharing and access agreement. Mr. Joshua King, an operations research analyst at FIMA was instrumental in orchestrating the agreement and advising HUD and 2M on the data structure.

Disclaimer

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FOREWORD

As the extent and costs of flood damage increase throughout the United States, the U.S. Department of Housing and Urban Development (HUD) is developing analytical tools to better understand the risk of flood hazard to Federal Housing Administration (FHA) homeowners and the collateral securing their home loan and mortgage insurance. HUD's 2018–2022 Strategic Plan directs the Department to “support sustainable homeownership and financial viability,” which includes responsibly balancing the HUD role to support homeowners while safeguarding the American taxpayer, and ensuring its insurance requirements and premiums do not encourage excessive risk-taking. HUD is, therefore, gathering data and conducting new analyses to learn about the exposure of home loan collateral to hazard risks—especially flood risk—and prepare for the underlying liabilities.

One of HUD's largest potential liabilities is the mortgages insured through FHA, which includes over \$1.26 trillion in mortgage debt on 8 million homes. To prudently manage this large asset class, HUD needs information about the portfolio's flood risk exposure and the extent to which FHA homeowners are required to carry requisite flood insurance policies provided by the National Flood Insurance Program (NFIP). Despite conducting an initial check of a property's flood risk and flood insurance status, HUD does not electronically document compliance with this requirement and is unable to monitor it in real time.

Through a unique arrangement with NFIP, HUD gained access to a database of property-level flood insurance policies and damage claims for the past decade in North Carolina and Florida. This data enabled researchers to link FHA-insured mortgages with flood insurance policies and damage claims for the first time and provided insight into the level of compliance with the flood insurance mandate relative to flood risk exposure in these two states. The data also enabled researchers to begin examining potential causal relationships between flood damage and mortgage delinquency.

Though the analysis is limited to just two states, several findings emerged that warrant further investigation and development of new analytical tools. The first finding is that this portfolio is very exposed to flood risk, yet many homeowners that are at risk are not covered by adequate flood insurance—even when it is required. In both states, over one-half of the FHA-insured mortgages in these states are located within or very close to a high-risk flood zone, yet less than one-fifth of such homes have insurance, and only about one-half of homes required to have insurance are in compliance. Initial examination of the data shows that flood insurance damage claims are associated with a higher likelihood of subsequent mortgage default. Though the finding is preliminary, it aligns with findings in other studies and portends a serious systemic risk to the portfolio in the context of increasing flood events, nationally. Overall, the analysis demonstrated most clearly that HUD needs more detailed data to regularly conduct audits of compliance with the flood insurance requirement. FHA conducts random monitoring of compliance on individual properties but does not have access to the digital data needed to routinely conduct analysis across its entire stock or carry out follow-up examinations of the research presented here.

This analysis was intended as an initial step towards demonstrating the value of detailed data on the flood risk exposure of FHA-insured mortgages and compliance with the insurance mandate. The findings from two states demonstrate the need to conduct additional analysis on a broader scope to answer critical questions. What is the national rate of compliance with the flood insurance mandate? What is

the dollar value of HUD liability that is not protected by hazard insurance? Moreover, further investigation of links between flood insurance claims and premium rate changes with mortgage performance is vital to understanding HUD exposure to systemic losses in the context of heightened regional and national flood risk. Answers to such questions are necessary for HUD to adequately limit, manage, and price its liabilities. With this report and pending efforts to improve data quality, HUD is moving in the direction of securing the integrity of a fundamentally important, but potentially fragile, mortgage insurance program and holding true to its stated mission of sustaining homeownership and viability for American homeowners and all those striving to become one.

While not the guiding purpose of the study, I would be remiss if I did not mention HUD's effort to revise FHA regulations to allow FHA homebuyers in Special Flood Hazard Areas (SFHAs) the option to meet the mandatory flood insurance requirement with the purchase of a private flood insurance policy (see RIN: 2502-AJ43). HUD finalized this rule on November 10, 2020. This rule aligns FHA regulations and standards with the congressional intent of the Biggert-Waters Insurance Reform Act of 2012 requiring federally regulated lenders and the government-sponsored enterprises to accept private flood insurance as the satisfaction of the flood insurance requirement if the policies meet requirements for coverage and counter-party risk. Moreover, it is hoped that these changes will increase consumer choice and affordability of flood insurance for homebuyers while encouraging greater use of private flood insurance. These changes will also hopefully bring about an alternative to insulate potential FHA homebuyers from the costly impacts of delay or a canceled purchase should a temporary lapse in the NFIP's authorization occur.

A handwritten signature in black ink, appearing to read 'S. Appleton', with a long, sweeping horizontal line extending to the right.

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EXECUTIVE SUMMARY

Objectives of the Study

Currently, the premium-financed and taxpayer-guaranteed Federal Housing Administration (FHA) Mutual Mortgage Insurance fund within the U.S. Department of Housing and Urban Development (HUD) insures more than \$1.26 trillion of mortgage debt on 8.12 million single-family homes. Because the fund can borrow from the U.S. Treasury if necessary, this portfolio is one of HUD's largest potential liabilities. As part of its obligation to prudently manage this portfolio amid increasing flood and flood-related disaster risk, HUD seeks to develop better analytical information about its flood risk exposure. HUD contracted with 2M Research to better understand the flood risk exposure of FHA single-family homes and compliance with flood insurance requirements. The study has three research objectives:

1. Examine the number and proportion of homes located in Special Flood Hazard Areas (SFHAs) that have mortgages secured by FHA.
2. Using National Flood Insurance Program (NFIP) data, determine whether the FHA single-family home mortgages in SFHAs comply with the FHA requirement to carry flood insurance.
3. Explore the relationship between flood insurance coverage and premiums, claims against NFIP, and loan performance.

Background of the National Flood Insurance Program

Flooding has become a recurrent natural hazard in the United States, with a significant percentage of the population vulnerable to the event (Kunreuther et al., 2019). In addition to floods being the most common natural disaster, they are also the most damaging, with 8 out of the 10 costliest catastrophes in the United States involving flooding (Karapiperis, 2017). Floods often cause enormous loss to life, property, and the environment. In the United States, floods and water-related events such as severe storms and hurricanes have resulted in more than \$1 trillion in losses over the last four decades, as estimated by the National Oceanic and Atmospheric Administration.

Damage caused by flooding is not typically covered under a standard homeowner's policy. Instead, flood damage is covered by a federally backed policy issued by NFIP, which is available to homeowners, renters, and small businesses (Karapiperis, 2017). Private insurers have not been historically able to provide flood insurance at affordable rates in the marketplace, because the cost of paying out claims for flood damage could not be offset by affordable premiums. Until the establishment of NFIP, the national response to flood disasters was generally limited to providing funds for flood control projects and disaster assistance for flood victims (Dixon et al., 2006). The catastrophic nature of flooding led to the decoupling of flood insurance coverage from homeowners' insurance policies in the mid-20th century and a rise in the lack of affordable, stand-alone flood insurance policies. Given that many properties already existed in flood-prone areas, the federal government intervened to provide an insurance option for those homeowners, with the intention that (1) the designation of specified flood zones would serve as a way to inform buyers of the risks in those areas and that (2) the additional requirement to purchase flood insurance would discourage further development in those flood-prone areas. NFIP was created in 1968 with these goals and has since evolved to take on additional roles that reduce risks, losses, and costs associated with flooding.

The Flood Disaster Protection Act of 1973,¹ one of the key pieces of legislation governing NFIP, introduced the mandatory purchase provision. This law required the purchase of flood insurance as a condition for obtaining a mortgage loan from federally regulated lending institutions for properties in an SFHA and as a condition for obtaining federal assistance. Generally, the mandatory purchase requirement applies to three types of property owners with homes located in an SFHA of participating communities:

- a) Those with a property loan issued by a federally regulated lender or a government-sponsored enterprise.
- b) Those with a mortgage backed by the federal government—such as FHA, the U.S. Department of Veterans Affairs, or the U.S. Department of Agriculture—or a mortgage that has been transferred to a federal agency—such as FHA.
- c) Those who receive federal financial assistance for acquisition, construction, improvement, or disaster recovery of a property located in an SFHA (Shabman, Kousky, and Lingle, 2019; Dixon et al., 2006).

Research Approach

This study combined datasets from three main sources: HUD’s quarterly extracts of single-family FHA property database, the Federal Emergency Management Agency’s (FEMA) property-level NFIP database, and FEMA’s SFHA status. The study team also utilized parcel and building footprint data to better understand how properties with FHA-insured mortgages overlap with SFHAs. We downloaded building footprint data on ArcGIS online for North Carolina provided by the North Carolina Floodplain Mapping Program (fris.nc.gov) and building footprint data for Florida provided by the Oak Ridge National Laboratory (ornl.gov).

Our analytical approach involved: first, estimating the number and proportion of FHA single-family home mortgages in FEMA’s SFHAs; second, determining whether the homes are in FEMA’s property-level NFIP database and whether they are covered by flood insurance; and third, generating this information by year from 2011 through 2019 and using this information to create a longitudinal database that allowed us to assess the relationship between loan performance, flood insurance coverage and premiums, and claims against NFIP.

Key Findings

The findings from this study fall into three categories based on the study’s objectives: (1) extent of flood risk to FHA single-family properties; (2) extent of properties with FHA-insured mortgages in compliance with the requirement to carry flood insurance; and (3) relationship between NFIP claims, insurance coverage, and FHA loan performance.

¹ Until the adoption of the Flood Disaster Protection Act of 1973, the purchase of flood insurance was voluntary. The mandatory purchase provision was further strengthened by the National Flood Insurance Reform Act of 1994. This Act imposed significant new obligations on lenders and servicers and tightened the requirement for the receipt of disaster assistance (FEMA, 2007).

EXTENT OF FLOOD RISK TO FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES

In addressing this objective, we examined the number of FHA single-family properties that are either inside SFHAs or close to SFHAs (within 600 meters of an SFHA), or outside SFHAs. We also examined the annual changes in the number of FHA single-family properties located within an SFHA, as well as the number of nonperforming mortgaged properties inside and outside an SFHA. The results of our analysis suggest the following:

- The percentage of FHA single-family properties inside SFHAs in our study states were relatively small compared with those outside SFHAs, although exposure to flood risk in 2019 was much higher in Florida (approximately 20 percent) than in North Carolina (approximately 5 percent). In both Florida and North Carolina, properties with FHA-insured mortgages inside SFHAs were mostly in zone A areas, which have a lower level of risk than zone V areas.
- The percentage of properties with FHA-insured mortgages that were within 600 meters of SFHAs in 2019 in our study states were much larger than those that were within an SFHA. Approximately 80 and 54 percent of properties with FHA-insured mortgages in Florida and North Carolina, respectively, were within 600 meters of SFHAs.
- While the total number of active mortgages increased quite dramatically from 2011 to 2019, the proportion of properties with FHA-insured mortgages within 600 meters of or inside an SFHA remained relatively stable during this time.
- Although there was no significant variation in default rates for properties with FHA-insured mortgages inside and outside an SFHA, the default rates appeared much higher for Florida and North Carolina in 2017 and 2018, respectively, which can be attributed mainly to two major hurricanes: Hurricane Irma in Florida in 2017 and Hurricane Florence in North Carolina in 2018, which caused extensive flooding in these states.

EXTENT OF FEDERAL HOUSING ADMINISTRATION-INSURED PROPERTIES IN COMPLIANCE WITH THE MANDATORY PURCHASE REQUIREMENT

In addition to examining the number of FHA single-family homes with flood insurance by year, inside and outside of an SFHA, we examined the annual change in the number of active flood insurance policies among all FHA single-family properties and for those inside an SFHA. We also examined policy drop and policy take-up, by year, for all FHA single-family properties and for homes inside an SFHA. In addition, we examined the percentage of properties with FHA-insured mortgages inside an SFHA that have had flood insurance continuously from the date of the beginning of the FHA-backed mortgage. The results of these analyses were presented under two different methods—moderate and conservative—of classifying FHA-insured properties as being inside or outside an SFHA. Our findings are as follows:

- On average, the flood insurance coverage rate was significantly larger for properties with FHA-insured mortgages inside an SFHA than those outside an SFHA. Our estimates further revealed variation in the rates of holding flood insurance across the study's two states and by flood classification method. In both states, the flood insurance coverage rate for FHA-insured properties inside an SFHA was larger under the conservative method than under the moderate method, albeit the rates in Florida, on average, were larger than the rates in North Carolina.
- FHA-insured properties near (less than 600 meters) an SFHA carry flood insurance at rates similar to rates for properties farther away. In Florida, the conservative estimate showed approximately 5 percent of FHA-insured properties near an SFHA and 5 percent of FHA-insured

properties farther away from an SFHA carried flood insurance in 2019. In North Carolina, the conservative estimate showed approximately 2 percent of FHA-insured properties near an SFHA and 1 percent of FHA-insured properties farther away from an SFHA carried flood insurance in 2019. In contrast, the conservative estimate showed 65 percent of FHA-insured properties in Florida and 49 percent of FHA-insured properties in North Carolina *inside* an SFHA carried flood insurance in 2019. The mandatory purchase requirement appears as a major factor in a homeowner's decision to purchase flood insurance.

- The percentage of FHA-insured properties with active flood insurance policies, for properties inside an SFHA, and overall, grew over time for both Florida and North Carolina, except for a slight decrease in Florida during 2018 and 2019. In particular, the two states experienced substantial growth in the number of FHA-insured properties in 2011 through 2012 for all FHA properties and for properties inside an SFHA.
- For flood insurance policy take-up rates, our estimates indicate a relatively faster-growing trend, on average, for all FHA-insured properties compared to the trend for FHA-insured properties inside an SFHA in North Carolina. The flood insurance policy take-up rates in Florida fluctuated over time; however, the take-up rates for all FHA-insured properties were higher than those for the FHA-insured properties inside an SFHA. In addition, flood insurance policy drop rates consistently decreased from 2012 through 2019 for all FHA-insured properties and those inside an SFHA in North Carolina.
- Florida has a much larger percentage of all FHA-insured properties that had flood insurance continuously compared to North Carolina. However, this share in Florida decreased slightly from 2011 through 2019, while the share in North Carolina stayed constant across all years of the study. Meanwhile, the proportion of FHA-insured properties inside an SFHA that were continuously insured slightly increased for both North Carolina and Florida.

RELATIONSHIP BETWEEN NATIONAL FLOOD INSURANCE PROGRAM CLAIMS, FLOOD INSURANCE PREMIUMS, AND FEDERAL HOUSING ADMINISTRATION LOAN PERFORMANCE

The final aspect of the analysis explored the relationship between NFIP claims, flood insurance premiums, and FHA loan performance. In conducting this exploration, we examined: (1) the relationship between the next-year default rate of FHA-insured single-family properties by flood insurance coverage and SFHA status; (2) average number of claims per policy year for all flood-insured FHA single-family properties and for those inside an SFHA; and (3) the relationship between flood insurance claims, flood insurance premiums, and loan performance, using a logistic regression model. The key findings are as follows:

- Our results show that flood insurance coverage does not significantly matter when determining default rates for FHA-insured properties inside or outside an SFHA. On average, the difference between the next year's default rate of FHA-insured properties with flood insurance in the current year and of those without flood insurance in the current year, irrespective of flood zone status, was less than 0.5 percentage point in both Florida and North Carolina. It is important to note, however, that the average default rate of the next year is highest for FHA-insured properties inside an SFHA with flood insurance coverage in the current year (average of 3.21 percent in Florida and average of 2.61 percent in North Carolina).
- Regarding flood insurance claim rates, our estimates indicate low flood insurance claim rates for all FHA-insured properties for both North Carolina and Florida in most years. Unusually high

flood insurance claim rates, however, were observed in 2011, 2016, and 2018 for North Carolina, and in 2017 for Florida, which can be attributed mainly to hurricanes in those years. For example, the high flood insurance claim rate in Florida in 2017 corresponded to the occurrence of Hurricane Irma in 2017. The results also indicate that FHA-insured properties inside an SFHA were slightly more likely to file flood insurance claims in both Florida and North Carolina.

- Results of our logistic regression analysis indicate evidence of a relationship between flood insurance claims and loan performance in both study states, though the results differ for the effect of flood insurance premiums on loan performance. In North Carolina, our results show that higher flood insurance premium amounts and having a flood insurance claim increase the likelihood of defaulting in the next year. In Florida, however, we only found a relationship (a positive relationship) between having a flood insurance claim and the odds of defaulting in the next year. Premiums mattering more in North Carolina may be due to the fact that flood insurance is generally more expensive in North Carolina,² especially inside an SFHA. Therefore, higher premium amounts may place more burden on homeowners in North Carolina than in Florida.

Limitations and Further Work

Notwithstanding the detailed empirical insights provided in this study, there are limitations worth highlighting for further research. First, the study is limited to two states and should, therefore, be considered as a pilot study. However, the research team gained a lot of knowledge in working with the data that is transferable to HUD and other researchers that will make studies of more states or even of the entire country much easier than before this pilot. Second, the determination of FHA properties being in/out of the SFHA relies on the latest SFHA geographic definition. To the extent that the boundaries change over time, the findings may be different using temporally consistent boundary files. However, our analysis of the potential changes in the boundary demonstrated that this was a minor consideration for these two states. It could be more significant in other areas. Third, the study relied on address matching to determine if FHA properties have flood insurance. Finding a way to avoid address matching would likely increase the accuracy of the analysis.

There are also several open questions that the limited analysis in this report did not answer. The current study has focused mainly on flood risk exposure and loan performance of FHA-insured properties and does not compare with other properties. To place such analysis into context to capture a more complete picture of the extent of the risk, future research could help generate a better understanding by comparing FHA rates of properties in SFHAs with national trends, government-sponsored enterprises (GSEs), and conventional mortgages. Second, this study does not fully explain why default rates are so similar, and in fact slightly higher, for FHA-insured properties with flood insurance in an SFHA when compared to FHA-insured properties in an SFHA without flood insurance. Future work could examine default rates of FHA-insured properties with and without flood insurance before and after a major flooding event to investigate this issue further. Additionally, while this study provides estimates of the

² The mean flood insurance policy premium amount of all FHA-insured properties in North Carolina is \$503.97 (\$664.83 for properties inside an SFHA), while that of Florida is \$447.25 (\$545.22 for properties inside an SFHA).

extent of FHA-insured properties in compliance with the mandatory requirement, it is unclear how many of the properties are truly not compliant. Future research could work to obtain more detailed data on elevation, changes in SFHA boundaries over time, and other factors that may impact the requirement to have flood insurance. Finally, while the analysis focused on SFHA as a risk indicator, it may be beneficial in the future to examine areas outside of the 100-year flood plain that are impacted by floods and may still be at risk.

1 INTRODUCTION

Background of Study

Flooding has become a recurrent natural hazard in the United States, with a significant percentage of the population vulnerable to a flooding event.³ In addition to floods being the most common natural disaster, they are also the most damaging, with 8 out of the 10 costliest catastrophes in the United States involving flooding (Karapiperis, 2017). Floods often cause enormous loss to life, property, and the environment. In the United States, floods and water-related events such as severe storms and hurricanes have resulted in more than \$1 trillion in losses over the last four decades as estimated by the National Oceanic and Atmospheric Administration (NOAA).⁴ According to NOAA's National Centers for Environmental Information, these floods and their debilitating effects are occurring with increasing frequency. This fact is reflected in the rising number of flood-related Presidential disaster declarations. In the last 40 years, approximately 1,700 presidential disaster declarations have been made, and more than 80 percent of these declarations are tied to flood and flood-related events (Kunreuther et al., 2019). Further, the increasing flood risk in the United States is noticeable in the increasing trend of flood insurance claims from the National Flood Insurance Program (NFIP) (Kunreuther et al., 2019). Since its inception, NFIP's 6 costliest years have all occurred since 2005. In 2005 alone, the program paid in more than \$17 billion⁵ in claims, primarily as a result of Hurricane Katrina (Kunreuther et al., 2019). Other catastrophic hurricanes such as Hurricanes Sandy, Harvey, Irma, and Maria led to record losses for NFIP in 2012 (about \$10 billion in claims paid) and in 2017 (an estimated \$20 billion in claims paid) (Kunreuther et al., 2019).

Although most catastrophic events have been associated with major hurricanes, inland flooding, such as that caused by more than 20 inches of rainfall in parts of Louisiana in August 2016, has also caused significant losses (Kunreuther et al., 2019). Climate change and, in particular, storm surges and sea-level rise may significantly increase flood risk and losses from flooding in the coming years. By the year 2100, flooding is estimated to have caused approximately \$1 trillion in damage to properties, representing about 2 percent of United States housing stock (Kunreuther et al., 2019).

Damage caused by flooding is not typically covered under a standard homeowner's policy. Instead, flood damage is covered by a federally backed policy issued by NFIP, which is available to homeowners, renters, and small businesses (Karapiperis, 2017). Historically, private insurers have not been able to provide flood insurance at affordable rates in the marketplace because the cost of paying out claims for flood damage could not be offset by affordable premiums. Until the establishment of NFIP, the national response to flood disasters was generally limited to providing funds for flood control projects and disaster assistance for flood victims (Dixon et al., 2006). The catastrophic nature of flooding led to the decoupling of flood insurance coverage from homeowners' insurance policies in the mid-20th century

³ Roughly one-half the population of the United States (around 168 million people) lives in coastal watershed counties that represent just under 20 percent of the national land area, with some 23 million people—or 8 percent of the total population—living in low-elevation coastal areas (Kunreuther et al., 2019).

⁴ Statistics on the cost of disaster events across the United States over the last 40 years (1980 through 2019) are available at <https://www.ncdc.noaa.gov/billions/overview>.

⁵ This cost is more than what the program has paid, altogether, since its inception in 1968 and continuing through 2004.

and the lack of affordable stand-alone flood insurance policies. Given that a number of properties already existed in flood-prone areas, the Federal Government intervened to provide an insurance option for those homeowners, with the intention that (1) the designation of specified flood zones would serve as a way to inform buyers of the risks in those areas and (2) the additional requirement to purchase flood insurance would discourage further development in those flood-prone areas. With these goals, the National Flood Insurance Program (NFIP) was created in 1968 and has since evolved to cover additional roles that reduce risks, losses, and costs associated with flooding. Administered by the Mitigation Division of the Federal Emergency Management Agency (FEMA), NFIP combines the concepts of insurance, mapping, mitigation, and regulation. NFIP provides an incentive for communities to adopt a floodplain management ordinance to mitigate the effects of flooding on new and existing construction (FEMA, 2007).

Since its inception, NFIP has been the major provider of flood insurance in the United States. Purchasing flood insurance through NFIP is generally voluntary, except for property owners who are in a Special Flood Hazard Area (SFHA)⁶ and whose mortgage loan is from a federally backed or regulated lender⁷ (Horn and Webel, 2019). NFIP's functions regarding insurance include establishing the deductible/limit menu and setting associated premiums, including establishing rules to determine subsidized premiums for certain existing properties. NFIP manages the Community Rating System (CRS), a voluntary program started in 1990 that provides discounts on flood insurance premiums in those communities that establish floodplain management programs and mitigation actions that exceed NFIP minimum requirements. To date, approximately 1,000 communities participate in CRS (FEMA, 2018). The federally backed insurance coverage under NFIP operates through public-private collaboration. Private insurance companies write flood policies, as well as process, defend, settle, and pay all claims, while NFIP is responsible for underwriting the losses (Michel-Kerjan, 2010).

Currently, NFIP provides approximately \$1.42 trillion in coverage for more than 5 million residential flood policies. In fiscal year 2018, the program received approximately \$3.5 billion in annual premium revenue; \$1.1 billion in assessment, fees, and surcharges; and \$1.0 billion in payments from private reinsurers (Horn and Webel 2019).⁸ In 2017, FEMA began to re-insure NFIP, to guarantee the soundness of the program moving forward. From 2017 through 2020, FEMA has secured approximately \$5 billion in traditional reinsurance coverage and has paid a reinsurance premium ranging from \$150 million to \$235 million. These reinsurance purchases have covered losses from a single flooding event starting at \$4 billion and costing as much as \$10 billion. Currently, there are 27 private reinsurance markets under FEMA's 2020 reinsurance agreement.⁹

Insurance prices are set nationally by NFIP and vary by contract (choice of limit and deductible), flood zone, and characteristics of the insured house. Under the regular program, the total insurance limit for building coverage is \$250,000 for single-family dwellings. The minimum deductible depends on the total coverage and the SFHA in which the property is located. The SFHA and the building type determine the

⁶ In 1973, Congress passed the Flood Disaster Protection Act (P.L. 93-234), which established the mandatory purchase requirement for property owners in an SFHA with a mortgage loan from a federally backed or regulated lender. This Act also required that for communities to be eligible for federal disaster aid, they must participate in NFIP (Kunreuther et al., 2019).

⁷ See section 3.2 for a background discussion on mandatory purchase provision under NFIP.

⁸ Statistics on NFIP policy and claims are available at: <https://www.fema.gov/policy-claim-statistics-flood-insurance>.

⁹ Details of NFIP's Reinsurance Program are available at: <https://www.fema.gov/nfip-reinsurance-program>.

basic and additional rates per \$100 of coverage (FEMA, 2019). Above this basic calculation, additional charges and discounts may be applied (FEMA, 2015).¹⁰ Therefore, variation in insurance prices across states is driven by variation in flood risk, exposure of the insured property, and the coverage purchased per policy. More than two-thirds of NFIP policies are in five coastal states: Florida, Texas, Louisiana, California, and New Jersey (Michel-Kerjan, 2010). Exhibit 1.1 below presents NFIP summary statistics for these five states in 2010.

Exhibit 1.1 | Summary of National Flood Insurance Program Statistics, 2010

Geographic Area	No. of Policies	Percentage Nationwide	Insurance Penetration ¹¹	Annual Premium per Policy	Premium per \$1,000 of Coverage
National	5,629,263	-	4%	\$572	\$2.64
Florida	2,141,076	38.03%	25%	\$454	\$2.05
Texas	681,425	12.11%	7%	\$483	\$2.09
Louisiana	483,593	8.59%	26%	\$648	\$3.00
California	276,915	4.92%	2%	\$720	\$2.92
New Jersey	229,461	4.08%	6%	\$811	\$3.70
Top Five States	3,812,470	67.73%	10%	\$524	\$2.34

Source: Michel-Kerjan, 2010

In addition to its social goals of providing flood insurance in flood-prone areas to property owners who otherwise would not be able to obtain it in the private market, NFIP also engages in “non-insurance” activities, including flood hazard mapping, floodplain management, and flood risk mitigation programs (Horn and Webel, 2019). Through the Risk Mapping, Assessment, and Planning (MAP) program, FEMA identifies flood hazards, assesses flood risks, and partners with states and communities to provide accurate flood hazard and risk data to guide communities to implement mitigation actions. Flood hazard mapping forms the basis of NFIP regulations and flood insurance requirements. Communities can enter the MAP program by developing floodplain management¹² policies and, in return, homeowners, renters, and business owners in those communities will become eligible to purchase federally backed flood insurance (Holladay and Schwartz, 2010). NFIP requires participating communities to adopt and enforce minimum construction and land use regulations that make them less vulnerable to flooding. Nationally, more than 22,000 communities¹³ participate in NFIP (Horn and Webel, 2019).

¹⁰ Discounts include deductible factor, Increased Cost of Compliance premium, CRS discount, Reserve Fund Assessment, probation surcharge, Homeowner Flood Insurance Affordability Act of 2014 surcharge, and the federal policy fee.

¹¹ Insurance penetration is the ratio of the number of active insurance policies in a state compared to the number of households in that state.

¹² Floodplain management is broadly defined to include all actions that states and communities can take to reduce flood damage to both new and existing buildings and infrastructure (FEMA, 2018).

¹³ Detailed information about the communities that participate in the NFIP can be found here: <https://www.fema.gov/national-flood-insurance-program-community-status-book>.

NFIP creates flood maps of participating communities, dividing them into different zones according to varying levels of flood risk (Michel-Kerjan, 2010).¹⁴ Zones B, C, and X are areas of moderate to low risk. High-risk areas or SFHAs have a 1 percent chance of flooding each year and are divided into zones V and A. According to a study by Tobin and Calfee (2005), more than two-thirds of all NFIP policies cover properties in an A zone, which designates areas that are subject to the 1 percent annual chance of flooding. A zones are typically adjacent to rivers, streams, and lakes, although such zones are also designated in coastal areas, landward of V zones, which are coastal areas subject to high-velocity wave action. Less than 2 percent of NFIP policies cover properties in V zones. V zones are high-risk coastal areas that face an additional hazard associated with storm waves. A and V zones comprise the SFHAs covered by the mandatory purchase requirement (Tobin and Calfee, 2005).

Objectives of this Study

In light of recent severe weather events across the United States, assessing homeowners' exposure to flood hazard risk is an increasingly important concern. One of the U.S. Department of Housing and Urban Development's (HUD) objectives in its 2018 through 2022 Strategic Plan is to "support sustainable homeownership while safeguarding the American taxpayer." To achieve this goal, HUD seeks to understand the exposure of its asset portfolios to flood hazard risk. HUD administers the Federal Housing Administration (FHA) Mutual Mortgage Insurance program fund that insures lenders against loss on more than \$1.26 trillion of the mortgage debt of 8.12 million low-wealth single-family homeowners. To prudently manage this portfolio, HUD must develop analytical tools that can help the agency obtain better information about flood risk exposure.

HUD contracted with 2M Research to better understand the flood risk exposure of FHA single-family homes and compliance with flood insurance requirements. The study has three research objectives:

1. Examine the number and proportion of homes located in SFHAs that have mortgages secured by FHA.
2. Using NFIP data, determine whether the FHA single-family home mortgages in SFHAs comply with the requirement to carry flood insurance.
3. Explore the relationship between loan performance, flood insurance coverage and premiums, and claims against NFIP.

In addressing these objectives, the study team first classified FHA single-family home mortgages as being inside or outside FEMA SFHAs. Due to potential inaccuracies in some mortgage addresses, the study team determined the SFHA status of FHA single-family mortgages using three different SFHA classification methods. Mortgages with address inaccuracies are handled differently under each classification method. The study team then estimated the number and proportion of FHA single-family home mortgages in FEMA's SFHAs for each classification method.

The analysis for research objectives 2 and 3 uses the SFHA classification method that produces a conservative estimate of the number and proportion of FHA single-family home mortgages inside SFHAs. The study team then determined whether the homes were in FEMA's property-level NFIP database and

¹⁴ See appendix B for the definition of FEMA flood zone designations.

whether they were covered by flood insurance. We then grouped the loans according to the preceding criteria and arranged them by month and year from 2011 through 2019 into a longitudinal database. The database allowed the study team to assess the relationship between loan performance, flood insurance coverage and premiums, and claims against NFIP.

Organization of this Report

The outline of this report is as follows. Following this introduction, Chapter 2 provides a summary of the data used in the study. The chapter also outlines the study team's approach to addressing each research objective. Chapter 3 reports the results of the study and is divided into three main sections in line with the study objectives. In the first section of Chapter 3, the study team discusses the extent of flood risk facing FHA's portfolio by examining the number and proportion of FHA single-family properties located inside and outside of SFHAs. In the second section, we examine compliance with the mandatory purchase requirement for FHA single-family properties by year and inside and outside of SFHAs. In the last section of Chapter 3, we investigate the relationship between the loan performance of homes that have experienced changes in insurance rates or have recently been required to acquire a flood insurance policy. We also examine the effect of a flood insurance claim or a change in flood insurance policy premium on loan performance of properties with FHA-insured mortgage. Chapter 4, the conclusion, highlights the key findings of the study, discusses the limitations of the study, and identifies topics for additional research.

2 DATA SOURCES AND METHODOLOGY

Data Sources

To address the research objectives outlined in Chapter 1, the study team used data from three main sources: the U.S. Department of Housing and Urban Development’s (HUD) quarterly extracts of single-family Federal Housing Administration (FHA) property database; the Federal Emergency Management Agency’s (FEMA) property-level National Flood Insurance Program (NFIP) database; and FEMA’s Special Flood Hazard Area (SFHA) status. HUD provided the FHA property data as well as the NFIP databases that include property-level insurance policies, premiums, and damage claims for Florida and North Carolina.¹⁵ The study team accessed the SFHA data, which are public, from the FEMA Map Service Center (MSC) website. This section outlines the data sources used for the analyses.

FEDERAL HOUSING ADMINISTRATION PROPERTY-LEVEL DATA

The FHA property-level data included information on all single-family properties in the United States with mortgage loans that are backed by FHA mortgage insurance. For work on this task order, HUD provided the study team with data on 713,090 properties with FHA-insured mortgages in Florida and 262,558 mortgaged properties with FHA-insurance in North Carolina with mortgage insurance endorsement dates after January 1, 2011. Exhibit 2.1 provides a list of the specific variables from the FHA property-level data that the study team used to address the three research questions.

Exhibit 2.1 | Description of Key Variables in the Federal Housing Administration Property-Level Data

Name	Description	Purpose
Case Number	A unique case identifier that identifies the application for a specific property’s mortgage loan insurance.	The study team used this variable to match the information on mortgage insurance to the information on default.
SOA Code	Section of Act (SOA) code that describes the type of loan on the property.	The study team used this variable to restrict the analysis to standard 203(b) ¹⁶ FHA-insured properties.
Endorsement Date	The effective date of mortgage insurance endorsement by FHA.	The study team used this variable as the start date of the FHA insurance.
Term Date	The date the mortgage insurance was terminated or canceled by the lender.	The study team used this variable as the end date of the FHA mortgage insurance.

¹⁵ With HUD’s approval, the study team limited the geographical scope of the study from a national-level analysis to two states, Florida and North Carolina, purely for logistical reasons. Within the time limits of the study, and given that the data are extremely large—which could result in challenges with transferring, processing, and analyzing the data—it was more feasible to accomplish the objectives of the study on a smaller scale. We selected Florida and North Carolina mainly due to the availability of data, especially parcel and building footprint data. Florida, in particular, has seen many changes in flooding and changes in how insurance policy premiums have been enacted, as well as claims made against NFIP policies.

¹⁶ This comprises the majority of FHA-insured mortgages but does not include certain smaller FHA programs such as 203(k) mortgages for home repairs or improvements, or reserve mortgages.

Name	Description	Purpose
Insurance Status Code	The status of the FHA insurance. This variable can take three values: active (A), terminated with claim (C), or terminated with no claim (T).	The study team used this variable to determine whether mortgage insurance was still active at the time of receiving the data. If the insurance status code was equal to A, the study team set the end date of the FHA mortgage insurance as November 30, 2019.
Address	The physical address of the FHA-insured property.	The study team used this variable to understand the location of properties and their relationships to SFHAs.
ZIP Code	The 9-digit postal ZIP Code where the property is located.	The study team used this variable to understand the location of properties and their relationships to SFHAs.
City	The city in which the insured property is located.	The study team used this variable to understand the location of properties and their relationships to SFHAs.
Latitude, Longitude	Geographical latitude and longitude derived by geocoding the address using the 2010 Census.	The study team used this variable to understand the location of properties and their relationships to SFHAs.
Default Episode Number	An episode number assigned to the case for each distinct default episode.	The study team used this variable to determine when a property with an FHA-insured mortgage is in default.
Default 90-Day Indicator	An indicator that is equal to “Y” when a case is 3 or more months delinquent. The default value is “N” (no). The data are also designated “N” when the case is less than 90 days delinquent.	The study team used this variable to determine when a property with an FHA-insured mortgage is in default.

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

NATIONAL FLOOD INSURANCE PROGRAM DATA

The NFIP data included information on the flood insurance policies, premiums, and damage claims for properties in the United States. HUD provided data on flood insurance policies held for properties in Florida and North Carolina, which were similar to the FHA property-level data. The NFIP data files HUD delivered included information on 20,134,290 policies in Florida and 2,033,714 policies in North Carolina, with policy start dates from July 30, 1974, and May 1, 1974, respectively. Exhibit 2.2 provides a list of the specific variables from the NFIP data the study team used to address the three research objectives.

Exhibit 2.2 | Description of Key Variables in the National Flood Insurance Program Data

Name	Description	Purpose
In-Force Date	Policy in-force date.	The study team used this variable as the start date of the policy.
Out-Force Date	Policy out-force date.	The study team used this variable as the end date of the policy if the policy was not canceled.
Cancellation Date	Cancellation date of policy.	The study team used this variable as the end date of the policy if the policy was canceled.
Official Latitude, Official Longitude	Latitude and longitude of the property with the flood insurance policy.	The study team used this variable to match flood insurance policies to the corresponding FHA-insured mortgage and to match the policy data to the flood insurance claims data.
Rep_address2	The physical street address line for the property with the flood insurance policy.	The study team used this variable to match flood insurance policies to the corresponding FHA-insured mortgage and to match the policy data to the flood insurance claims data.
City	City in which the property with the flood insurance policy is located.	The study team used this variable to match flood insurance policies to the corresponding FHA-insured mortgage and to match the policy data to the flood insurance claims data.
Zip	ZIP Code of the property with the flood insurance policy.	The study team used this variable to match flood insurance policies to the corresponding FHA-insured mortgage and to match the policy data to the flood insurance claims data.
Dt_of_loss	Date of loss.	The study team used this variable from the claims dataset to define valid claims as those for whom the date of loss occurred while the policy was still active.

FHA = Federal Housing Administration.

SPECIAL FLOOD HAZARD AREA DATA

The SFHA area data come from the National Flood Hazard Layer (NFHL) provided as a series of geographic information system (GIS) layers by FEMA MSC. The study team downloaded the state-level files for Florida and North Carolina and imported them into ArcGIS software. The study team used the layer S_Fld_Haz_Ar, which provides flood hazard information on all Flood Insurance Rate Map (FIRM) panels within a state. The layer includes a variable called SFHA_TF that indicates whether a FIRM panel is an SFHA (T for “true”) or not (F for “false”). The study team used this variable to identify the location of all SFHAs within each state.

An important limitation of the NFHL data is that FEMA does not maintain historical SFHA boundaries. The study team thus only has the most current NFHL data (as of November 2019) for use in the analysis.

SFHA boundaries, however, can change over time. The NFHL includes a layer S_LOMR, which provides a letter of map revisions (LOMRs) that can indicate changes in the SFHA boundary over time. Exhibit 2.3 shows the number and percentage of FIRM panels with SFHAs in Florida and North Carolina with reported LOMRs, as well as the total square miles of all LOMRs in the state from 2011 to 2019. In both states, the number of panels with LOMR is very low. In Florida, the total square miles of LOMRs are relatively large in 2011 (259.21 square miles) and 2017 (124.39 square miles), while the number of square miles of LOMRs in North Carolina is small across all years (22.55 square miles is the largest in 2018). For the purposes of this analysis, if a property was located in an SFHA using the current NFHL data, we assumed that the property was located in the SFHA for all years of our analysis. Although there are some changes in SFHA boundaries over time, exhibit 2.3 shows that the changes are rare and usually have a small geographic scope. Changes in SFHA boundaries likely introduce a small amount of error in the analysis presented in this report.

Exhibit 2.3 | Information on Letters of Map Revisions in Florida and North Carolina, 2011–2019

Year	Florida		North Carolina	
	Number (%) of FIRM Panels with SFHA and LOMR	Total Square Miles of LOMRs	Number (%) of FIRM Panels with SFHA and LOMR	Total Square Miles of LOMRs
2011	115 (1.65%)	259.21	46 (0.44%)	5.59
2012	46 (0.66%)	8.06	5 (0.05%)	0.51
2013	60 (0.86%)	12.04	21 (0.20%)	2.42
2014	75 (1.07%)	24.61	53 (0.51%)	6.55
2015	86 (1.23%)	23.21	29 (0.28%)	3.26
2016	142 (2.04%)	30.63	30 (0.29%)	3.16
2017	148 (2.12%)	124.39	60 (0.58%)	13.84
2018	182 (2.61%)	81.87	50 (0.48%)	22.55
2019	153 (2.19%)	43.41	25 (0.24%)	6.98

FIRM = Flood Insurance Rate Map. LOMR = Letter of Map Revisions. SFHA = Special Flood Hazard Area.

PARCEL AND BUILDING FOOTPRINT DATA

The study team obtained and utilized parcel data and building footprint data for both North Carolina and Florida. Parcel data for the state of North Carolina was obtained from NC OneMap (nconemap.gov) while parcel data for the state of Florida was obtained from the Florida Geographic Data Library (fgdl.org). The study team identified building footprint data using 2M Research’s subscription to ArcGIS online. Specifically, the study team downloaded building footprint data on ArcGIS online for North Carolina provided by the North Carolina Floodplain Mapping Program (fris.nc.gov) and building footprint data for Florida provided by the Oak Ridge National Laboratory (ornl.gov).

The study team used the parcel and building footprint data to improve the analyses in several ways:

1. The parcel data improved matches between FHA and NFIP data. Using the parcel shapefiles for each state, the study team was able to plot FHA and NFIP properties on the parcel maps. The study team was then able to determine which FHA and NFIP properties shared a parcel. Properties that shared the same parcel were matched together. Although the study team could have matched properties on their latitude and longitude without matching to the parcel shapefiles, the study team found that matching properties from both sources to common

geography significantly improved the merge between FHA and NFIP. This is because latitude and longitude between the two sources may differ slightly. Moreover, the parcel files provided boundaries so that properties that were close together would only be joined if there was evidence that they were located on the same parcel.

2. The building footprint data allowed the study team to more accurately assess the location of properties in both North Carolina and Florida. SFHAs are often very small geographies and we found that our estimates of properties inside an SFHA changed when using building footprints as opposed to latitude and longitude to understand property locations. Latitudes and longitudes are points, and there are several cases in which only a part of a property intersects with an SFHA. Using building footprints helped us to appropriately classify these properties as within an SFHA, even if the point projected from the property's latitude and longitude was outside the SFHA.
3. Finally, similar to the building footprints, the study team was also able to use the parcel shapefiles to identify properties in parcels that intersect with an SFHA, even if their building footprint or latitude and longitude point did not. This process informed our minimum, maximum, and moderate estimates that are described below.

Approach to Research Objectives

This section provides a detailed outline of how the study team addressed the study objectives. For each objective, we describe the methods used to prepare the data for analysis.

APPROACH TO RESEARCH OBJECTIVE 1

The first objective of this study is to examine the number and proportion of homes located in SFHAs that have mortgages secured by FHA. To address this objective, the study team began by cleaning the FHA property data. In the FHA property data, the *case number* variable uniquely identifies each application for a specific property's mortgage insurance. The study team used the SOA code variable to keep only standard 203(b) FHA insured properties. This comprises the majority of FHA-insured mortgages but does not include certain smaller FHA programs such as 203(k) mortgages for home repairs or improvements, or reverse mortgages. To determine the period during which a case is active, the study team set the endorsement date as the start date of the FHA mortgage insurance and created an end date variable. The end date variable is the termination date of the FHA mortgage insurance if the FHA mortgage insurance was terminated. If the FHA mortgage did not have a termination date and it was listed as currently active, the end date variable was set to November 30, 2019. FHA properties that did not have a valid start or end date entry were dropped from the analysis.

The study team then analyzed the latitude and longitude of each case in the FHA data. The study team noted that several properties shared the same latitude and longitude, despite having different addresses. In addition, some cases in the data had different latitude and longitude coordinates, despite sharing the same address.¹⁷ The study team attempted to re-geocode these addresses (27,526 in Florida

¹⁷ Since the file is at the mortgage case level, many addresses were repeated with different case numbers, likely because a property mortgage loan and case number can change over time with a refinance or sale. The study team did not re-geocode these addresses if the repeated addresses also had repeated latitude and longitude coordinates.

and 9,373 in North Carolina) to improve the accuracy of the latitude and longitude coordinates of the properties with FHA-insured mortgages.

Next, the study team used GIS to identify the FHA-insured properties located inside SFHAs. The study team located parcel and building footprint data for the state of North Carolina and Florida and identified the parcel and building matched to each FHA-insured property based on the property's latitude and longitude coordinates. The study team then intersected parcels and buildings with SFHAs to understand which parcels and buildings overlap with an SFHA. Even after re-geocoding, there were still some properties with latitudes and longitudes that likely were inaccurate (either a shared latitude and longitude across multiple addresses or different latitudes and longitudes within the same address). The properties with inaccurate coordinates were not matched to parcels or buildings; however, the study team did intersect the latitude and longitude coordinates for those properties within an SFHA for the moderate estimate described below. The study team provides three estimates which handle address properties with inaccurate latitude and longitude coordinates differently:

1. A minimum estimate that considers any properties with inaccurate latitude and longitude coordinates to be outside of an SFHA. This estimate also considers properties to be outside of SFHAs if their building footprints do not intersect with an SFHA, regardless of whether their parcels intersect with an SFHA.
2. A maximum estimate that considers any properties with inaccurate coordinates to be within an SFHA, as long as the ZIP Code of the property intersects with an SFHA. This estimate also considers properties to be within SFHAs if their parcels intersect with an SFHA, regardless of whether their building footprints intersect with SFHAs.
3. A moderate estimate that uses the inaccurate latitude and longitude coordinates to determine SFHA status and that assumes properties are within SFHAs if their parcels or building footprints intersect with SFHAs.

Finally, the study team also reports an estimate of the number of properties that are either inside or within 600 meters (about a 10-minute walk) of an SFHA using the latitude and longitude coordinates (including those deemed inaccurate). Properties that are near an SFHA likely have increased flood risk compared to properties further away and it is important we examine the number of properties with FHA-insured mortgages that may be exposed to increased flood risk, regardless of whether the property is within the SFHA boundary.

After determining the SFHA status of each case in the data, the study team determined the year when each case defaulted if the property had any default activity. To determine the default year, the study team identified the year of the first instance that the 90-day delinquency indicator was equal to "Y."

Below, the study team reports the process for examining SFHA status for active FHA mortgages, as well as the default rate of FHA mortgages by SFHA status by year from 2011 through 2019.

APPROACH TO RESEARCH OBJECTIVE 2

The second objective of this study is to assess the extent of flood insurance coverage held by FHA-insured single-family properties in Florida and North Carolina. To achieve this research objective, the study team needed to merge three separate datasets: the FHA-insured single-family property data, the NFIP flood insurance policy data, and the NFIP flood insurance claims data.

The study team began by merging the FHA-insured single-family property data with the NFIP policy data. The FHA property data included an observation for each application for a specific property's mortgage insurance. The study team anticipated that there could be different applications for mortgage insurance on the same property—for instance, if a property's ownership changed. Furthermore, every application for mortgage insurance could be matched to multiple flood insurance policies in the NFIP data. The study team merged the FHA property data to the NFIP flood insurance policy data by restricting the merge to only those properties with unique entries in the relevant address fields. The FHA property data and the NFIP policy data were merged in four rounds, with different combinations of location and address variables in each round. The first round of the merge exercise used variables for ZIP Code, street address, and city; the second round used variables for ZIP Code and street address; the third round used variables for latitude and longitude; and the fourth round used a variable for ZIP Code and standardized street address. Details of the merge results are provided in the Data Analysis section below.

The data on flood insurance policies and claims were provided to the study team as two separate files. The study team used a combination of address variables (ZIP Code, street address, and city); premium on the policy; policy start date; and policy end date to merge the policy data with the claims data. The final step was to merge the policy-claims data to FHA policy data using a unique identity variable generated as a combination of the ZIP Code, address, and policy start and end dates. A more detailed accounting of the study team's data-merging process is presented in appendix A.

Aggregate Descriptive Measures

After merging the datasets, the study team calculated aggregate measures to describe the extent of flood insurance coverage held by FHA-insured properties from 2011 through 2019. To compute these measures the study team assumed that an FHA-insured property is active in a year if the start and end dates of mortgage insurance include any days in that year. In a similar manner, the study team assumed that an FHA-insured property had an active flood insurance policy in a year if the start and end dates of the policy included any days in that year. A claim was assumed to be valid if the date of loss was within the start and end date of the associated policy. These assumptions allowed the study team to create a list of properties with active mortgage and/or flood insurance policies each year and to assess the extent of flood insurance coverage for FHA-insured properties.

The following are the aggregate descriptive measures presented in the results section.

1. The total number of FHA single-family properties with flood insurance as per NFIP data, by year.
2. The total number of FHA single-family properties inside an SFHA that have flood insurance, by year.
3. Policy drop rate: By year, the number of FHA single-family properties that drop flood insurance from the previous year and by year, the number of FHA single-family properties inside an SFHA that drop flood insurance from the previous year.
4. Policy take-up: By year, the number of FHA single-family properties that acquire flood insurance without having had it the previous year and by year, the number of FHA single-family properties inside an SFHA that acquire flood insurance without having had it the previous year.
5. The annual change in the number of active flood insurance policies among all FHA single-family properties and the annual change in the number of active flood insurance policies among FHA single-family properties inside an SFHA.

6. The total number of FHA single-family properties that have had flood insurance continuously from the date of the beginning of the FHA-backed mortgage to the last date the mortgage is observed in the data.
7. The total number of FHA single-family properties inside SFHAs that have had flood insurance continuously, as defined in item seven.

APPROACH TO RESEARCH OBJECTIVE 3

The third objective of this research study is to assess the relationship between loan performance of FHA-insured properties in Florida and North Carolina, flood insurance claims and flood insurance premium changes. The analysis under research objective 3 was conducted using the dataset created under Research Objective 2, which combined the FHA-insured single-family property data, the NFIP flood insurance policy data, and the NFIP flood insurance claims data.

To facilitate analysis under Research Objective 3, the study team created a longitudinal data file with yearly frequency. The unit of observation is the case number which identifies an application for a specific property's mortgage insurance. The 2M study team presents cross-tabulations that explore the relationship between flood insurance claims, loan performance, and flood insurance coverage. Loan performance is measured by an indicator for default. The study team calculated for each year default rates for FHA-insured properties by SFHA status and flood insurance coverage status. The study team also presents by year and SFHA status the claim rate for FHA-insured properties with flood insurance.

The study team also examined the relationship between loan performance and flood insurance claims using a logistic regression model. In particular, the study team analyzed the effect of a flood insurance claim or a change in flood insurance policy premium on loan performance for the FHA-insured property.

3 RESULTS

Extent of Flood Risk of Federal Housing Administration Single-Family Properties

This section addresses the first objective of the study. Specifically, it presents the findings on the number of Federal Housing Administration (FHA) single-family properties inside and outside Special Flood Hazard Areas (SFHAs). Also presented are findings on the number of FHA single-family properties that are either inside SFHAs or close to SFHAs (within 600 meters of an SFHA). The study team chose 600 meters because it reflects properties that are near SFHAs (within one-third of a mile or a 10-minute walk) that likely still have higher levels of flood risk despite the fact that they do not conform to the government-drawn map of an SFHA. This section also presents annual changes in the number of FHA single-family properties located within an SFHA. The section ends by examining, by year, the number of nonperforming mortgaged properties inside and outside an SFHA. These results provide insight into the extent of flood risk FHA’s portfolio is facing.

FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES WITHIN AND OUTSIDE AN SFHA

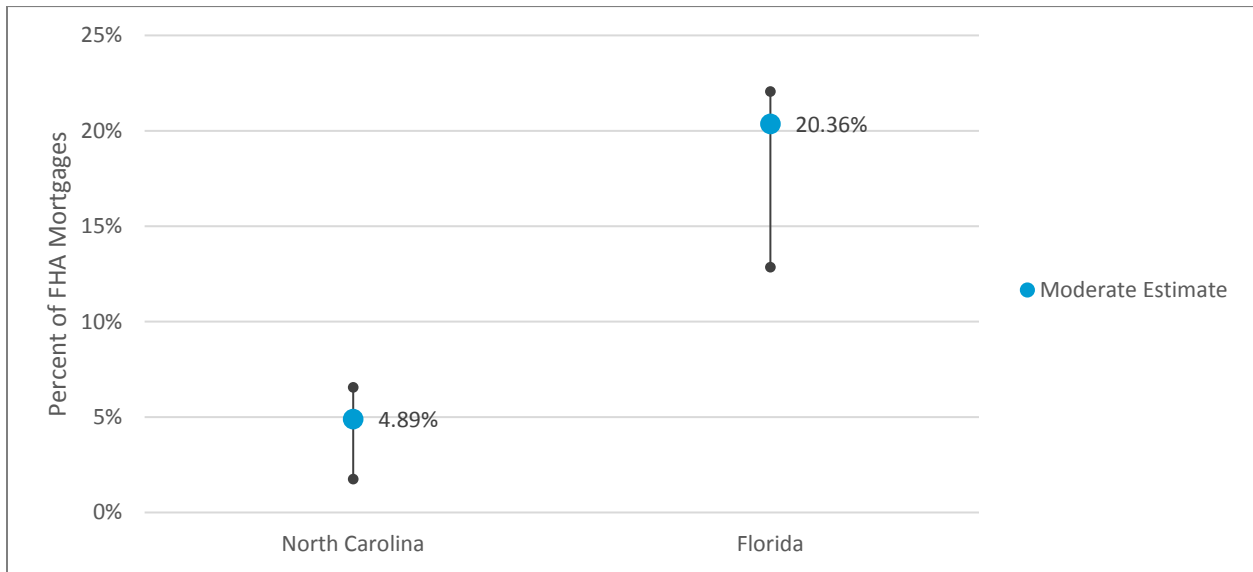
Exhibit 3.1 shows the number and percentage of mortgages that pertain to FHA single-family properties that were inside an SFHA in 2019 as well as the flood zone type (A or V). The exhibit shows that 8,673 (4.89 percent) mortgages are for properties inside an SFHA in North Carolina, and 101,128 (20.36 percent) mortgages are for properties inside an SFHA in Florida. Exposure to flood risk for FHA-insured properties in 2019 was thus much higher in Florida than in North Carolina. In both North Carolina and Florida, properties with FHA-insured mortgages inside an SFHA were mostly in zone A areas, which have a lower level of risk than zone V areas.

Exhibit 3.1 | Number and Percentage of Federal Housing Administration Mortgages Inside a Special Flood Hazard Area in 2019, Using the Moderate Estimate

State	Zone A (High Risk)	Zone V (High-Risk Coastal Area)	Total
North Carolina	8,648 (4.88%)	25 (0.01%)	8,673 (4.89%)
Florida	100,909 (20.32%)	219 (0.04%)	101,128 (20.36%)

Exhibit 3.2 shows the degree of potential variability in the estimated number of properties with FHA-insured mortgages inside an SFHA in both states, depending on how the study team chose to handle inaccurate latitude and longitudes and parcel boundaries (see Approach to Research Questions). In North Carolina, the minimum, or most conservative estimate was that about 1.75 percent of mortgages (3,098 mortgages) were for properties within SFHAs. The maximum, or most liberal, estimate was that about 6.56 percent of mortgages (11,616 mortgages) were for properties within SFHAs. In Florida, the minimum estimate was that about 12.85 percent (63,821 mortgages) were for properties within SFHAs and the maximum estimate was that about 22.06 percent (109,585 mortgages) were properties within SFHAs.

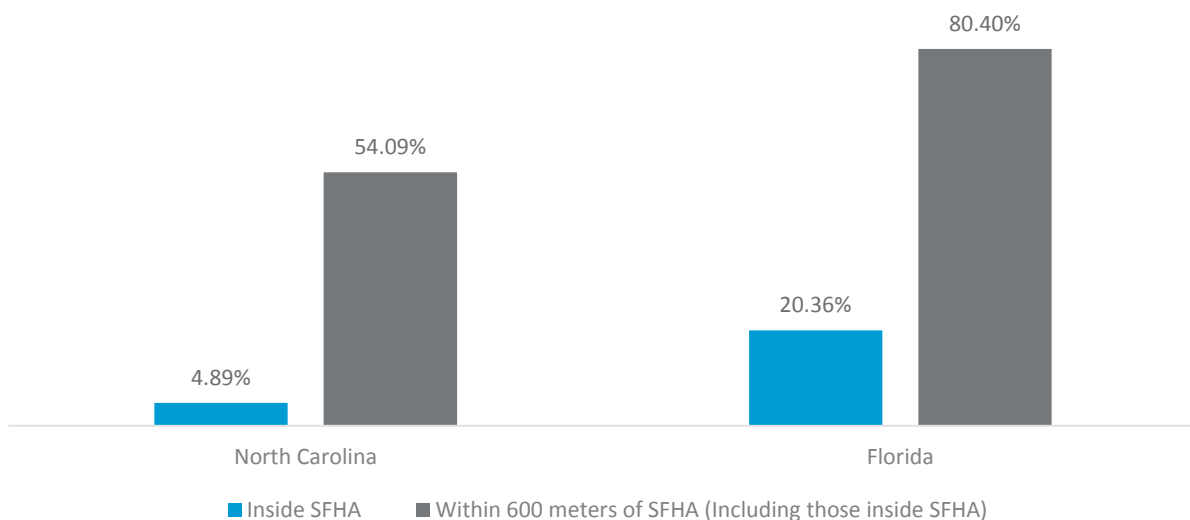
Exhibit 3.2 | Percentage of Properties with Federal Housing Administration-Insured Mortgages Inside a Special Flood Hazard Area in Florida and North Carolina in 2019, Minimum and Maximum Estimates Included



FHA = Federal Housing Administration.

Finally, exhibit 3.3 shows that the percentage of properties with FHA-insured mortgages in North Carolina and Florida that were near (inside or within 600 meters of) SFHAs is much larger than those that were within an SFHA boundary in 2019. About 54.09 percent of properties with FHA-insured mortgages were within 600 meters of SFHAs in North Carolina and about 80.40 percent were within 600 meters of SFHAs in Florida.

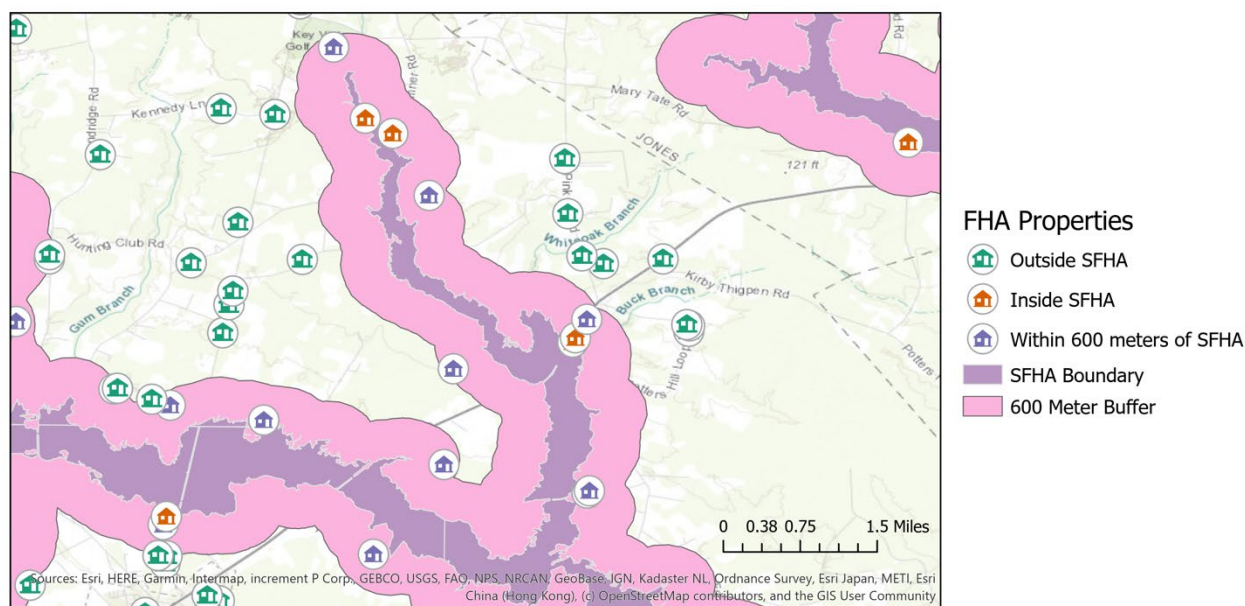
Exhibit 3.3 | Percentage of Properties with Federal Housing Administration-Insured Mortgages Inside and Within 600 Meters of Special Flood Hazard Areas in North Carolina and Florida, 2019



SFHA = Special Flood Hazard Area.

The large discrepancy in the number of properties inside an SFHA and within 600 meters of an SFHA highlights that SFHAs are typically very narrow in width because they are often found along rivers, creeks, and other smaller bodies of water. Exhibit 3.4 shows a map of SFHA and FHA properties in a small section of North Carolina. The map shows that while the SFHA boundary is small and only contains a few FHA-insured properties, several other FHA-insured properties are located within a 600-meter buffer of the SFHA boundary. As these properties are not technically inside an SFHA, a flood insurance policy is not required; however, the risk of flooding is likely still higher there than for properties farther away from an SFHA. Future analysis of flood risk may examine 500-year floodplains or properties within certain distances of SFHAs to capture a more complete picture of properties that are at risk of flooding.

Exhibit 3.4 | Example Map of Special Flood Hazard Area and Properties with Federal Housing Administration-Insured Mortgages in North Carolina



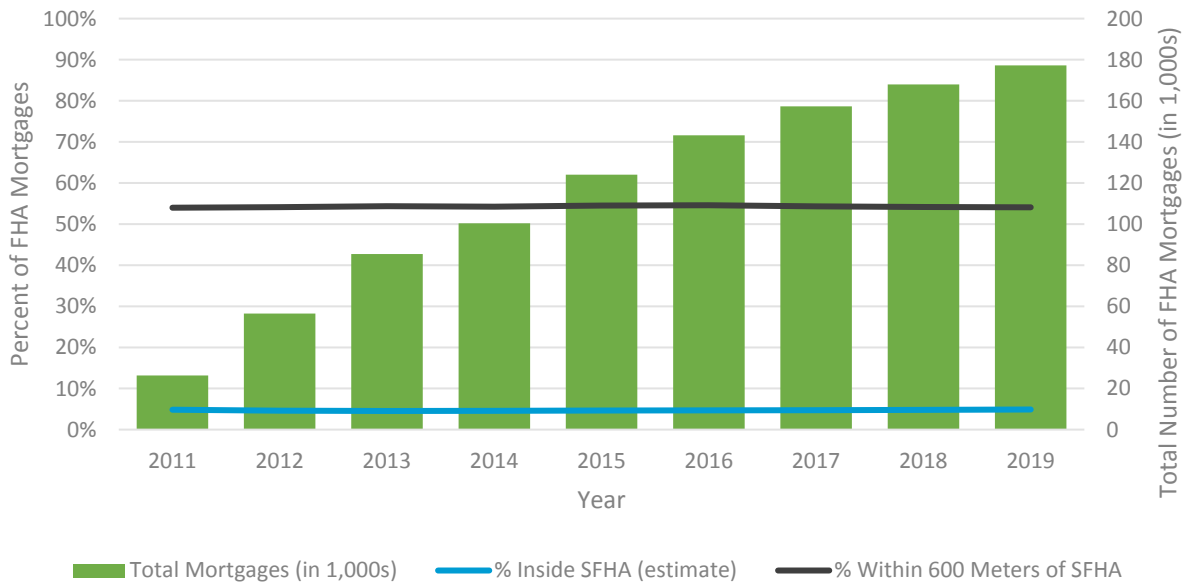
FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

ANNUAL CHANGES IN THE NUMBER OF FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES WITHIN A SPECIAL FLOOD HAZARD AREA

Exhibit 3.5 shows the estimated number and percentage of active mortgages in North Carolina that correspond to FHA-insured properties inside an SFHA and within 600 meters of an SFHA over time from 2011 through 2019. The exhibit shows that the total number of active mortgages increased quite dramatically over time from 26,303 in 2011 to 177,195 in 2019. The number of FHA-insured properties inside an SFHA and within 600 meters of an SFHA also increased from 1,277 (inside) and 14,202 (within 600 meters) in 2011 to 8,673 (inside) and 95,840 (within 600 meters) in 2019. Despite the increases in the absolute number of FHA-insured properties, the percentage of properties inside an SFHA and within 600 meters of an SFHA stayed relatively stable at about 5 percent and 54 percent, respectively.¹⁸

¹⁸ Note that we are unable to examine changes in SFHA boundaries over time; however, in most cases, the boundaries do not change for long periods of time, as shown in exhibit 2.3 in Chapter 2. Therefore, we do not expect these results would change very much if we were able to include SFHA boundary changes.

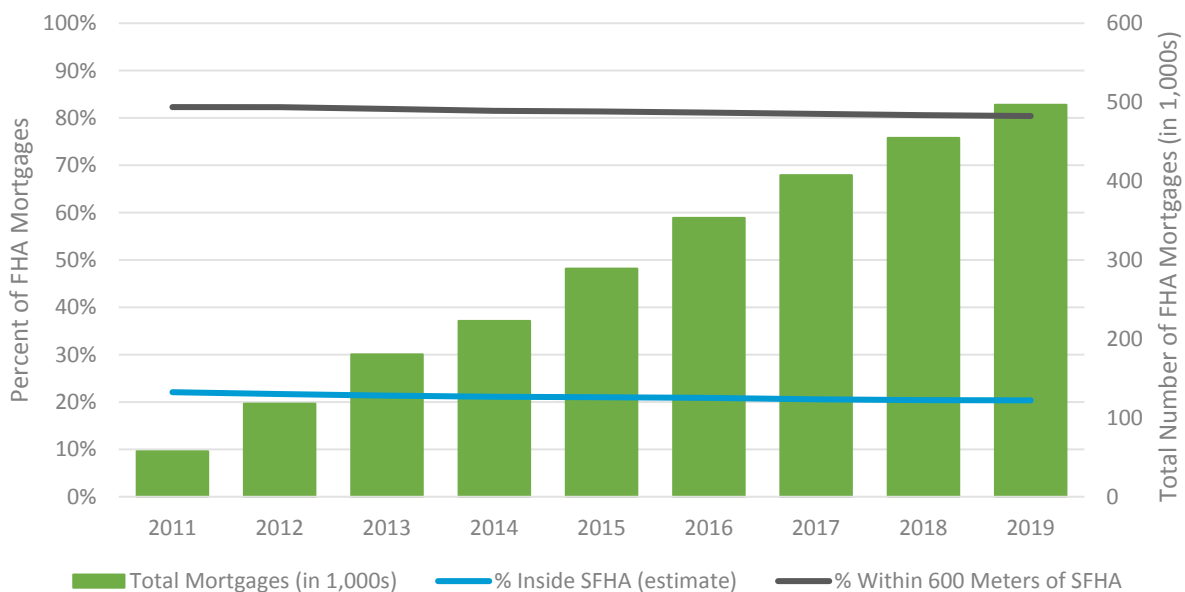
Exhibit 3.5 | Mortgages of Federal Housing Administration Properties in North Carolina: Total and Share of Properties Inside and Near Special Flood Hazard Area, 2011–2019



FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Exhibit 3.6 shows the results for Florida. Again, despite large increases in the total number of active mortgages over time (57,479 in 2011 to 496,597 in 2019, as well as large increases in the number of active mortgages for properties inside (12,692 in 2011 to 101,128 in 2019) and within 600 meters of SFHAs (47,298 in 2011 to 399,271 in 2019), the percentage of properties inside an SFHA and within 600 meters of an SFHA remained stable (at about 21 percent and 81 percent, respectively).

Exhibit 3.6 | Mortgages of Federal Housing Administration Properties in Florida: Total and Share of Properties Inside and Near a Special Flood Hazard Area, 2011 through 2019

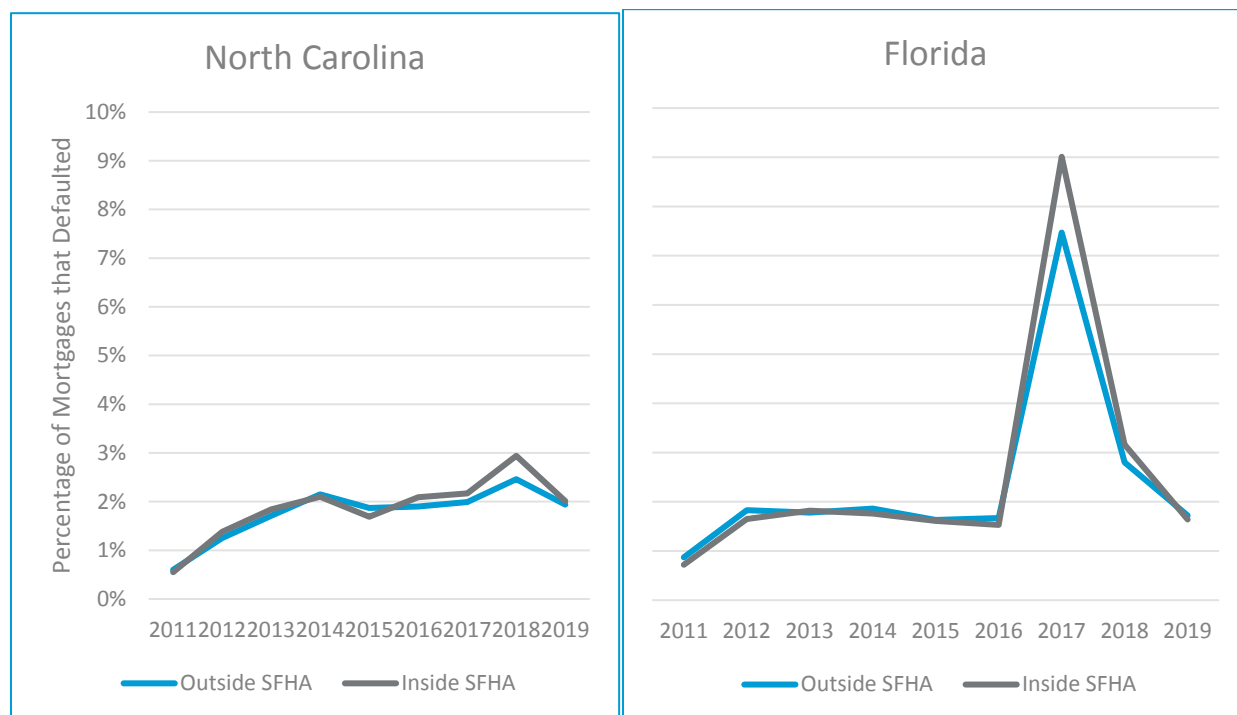


FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

NONPERFORMING LOAN PROPERTIES INSIDE AND OUTSIDE A SPECIAL FLOOD HAZARD AREA

Exhibit 3.7 compares the percentage of mortgages that defaulted by year for properties inside versus outside an SFHA. The exhibit shows that, in most years, there is very little difference in the default rate for properties inside and outside an SFHA; however, there are 2 years that have higher default rates in an SFHA—2018 in North Carolina and 2017 in Florida. Both these years correspond to major hurricanes that caused extensive flooding in the two states, and both of these years had overall higher default rates for all properties with FHA-insured mortgages. In September 2018, Hurricane Florence caused major flooding in North Carolina. In September 2017, Hurricane Irma, a Category 5 storm, caused extensive flooding and damage in Florida. Finally, there was a moderate spike in the default rate in 2014 in North Carolina, corresponding to Hurricane Arthur, which hit the Outer Banks. Exhibit 3.7 therefore, provides some evidence that, during major flooding events, default rates tend to be higher for FHA-insured mortgages inside an SFHA than outside an SFHA.

Exhibit 3.7 | Percentage of Mortgages for Federal Housing Administration Properties that Defaulted Inside and Outside a Special Flood Hazard Area in North Carolina and Florida, 2011–2019



SFHA = Special Flood Hazard Area.

Extent of Federal Housing Administration Properties in Compliance with Requirement to Carry Flood Insurance

This section presents findings on the second objective of the study and is organized into six main sections. Before delving into the major results, the study team first present a brief background of the mandatory purchase requirement, as well as a review of studies that have examined compliance with this provision. Subsequently, we present our findings on the number of FHA single-family homes with

flood insurance by year as well as inside and outside an SFHA. Next, we present our findings on the annual change in the number of active flood insurance policies among all FHA single-family properties and for those inside an SFHA. Findings on policy drop and policy take-up, by year, for all FHA single-family properties and for the homes inside an SFHA, are also presented. The section concludes with a discussion on the total number of all FHA single-family properties and homes inside an SFHA that had flood insurance continuously from mortgage origination by an FHA-approved lender.

BACKGROUND AND RELEVANT LITERATURE ON THE MANDATORY PURCHASE PROVISION

The Flood Disaster Protection Act of 1973,¹⁹ one of the key pieces of legislation governing the National Flood Insurance Program (NFIP), introduced the mandatory purchase provision. This law required the purchase of flood insurance as a condition for obtaining a mortgage loan from federally regulated lending institutions for properties in an SFHA and as a condition for obtaining federal assistance. Generally, the mandatory purchase requirement applies to three types of property owners with homes located in the SFHA of participating communities:

- a) Those with a property loan issued by a federally regulated lender or a government-sponsored enterprise.
- b) Those with a mortgage backed by the Federal Government, such as FHA, Veteran's Administration, or U.S. Department of Agriculture, or a mortgage that has been transferred to a federal agency, such as FHA.
- c) Those who receive federal financial assistance for acquisition, construction, improvement, or disaster recovery of a property located in an SFHA (Shabman et al., 2019; Dixon et al., 2006).

In a study conducted by RAND, Dixon et al. (2006) estimated that approximately 50 to 60 percent of single-family homes in SFHAs are subject to the mandatory purchase requirement.²⁰ Several studies have examined compliance with the mandatory requirement. Tobin and Calfee (2005) cite several of these studies by the General Accounting Office (GAO)²¹ and the Federal Emergency Management Agency (FEMA). In the late 1980s, FEMA²² estimated that only about 12 percent of households, out of the 11 million households that could be covered by flood insurance in 1987, actually carried insurance. In a 1999 study, FEMA examined applications for disaster assistance from flood victims in August 1998 in northern Vermont, with the goal of determining the extent of compliance. Of the applicants in SFHAs, FEMA found only 16 percent had flood insurance. Of the remaining 84 percent of applicants who did not carry flood insurance, about one-half of them had mortgages from federally regulated lenders and should have had insurance (FEMA Region I 1999, cited in Tobin and Calfee, 2005). In 2000, FEMA's Office of Inspector General further examined compliance with the mandatory purchase requirement in 16 communities across 10 states. Although compliance rates in these communities were very high at 90

¹⁹ Until the adoption of the Flood Disaster Protection Act of 1973, the purchase of flood insurance was voluntary. The mandatory purchase provision was further strengthened by the National Flood Insurance Reform Act of 1994. This Act imposed significant new obligations on lenders and servicers and tightened the requirement for the receipt of disaster assistance (FEMA, 2007).

²⁰ FEMA currently estimates that there are about 7.9 million structures located within SFHAs (Tobin and Calfee, 2005).

²¹ The Flood Insurance Reform Act of 2004 directs GAO to conduct a study of the "adequacy of the scope of coverage provided under flood insurance policies in meeting the intended goal of Congress that flood victims be restored to their pre-flood conditions" (Tobin and Calfee, 2005).

²² This study was completed prior to the 1994 legislation that considerably strengthened the mandatory purchase provisions.

percent, the FEMA study noted that these rates were affected by the overrepresentation of coastal communities, which typically have high compliance rates, in the sample (FEMA, 2000, cited in Tobin and Calfee, 2005). Therefore, compliance nationwide was expected to be much lower on the order of 75 to 80 percent (Dixon et al., 2006).

In its first study in 1990, GAO examined the level of noncompliance for flood insurance in two sample states: Maine and Texas. The study found that, for both states, about 64 percent of properties required to have insurance did have insurance (GAO, 1990). In a second study in 1993, GAO examined the extent of compliance with the mandatory purchase requirement following the floods in New York and New Jersey in 1992. In that study, GAO examined why homeowners who had applied for disaster assistance in the two states had not been covered by flood insurance, although they lived within SFHAs. Of the 752 flood disaster victims, 31 percent had mortgages from federally regulated lenders and were required to have flood insurance (GAO, 1993, cited in Tobin and Calfee, 2005). Using data on new mortgages and new flood insurance policies in 2002, GAO examined variations in compliance across the life of a mortgage loan. The study concluded that the compliance rate was high at mortgage origination; however, due to the dearth of sufficient data, the study was not able to determine whether compliance rates changed during the life of the loan (GAO, 2002, cited in Dixon et al., 2006).

The objective of this section is to assess the extent to which FHA single-family homes are in compliance with the mandatory requirement, by examining the number of FHA single-family homes with flood insurance by year and inside and outside the SFHA. In this section, the study team also examined the average number of claims per policy year for all flood-insured FHA single-family properties, and for those located within the SFHA, as well as the annual change in the number of active flood insurance policies among all FHA single-family properties and for those inside the SFHA. Findings on policy drop and policy take-up, by year, for all FHA single-family properties and for the homes inside the SFHA, are also presented. The section closes by presenting the total number of all FHA single-family properties and homes inside the SFHA that have had flood insurance continuously since origination from an FHA-approved lender.

FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES (ALL AND THOSE WITHIN A SPECIAL FLOOD HAZARD AREA) WITH FLOOD INSURANCE, BY YEAR

Under research objective 1, FHA-insured single-family properties were classified as being inside or outside an SFHA based on the latest available Flood Insurance Rate Maps for Florida and North Carolina. The analysis presented for research objective 2 assumes that SFHA status for FHA single-family properties does not change over time. For instance, if a property was classified as being inside an SFHA in 2019, we assumed that the property was inside an SFHA in all the years from 2011 through 2019.

Exhibits 3.8 and 3.9 below present estimates of the percentage of FHA-insured properties that carried flood insurance from 2011 through 2019 in North Carolina and Florida respectively. The percentage of FHA-insured properties that carry flood insurance in a year was calculated as the share of FHA properties that had an active flood insurance policy in that year out of all FHA-insured properties. An FHA single-family property was considered to be active in a year if it was active for any amount of time in that year. We also assumed that an FHA-insured single-family property had an active flood insurance policy in a year if the policy was active for any amount of time in that year.

The exhibits below present the flood insurance coverage rate for all FHA-insured properties, and for FHA-insured properties inside and outside the SFHA separately. We present the flood insurance coverage rates under two different methods of classifying FHA-insured properties as being inside or outside an SFHA. The first method provides a moderate estimate of the number of FHA-insured properties that fall inside the SFHA. As described in the previous section, it uses the inaccurate latitude and longitude coordinates to determine SFHA status, and it assumes properties are within SFHAs if their parcels intersect with SFHAs.

The second method reveals a conservative estimate of the number of FHA-insured properties that fall inside an SFHA. Under this method, any FHA-insured properties with inaccurate latitude and longitude coordinates are classified as being outside the SFHA. In addition, FHA-insured properties are considered to be outside the SFHA if their parcels intersect with SFHAs, but the building footprints do not. The location of building footprints within their parcels helps identify whether a property may be required to carry flood insurance; however, it does not fully capture other features and property improvements, such as elevation, a result of which is that a property may not be required to carry flood insurance. Therefore, while our analyses provide a strong assessment of rates of FHA-insured properties that carry flood insurance, these are not synonymous with rates of compliance.

Exhibit 3.8 | Percentage of Federal Housing Administration-Insured Properties that Carried Flood Insurance in North Carolina

Year	NORTH CAROLINA: Percentage of FHA-insured properties with flood insurance				
	Total	Inside SFHA		Outside SFHA	
		Moderate	Conservative	Moderate	Conservative
2011	2.23	24.12	54.15	1.11	1.12
2012	2.18	24.28	55.03	1.11	1.12
2013	2.08	23.26	52.14	1.08	1.09
2014	1.87	21.23	49.03	0.95	0.96
2015	1.86	21.21	48.77	0.92	0.93
2016	1.79	20.98	48.03	0.84	0.85
2017	1.94	21.31	49.06	0.98	0.98
2018	2.16	22.34	50.51	1.14	1.15
2019	2.24	22.05	49.84	1.23	1.23

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

In North Carolina, the share of FHA-insured properties that carried flood insurance decreased from 2.23 percent in 2011 to 1.79 percent in 2016 and then increased to 2.24 percent in 2019. The flood insurance coverage rate for FHA-insured properties inside an SFHA under the conservative method is twice the rate than under the moderate method. When classified under the conservative method, the flood insurance coverage rate for properties inside the SFHA in North Carolina ranged from 48 percent to 55 percent. When classified under the moderate method, the flood insurance coverage rate for properties inside an SFHA in North Carolina ranged from 21 percent to 24 percent. For properties outside an SFHA, there is no significant difference in the rates using moderate and conservative methods.

Exhibit 3.9 below presents the share of FHA-insured properties in Florida that carried flood insurance from 2011 through 2019. The overall share of FHA-insured properties that had flood insurance decreased from 25 percent in 2011 to 14 percent in 2019. In Florida as well, the flood insurance

coverage rate for FHA-insured properties inside an SFHA was larger when calculated under the conservative method than under the moderate method. However, in Florida, the difference in flood insurance coverage rates was not as stark as in the case of North Carolina. Under both the moderate and conservative methods, the flood insurance coverage rates of FHA-insured properties inside an SFHA fluctuated over time. For FHA-insured properties classified as being outside an SFHA (under either method) the flood insurance coverage rate decreased from 17 percent in 2011 to 5 percent in 2019.

Exhibit 3.9 | Percentage of Federal Housing Administration-Insured Properties that Carried Flood Insurance in Florida

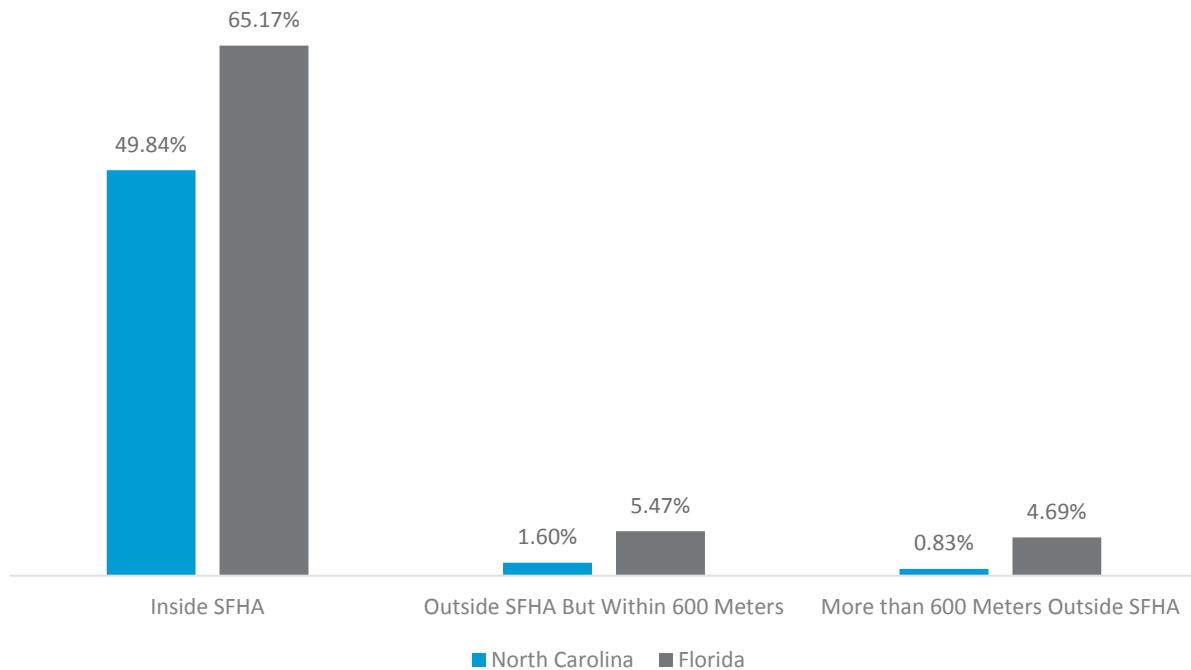
Year	FLORIDA: Percentage of FHA-insured properties with flood insurance				
	Total	Inside SFHA		Outside SFHA	
		Moderate	Conservative	Moderate	Conservative
2011	25.04	52.71	65.09	17.19	17.41
2012	24.21	53.55	66.19	16.09	16.25
2013	23.30	53.63	66.34	15.07	15.21
2014	22.32	54.29	68.04	13.77	13.88
2015	19.97	53.60	68.98	11.03	11.10
2016	16.65	51.01	67.90	7.63	7.69
2017	16.02	50.34	67.75	7.13	7.17
2018	15.31	49.51	67.57	6.54	6.58
2019	13.70	46.75	65.17	5.25	5.28

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

In both Florida and North Carolina, the total number of FHA insured properties that carried flood insurance policies increased between 2011 and 2019 both inside and outside the SFHA. For Florida, under the conservative method, the total number of FHA-insured properties with flood insurance policies increased from 14,391 in 2011 to 68,023 in 2019. In North Carolina, the total number of FHA-insured properties with flood insurance policies increased from 586 in 2011 to 3,978 in 2019. Exhibits C.1 and C.2 in appendix C provide further details.

Exhibit 3.10 investigates whether FHA-insured properties are more likely to have flood insurance policies if they are near the SFHA. The exhibit shows the percentage of FHA-insured properties, using the conservative estimate, in Florida and North Carolina, with flood insurance policies in 2019 inside an SFHA; outside, but within 600 meters of an SFHA; or more than 600 meters outside of an SFHA. FHA-insured properties near (600 meters or less) an SFHA, but not inside an SFHA, were only slightly more likely to carry flood insurance in 2019 than properties further away from an SFHA (more than 600 meters) in both states. This finding suggests that the requirement to carry flood insurance plays a big part in homeowners’ decision on whether to buy a flood insurance policy. Consideration of risk may also be a factor, as FHA-insured properties were slightly more likely to carry flood insurance when they were near an SFHA, but the evidence shows that risk consideration is likely a much smaller factor than the regulation.

Exhibit 3.10 | Percentage of Federal Housing Administration-Insured Properties with Flood Insurance Policies in 2019, Conservative Estimate



SFHA = Special Flood Hazard Area.

This subsection has presented the flood insurance coverage rates for FHA-insured properties under both the conservative and moderate methods of flood zone status classification. The remaining analysis for research objectives 2 and 3 uses the SFHA classification of properties that is produced by the conservative method.

ANNUAL CHANGE IN ACTIVE FLOOD INSURANCE POLICIES (AMONG ALL FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES AND AMONG THOSE WITHIN A SPECIAL FLOOD HAZARD AREA)

Exhibit 3.11 presents the annual change in the number of FHA-insured properties with active flood insurance policies from 2011 through 2019. The annual change in the FHA properties with active flood insurance policies was calculated as the percentage change in the number of FHA properties with active flood insurance policies from the previous year. The exhibit presents results for all FHA-insured properties and FHA-insured properties inside an SFHA separately.

Exhibit 3.11 | Annual Percentage Change in Number of Active Flood Insurance Policies Among Federal Housing Administration-Insured Properties

Year	North Carolina		Florida	
	Total	Inside SFHA	Total	Inside SFHA
2012	110	109	98	105
2013	44	41	47	52
2014	6	9	18	26
2015	23	28	16	32
2016	11	16	2	19
2017	19	14	11	14
2018	19	14	7	10
2019	10	6	-2	4

SFHA = Special Flood Hazard Area.

For both Florida and North Carolina, the percentage change in the number of FHA-insured properties with active flood insurance policies was the highest from 2011 through 2012, both overall and for properties inside an SFHA. However, as presented in exhibits 3.8 and 3.9, the proportion of FHA-insured properties with flood insurance coverage did not change much from 2011 through 2012. This fact suggests that the growth in the number of FHA-insured properties with active flood insurance policies (both overall and inside the SFHA) is driven by an increase in the number of FHA-insured properties both overall and inside the SFHA. The number of FHA-insured properties with active flood insurance policies—overall and inside the SFHA—was growing between 2011 and 2018, but at a decreasing rate.

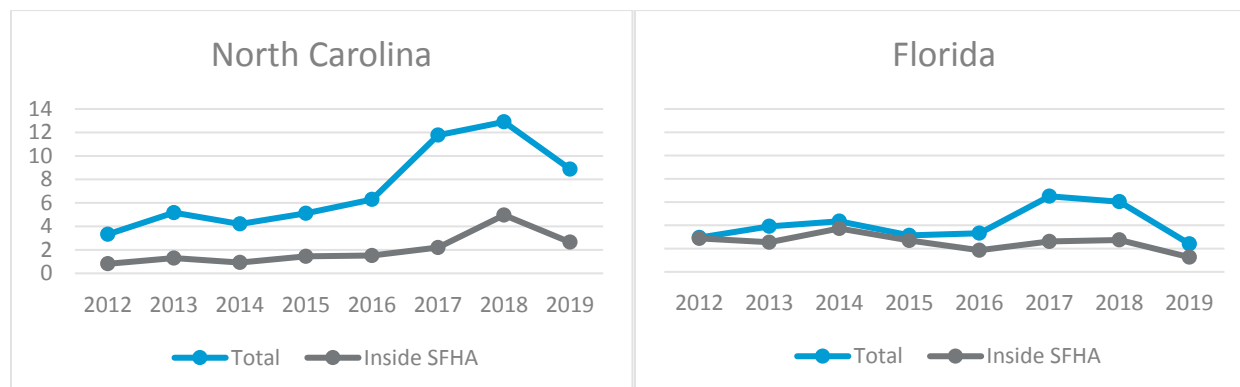
In the case of Florida, the annual change in FHA-insured properties with active flood insurance policies was positive in 2011 through 2018. However, the number of FHA-insured properties with active flood insurance policies decreased by 2 percent in 2018 through 2019. This decrease in 2018 and 2019 was driven by a decrease in the number of FHA single-family properties with active flood insurance policies outside an SFHA.

In North Carolina, the growth in the total number of FHA single-family properties with active flood insurance policies was positive but decreased from 2012 through 2019. The factors driving the annual change in the number of FHA properties with active flood insurance policies can be better understood by analyzing the flood insurance policy take-up rate and policy drop rate detailed below.

FLOOD INSURANCE POLICY TAKE-UP RATE BY YEAR FOR ALL FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES AND FOR PROPERTIES WITHIN A SPECIAL FLOOD HAZARD AREA

Exhibit 3.12 below shows the flood insurance policy take-up rate by year for all FHA single-family properties and for properties inside an SFHA for both North Carolina and Florida. The flood insurance policy take-up rate was calculated as follows: For each year, the study team first calculated the number of FHA single-family properties that did not have flood insurance in the previous year but had it in the current year. The study team then calculated the total number of FHA single-family properties that had active flood insurance policies in the current year. The flood insurance policy take-up rate in a year was defined as the share of FHA-insured properties with active flood insurance policies in a year that did not have flood insurance in the previous year.

Exhibit 3.12 | Flood Insurance Policy Take-Up Rate by Year for North Carolina and Florida for All Federal Housing Administration-Insured Single-Family Properties and for Properties Inside a Special Flood Hazard Area, 2011–2019



SFHA = Special Flood Hazard Area.

For both Florida and North Carolina, in 2012 through 2019, the flood insurance policy take-up rate for all FHA single-family properties was higher than the flood insurance policy take-up rate for FHA single-family properties inside an SFHA.

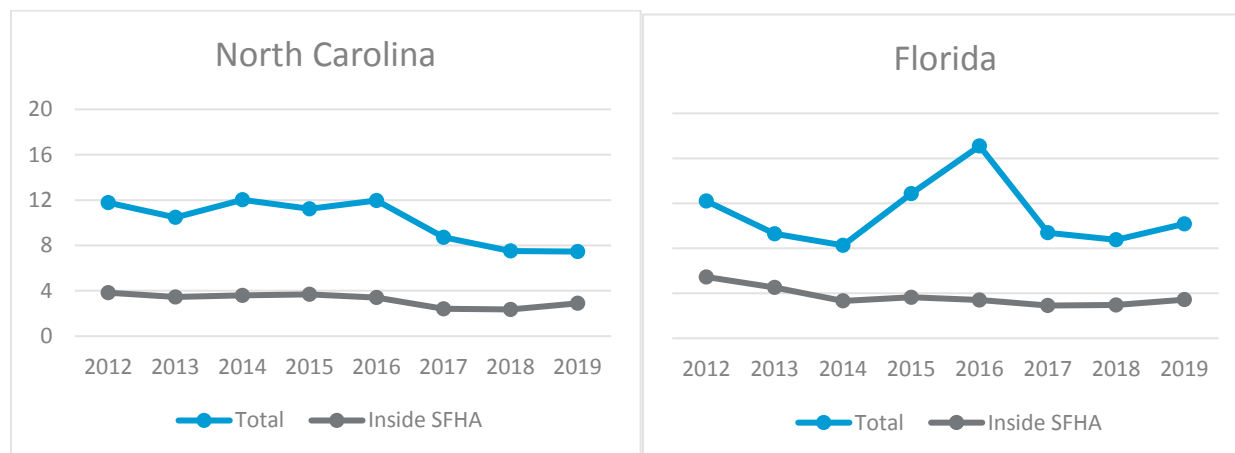
In North Carolina, the flood insurance policy take-up rate for all FHA single-family properties increased from 3 percent in 2012 to 13 percent in 2018 and decreased to 9 percent in 2019. For properties inside an SFHA, the flood insurance policy take-up rate followed a similar pattern, increasing from 1 percent in 2012 to 5 percent in 2018 and decreasing to 2.7 percent in 2019.

In Florida, the flood insurance policy take-up rate did not consistently increase from 2012 through 2019. The flood insurance policy take-up rate over this time period for all FHA single-family properties was, on average, higher than the take-up rate for properties inside an SFHA. However, in 2019, the flood insurance policy take-up rate was very similar for both types: 2.4 percent for all FHA-insured properties and 1.3 percent for FHA-insured properties inside an SFHA. Details regarding the number of FHA single-family properties, by year, that acquired flood insurance without having had it the previous year are provided in exhibits C.3 and C.4. in appendix C.

FLOOD INSURANCE POLICY DROP RATE BY YEAR FOR ALL FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES AND FOR PROPERTIES WITHIN A SPECIAL FLOOD HAZARD AREA

Exhibit 3.13 below shows the flood insurance policy drop rate by year for all FHA single-family properties and for properties inside an SFHA for both North Carolina and Florida. To calculate the flood insurance policy drop rate for each year, the study team first calculated the number of FHA single-family properties that had flood insurance in the previous year but did not have it in the current year. The study team then calculated the total number of FHA single-family properties that had active flood insurance policies in the previous year. The flood insurance policy drop rate in a year is defined as the share of FHA-insured properties with active flood insurance policies in the previous year that dropped their flood insurance policy in the current year.

Exhibit 3.13 | Flood insurance Policy Drop Rate by Year for North Carolina and Florida, 2011–2019



SFHA = Special Flood Hazard Area.

For both Florida and North Carolina, in 2012 through 2019, the flood insurance policy drop rate for all FHA single-family properties was higher than the flood insurance policy drop rate for FHA single-family properties inside an SFHA.

In North Carolina, the flood insurance policy drop rate for all FHA single-family properties decreased from 12 percent in 2012 to 7.5 percent in 2019. For properties inside an SFHA, the flood insurance policy drop rate neither increased nor decreased consistently during the study. From 2012 through 2019, the policy drop rate for properties inside an SFHA spanned a narrow range, the lowest being 2.4 percent in 2017 and the highest being 3.8 percent in 2012.

In Florida, the flood insurance policy drop rate for all FHA single-family properties increased in 2014 through 2016, with a peak policy drop rate of 17 percent in 2016. This trend was primarily driven by the drop in flood insurance policies for FHA properties that were outside an SFHA. Between 2016 and 2019, the flood insurance policy drop rate for all FHA single-family properties in Florida decreased from 17 percent in 2016 to 10 percent in 2019. Further details on the number of FHA properties that dropped flood insurance after having had it the previous year are available in exhibits C.5 and C.6 of appendix C.

FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES (OVERALL AND INSIDE A SPECIAL FLOOD HAZARD AREA) THAT HAVE HAD FLOOD INSURANCE CONTINUOUSLY

Exhibit 3.14 below presents the percentage of FHA single-family properties in Florida and North Carolina that had flood insurance continuously from 2011 through 2019. The exhibit presents the results separately for all FHA single-family properties and for FHA single-family properties inside an SFHA. An FHA single-family property is categorized as having flood insurance continuously if it had at least one active flood insurance policy in every year that the FHA mortgage insurance was active. The percentage of FHA single-family properties that had flood insurance continuously in a year is calculated as the share of all FHA single-family properties that had flood insurance continuously.

Exhibit 3.14 | Percent of Federal Housing Administration-Insured Properties that had Flood Insurance Continuously, Overall and Inside a Special Flood Hazard Area, 2011–2019

Year	North Carolina		Florida	
	Total	Inside SFHA	Total	Inside SFHA
2011	1.43	47.70	14.78	54.05
2012	1.44	48.88	14.58	55.77
2013	1.38	46.14	14.16	56.54
2014	1.30	44.06	13.75	57.84
2015	1.32	44.04	13.15	59.38
2016	1.32	43.83	12.28	59.64
2017	1.38	44.82	11.88	59.84
2018	1.50	45.00	11.75	60.31
2019	1.66	45.29	11.87	60.46

SFHA = Special Flood Hazard Area.

For both Florida and North Carolina, the share of FHA single-family properties that had flood insurance continuously is higher for the properties inside an SFHA than for all FHA single-family properties. In North Carolina, the share of all FHA single-family properties with continuous flood insurance is stable, at around 1 percent in 2011 through 2019. The share of FHA single-family properties inside an SFHA that had flood insurance continuously fluctuates over time.

In Florida, the share of all FHA single-family properties that had flood insurance continuously decreased from 15 percent in 2011 to 12 percent in 2019. On the other hand, the share of FHA single-family properties inside an SFHA that had flood insurance continuously increased from 54 percent in 2011 to 60 percent in 2019.

In both states, while the share of FHA-insured properties that continuously had flood insurance has fluctuated over time, the total number of FHA-insured properties (overall and inside the SFHA) that continuously had flood insurance coverage increased from 2011 through 2019. Exhibit C.7 in appendix C provides further details.

Relationship Between National Flood Insurance Program Claims, Flood Insurance Premiums, and Federal Housing Administration Loan Performance

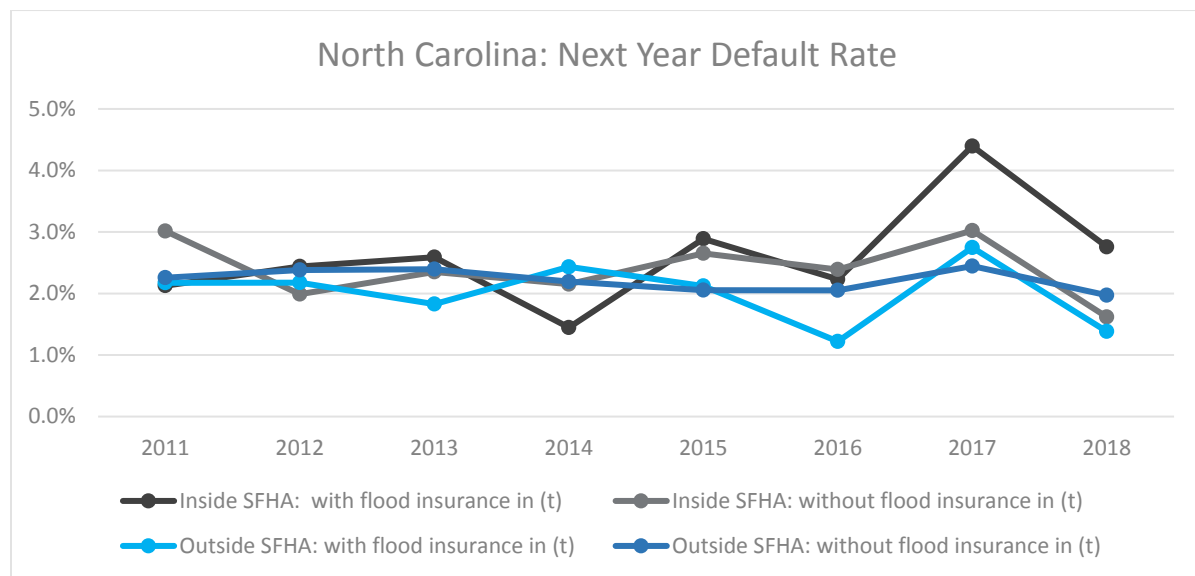
In the previous sections of this chapter, we have examined the proportion of properties with FHA-insured mortgages inside and outside SFHAs (in Section One) and the extent those properties carry flood insurance (in Section Two). These analyses have provided some insights into the extent of flood risk facing properties with FHA-insured mortgages, the loan performance of those properties, compliance with the mandatory requirement, the incidence of flood damage claims, and changes in the premium rates. In this section, through the combination of longitudinal data on FHA single-family status, SFHA status, and NFIP premiums, the study team examines evidence of a relationship between troubled mortgages and risk exposure, flood damage claims, and flood insurance premiums. The results of the analysis on the relationship between NFIP claims, flood insurance premiums, and FHA loan performance appear in three interrelated subsections. First, we present the findings on our analysis of the relationship between flood insurance coverage and FHA loan performance at the extensive margin,

which we have achieved by comparing the FHA-insured loan performance of properties (hereafter identified as “FHA-insured properties” for convenience²³) that had active flood insurance policies with the loan performance of FHA-insured properties that did not have active flood insurance policies. Next, we present findings on the average number of flood insurance claims per policy year for all flood-insured FHA single-family properties and for those inside an SFHA. This analysis only provides a backdrop for the final part of this section, where we explore the relationship between NFIP claims, flood insurance premiums, and loan performance.

DEFAULT RATE FOR FEDERAL HOUSING ADMINISTRATION-INSURED SINGLE FAMILY PROPERTIES BY FLOOD INSURANCE COVERAGE STATUS

This subsection explores the relationship between flood insurance coverage status and loan performance of FHA-insured single-family properties. The loan performance of an FHA-insured property was measured by an indicator of default. Exhibits 3.15 and 3.16 below present the next-year default rate of FHA-insured single-family properties by flood insurance coverage and SFHA status for North Carolina and Florida respectively. The next year’s default rate for FHA-insured properties inside an SFHA with flood insurance coverage in the current year was calculated as the share of FHA-insured properties inside an SFHA with flood insurance coverage in the current year that defaulted in the next year.

Exhibit 3.15 | North Carolina: Next Year Default Rate of Federal Housing Administration-Insured Properties by Flood Insurance Coverage and Special Flood Hazard Area Status



SFHA = Special Flood Hazard Area.

In North Carolina, for FHA-insured properties outside an SFHA, the next year’s default rate for properties with or without flood insurance coverage fluctuated over time. No clear patterns emerged when the

²³ We adopt this short-hand convention for identifying properties that have a mortgage loan insured by FHA with the recognition that FHA insures lenders against loss on mortgage loans, not properties. FHA does not insure property owners against loss on property.

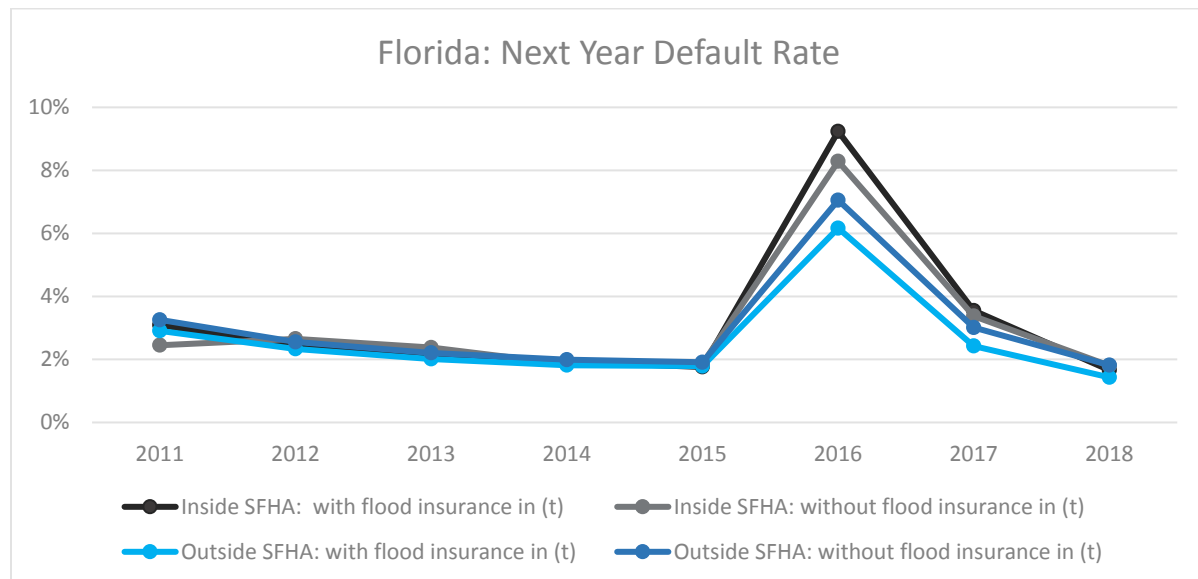
study team compared the default rates for properties outside an SFHA with and without flood insurance coverage.

From 2011 through 2018, the next year's default rate in North Carolina spanned a narrow range, the lowest being 1.22 percent in 2016 and the highest being 2.75 percent in 2017 for FHA-insured properties outside an SFHA with flood insurance coverage. Similarly, for FHA-insured properties outside an SFHA without flood insurance, the next year's default rate ranged from 1.97 percent in 2018 to 2.45 percent in 2017.

For properties with FHA-insured mortgages inside an SFHA, again, no clear pattern emerges. The next year's default rate fluctuated over time both for properties with flood insurance coverage in the current year and for properties without flood insurance coverage in the current year. However, there was a spike in the next year's default rate in 2017: 4.40 percent for properties with flood insurance coverage in 2017 and 3.02 percent for properties without flood insurance coverage in 2017. In other words, the share of properties inside the SFHA with flood insurance coverage in 2017 that defaulted in 2018 is 4.40 percent, the highest over the period of analysis. It is worth noting that this spike could correspond to one of two hurricanes that impacted North Carolina: Hurricane Matthew in 2016 and Hurricane Florence in 2018. However, solely based on exhibit 3.15 above, it is unclear whether the spike in next year's default rate in 2017 was a delayed effect of Hurricane Matthew or an immediate effect of Hurricane Florence.

Exhibit 3.16 below presents the next year's default rate for FHA-insured properties in Florida by flood insurance coverage status and FHA status.

Exhibit 3.26 | Florida: Next Year Default Rate of Federal Housing Administration-Insured Properties by Flood Insurance Coverage and Special Flood Hazard Area Status



SFHA = Special Flood Hazard Area.

In Florida, the next year's default rate for FHA-insured properties irrespective of flood insurance coverage status and flood zone status decreased between 2011 and 2015, increased sharply in 2016, and then decreased again through 2018. When averaging over all years, 2011 through 2019, the next

year's default rate is lowest for FHA-insured properties outside an SFHA with flood insurance coverage in the current year (2.61 percent). For FHA-insured properties outside the SFHA without flood insurance coverage in the current year, the average next year's default rate was 2.98 percent. The average next year's default rate was highest for FHA-insured properties inside an SFHA with flood insurance coverage in the current year, with an average of 3.21 percent for 2011 through 2018.

Exhibit 3.16 shows that the next year's default rate for all types of FHA-insured properties was highest in 2016, irrespective of SFHA or flood insurance coverage status. This sharp spike in the next year's default rate seems to correspond to the hurricanes in 2017, most likely Hurricane Irma. The patterns of next year default rate and weather events around the same time suggest an immediate effect of the hurricane in 2017, rather than a delayed effect of any earlier weather event.

CLAIMS RATE FOR ALL FLOOD-INSURED FEDERAL HOUSING ADMINISTRATION PROPERTIES AND THOSE WITHIN A SPECIAL FLOOD HAZARD AREA

In addition to the analysis of the relationship between flood insurance coverage and FHA loan performance at the extensive margin, the study team explored the relationship between FHA-insured properties and characteristics of the active flood insurance policies on those properties. As a prelude to that discussion in the next subsection, we present here the findings on the average number of claims per policy year for all flood-insured FHA single-family properties and for those inside an SFHA. Exhibit 3.17 below presents the claim rate for FHA-insured properties with flood insurance coverage for both North Carolina and Florida. The claim rate in a year is the share of flood-insured FHA-insured properties that made at least one claim in that year. For each state, Florida and North Carolina, exhibit 3.17 also lists major hurricanes that affected the state in each year.²⁴

Exhibit 3.17 | Flood Insurance Claim Rate for all Flood-Insured Federal Housing Administration-Insured Properties

Year	Florida			North Carolina		
	Major Hurricanes	Inside SFHA	Outside SFHA	Major Hurricanes	Inside SFHA	Outside SFHA
Mean Claim rate	N/A	0.6	0.3	N/A	4.8	1.4
2011	Irene, Rina	0.1	0.1	Irene	8.5	0.7
2012	Isaac, Sandy	0.4	0.3	Sandy	0.8	0.2
2013	-	0.1	0.1	-	0.9	0.6
2014	Arthur	0.1	0.2	Arthur	0.3	0.0
2015	Joaquin	0.2	0.1	-	0.7	0.2

²⁴ The information on hurricanes affecting North Carolina and Florida was collected from different sources. **North Carolina:** [https://en.wikipedia.org/wiki/List_of_North_Carolina_hurricanes_\(2000%E2%80%93present\)](https://en.wikipedia.org/wiki/List_of_North_Carolina_hurricanes_(2000%E2%80%93present)); <https://www.wsj.com/articles/the-worst-hurricanes-to-hit-the-carolinas-1536744601>; https://www.weather.gov/ilm/Top_20_Storms. **Florida:** [https://en.wikipedia.org/wiki/List_of_Florida_hurricanes_\(2000%E2%80%93present\)](https://en.wikipedia.org/wiki/List_of_Florida_hurricanes_(2000%E2%80%93present)); https://www.baynews9.com/fl/tampa/news/2015/8/28/tropical_storms_in_florida_since_2000; <https://www.coastalliving.com/travel/top-10/costliest-hurricanes-united-states>.

2016	Hermine, Matthew	0.4	0.1	Matthew	9.7	1.6
2017	Gert, Irma, Nate	2.5	1.0	Jose, Maria	0.4	0.2
2018	Michael	0.2	0.2	Florence	17.3	5.7
2019	Barry, Dorian, Humberto	0.0	0.0	Dorian, Humberto	0.4	0.2

N/A = data not available. SFHA = Special Flood Hazard Area.

In North Carolina, the flood insurance claim rate was particularly high in the years 2011, 2016, and 2018. These high rates appear to correspond to Hurricane Irene, Hurricane Matthew, and Hurricane Florence, respectively. In all three cases, the flood insurance claim rate for flood-insured FHA properties inside an SFHA was significantly higher than the flood insurance claim rate for flood-insured FHA-insured properties outside an SFHA. For the other years, the flood insurance claim rate was below 1.0 percent for flood-insured FHA-insured properties both inside and outside the SFHA, but always higher for FHA-insured properties inside an SFHA.

In Florida, the claim rate is much lower on average than in North Carolina. The claim rate was highest in 2017, with a claim rate of 2.5 percent for flood-insured FHA-insured properties inside the SFHA and a claim rate of 1.0 percent for flood-insured FHA-insured properties outside the SFHA. A higher-than-average claim rate in 2017 appears to correspond to Hurricane Irma.

The discrepancy in the magnitude of the claim rate between North Carolina and Florida could arise from the differences in the building codes in the two states. A 2018 report by the Insurance Institute of Building and Home Safety rates states on the effectiveness of adoption and enforcement of the building code program. Under this system, Florida is rated the highest among all states with a score of 95, while North Carolina has a score of 83 (IBHS, 2018). A prior study conducted by IBHS following Hurricane Charley in 2004 found that improvements to the codes adopted in 1996 and enforced in Florida resulted in a 60 percent reduction in residential property damage frequency (number of claims) and a 42 percent reduction in damage severity (cost of claims) (IBHS, 2004). Similar patterns in the magnitude of claims between North Carolina and Florida have been observed in reports examining claims for residential properties (see FEMA, 2017).

CHANGES IN LOAN PERFORMANCE BY FLOOD DAMAGE CLAIM, INSURANCE COVERAGE, AND SPECIAL FLOOD HAZARD AREA STATUS

The above two subsections present aggregate default rates and claim rates of FHA-insured properties by flood insurance coverage and SFHA status. In this part of the analysis, the study team further explores the relationship between loan performance and flood insurance coverage, claims, and SFHA status at the FHA-insured property level using a logistic regression model.

The unit of analysis is the case number, a unique number that identifies an application for a specific property's mortgage insurance. The dependent variable of interest is the loan performance of an FHA-insured mortgage, defined by a binary variable indicating the first time an FHA-insured mortgage was in default. The logistic regression analysis restricts the analysis to only those FHA-insured properties that have active flood insurance policies. The study team analyzed the effect of a flood insurance claim on loan performance of an FHA-insured mortgage.

The analysis described above was undertaken while accounting for the SFHA status of the FHA-insured mortgage, the monthly mortgage payment on the FHA-insured property, and the monthly effective income of the borrower.

Exhibit 3.18 below presents summary statistics of the monthly mortgage payments, the monthly effective income of the borrower, and the mortgage-to-income ratio of FHA-insured properties in Florida and North Carolina by flood zone status.

Exhibit 3.18 | Summary Statistics of Monthly Mortgage Payment, Monthly Effective Income, and Mortgage Payment to Income Ratio of FHA-insured Properties

	No. of Observations	Mean	25th Percentile	50th Percentile	75th Percentile
North Carolina					
Monthly mortgage payment	220,657	\$1,054	\$759	\$1,006	\$1,322
Inside SFHA	3,693	\$1,113	\$780	\$1,063	\$1,418
Outside SFHA	207,314	\$1,054	\$760	\$1,006	\$1,321
Adjusted monthly effective income	220,657	\$4,381	\$2,541	\$4,001	\$6,028
Inside SFHA	3,693	\$4,545	\$2,656	\$4,167	\$6,138
Outside SFHA	207,314	\$4,379	\$2,541	\$4,000	\$6,030
Adjusted ratio of mortgage payment to income	187,507	0.24	0.18	0.23	0.30
Inside SFHA	3,197	0.25	0.18	0.24	0.31
Outside SFHA	176,113	0.24	0.18	0.23	0.30
Policy premium amount	4,803	\$503.97	\$310.50	\$356.67	\$515.00
Inside SFHA	1,914	\$664.83	\$337.50	\$473.83	\$815.00
Outside SFHA	2,371	\$380.18	\$295.00	\$345.00	\$375.00
Florida					
Monthly mortgage payment	581,979	\$1,345	\$955	\$1,275	\$1,676
Inside SFHA	77,209	\$1,568	\$1,143	\$1,516	\$1,940
Outside SFHA	452,528	\$1,298	\$925	\$1,231	\$1,612
Adjusted monthly effective income	581,979	\$4,873	\$3,040	\$4,428	\$6,336
Inside SFHA	77,209	\$5,290	\$3,397	\$4,854	\$6,763
Outside SFHA	452,528	\$4,772	\$2,975	\$4,333	\$6,235
Adjusted ratio of mortgage payment to income	527,846	0.28	0.21	0.28	0.35
Inside SFHA	70,826	0.30	0.24	0.30	0.37
Outside SFHA	409,939	0.28	0.21	0.27	0.34
Policy premium amount	116,205	\$447	\$299.5	\$348	\$428
Inside SFHA	52,796	\$545.22	\$298.00	\$380.00	\$627.00
Outside SFHA	51,409	\$353.20	\$299.00	\$345.33	\$374.00

SFHA = Special Flood Hazard Area.

Notes: The statistics for adjusted monthly income and ratio of the mortgage payment to income presented above are calculated after adjusting low-income amounts in the data. The low-income amounts in the data are adjusted as follows. For each state, the study team determined the lowest percentile with an income value strictly greater than zero. For North Carolina, this was the 14th percentile of the income distribution. The study team then set the income amount to zero for income values between the 14th and 15th percentile of the income distribution. Following a similar method, for Florida income amounts between the 8th and 9th percentile are set to zero.

In North Carolina, the mean monthly mortgage payment on FHA-insured mortgages was very similar for FHA-insured properties inside and outside an SFHA. The mean monthly effective income is slightly higher for borrowers with FHA-insured properties inside an SFHA than for those with FHA-insured properties outside an SFHA. The distribution of mortgage payment-to-income ratio is very similar for properties outside an SFHA and inside an SFHA.

In the case of Florida, the mean monthly effective income and monthly mortgage payment were higher for FHA-insured properties inside an SFHA than for FHA-insured properties outside an SFHA. The median mortgage payment-to-income ratio was only slightly higher for properties inside the SFHA than outside an SFHA.

It is important to note that in both North Carolina and Florida, the income data has been adjusted to account for low-income amounts recorded in the FHA data²⁵. The regression analysis presented below includes the adjusted income amounts as a control. This is done to ensure that the estimates for the regression analysis is not driven by outliers in the data.

As indicated earlier, a logistic regression model was used to examine how the various variables described above affect the loan performance of an FHA-insured mortgage. The outcome of interest in a logistic model is a dichotomous variable (in this case whether or not there was a default against the FHA-insured mortgage in period $t+1$). The logistic regression model developed here estimates the odds that an FHA-insured mortgage defaulted in the next year given the mortgage and SFHA characteristics included in the model.²⁶ The results of the logistic regression model are presented in terms of odds ratios. This allows us to identify the effects of each variable on the relative likelihood of defaulting in the next year.²⁷ In the logistic regression model presented below, the odds ratio measures the association between the FHA-insured mortgage's characteristics in a given year and the FHA-insured mortgage's default event in the next year.

An odds ratio equal to 1 indicates no association between the FHA-insured mortgage's characteristics and the FHA-insured mortgage's default event in the next year. An odds ratio greater than 1 indicates a positive association between the FHA-insured mortgage's characteristics in a given year and the FHA-insured mortgage default event in the next year. In other words, the odds ratio for a particular explanatory variable represents the effect of that variable on the relative likelihood that the FHA-insured property will default in the next year.

The results of the analysis are summarized in exhibits 3.19 and 3.20 for North Carolina and Florida, respectively. The analysis uses data from all years, 2011 through 2019, but is restricted to FHA-insured properties with active flood insurance coverage in that year.

²⁵ The low income amounts in the data are adjusted as follows. For each state, the study team determined the lowest percentile with an income value strictly greater than zero. For North Carolina this was the 14th percentile of the income distribution. The study team then set the income amount to zero for income values between the 14th and 15th percentile of the income distribution. Following a similar method, for Florida income amounts between the 8th and 9th percentile are set to zero.

²⁶ "The odds of an event is the probability that an event occurs divided by the probability that it does not occur. Thus, if an event occurs with probability of 0.6, the odds ratio is 1.5 (0.6/0.4). The odds of an event and the probability of an event are fairly similar in magnitude for probabilities less than 0.25" (Dixon et al., 2006).

²⁷ While odds ratio must be interpreted with care, they are easier to interpret than the coefficients of the logistic regression (Dixon et al., 2006).

The outcome of interest or dependent variable in all columns is a variable that indicates whether an FHA-insured property defaulted in the next period, which is a proxy for loan performance. The first column of the exhibits present the effect of having at least one flood insurance claim in a given year on the relative likelihood of the FHA-insured property defaulting in the next year. Column (1) of exhibit 3.19 shows that the relative likelihood of defaulting in the next year is 1.9 times larger when an FHA-insured property had at least one flood insurance claim in the current year than when the FHA-insured property had no flood insurance claims in the current year. This result is statistically significant at a 99-percent confidence level.

Exhibit 3.19 | North Carolina: Flood Insurance Claims and Loan Performance

North Carolina						
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	(1)	(2)	(3)	(4)	(5)	(6)
At least one claim in t	1.896***	1.848**	1.675*			
At least one claim in t-1				1.722	1.726	2.092**
SFHA status		1.081	1.03		0.994	0.871
Monthly mortgage payment (logs)			1.783***			1.832***
Adjusted monthly effective income (logs)			0.472***			0.428***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0223***	0.0218***	0.161	0.0273***	0.0273***	0.477
No. of observations	15,451	15,451	13,335	10,839	10,839	9,326

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Notes: The symbols ***, **, and * represent significance values of $p \leq 0.01$, $p \leq 0.05$, and $p \leq 0.1$, respectively.

The second column of the exhibits present the results while additionally controlling for whether the FHA-insured property is inside or outside the SFHA. Column (2) of exhibit 3.19 shows that the relative likelihood of defaulting the next year is approximately 1.8 times larger when an FHA-insured property has at least one flood insurance claim in a year than when it has no flood insurance claims. The result is statistically significant at a 95-percent confidence level. However, the SFHA status of an FHA-insured property does not have a statistically significant impact on the relative likelihood of defaulting the next year.

The third column of the exhibits control for adjusted monthly income and mortgage payment separately. In exhibit 3.19 the relative likelihood of defaulting the next year for FHA-insured properties in North Carolina is larger and statistically significant at 90 percent confidence level when an FHA-insured property has at least one flood insurance claim in a year than when it has no flood insurance claims in a year. Columns (1) to (3) of exhibit 3.19 show that this result holds even when controlling for additional factors such as SFHA status, monthly mortgage payment, and adjusted monthly effective income. Among the additional controls, monthly mortgage payment and monthly effective income exhibit a statistically significant relationship with the relative likelihood of defaulting in the next year.

The result of interest in columns (1) to (3) of exhibits 3.19 and 3.20 is the effect of having at least one flood insurance claim in a year on the relative likelihood of the FHA-insured property defaulting in the next year. To investigate whether this relationship persists over a longer time lag, columns (4) to (6) of exhibits 3.19 and 3.20 examine the effect of having at least one flood insurance claim in the previous year on the relative likelihood of default in the next year (in other words, 2 years after the year of the flood insurance claim). Column (6) shows that when controlling for SFHA status, mortgage payment, and

monthly income, having at least one flood insurance claim in a year is associated with an increase in the relative likelihood of default 2 years in the future. This result is statistically significant at 90 percent confidence level. Column (6) of exhibit 3.19 shows that the relative likelihood of default in a year is 2.09 times larger when an FHA-insured property has at least one flood insurance claim 2 years prior than when it has no flood insurance claims.

Exhibit 3.20 presents the results of the logistic regression model for Florida. Column (1) in exhibit 3.20 shows that the relative likelihood of defaulting in the next year is 1.4 times larger when an FHA-insured property that has at least one claim in the current year than when it has no claims in the current year.

Exhibit 3.20 | Florida: Flood Insurance Claims and Loan Performance

	Florida					
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	(1)	(2)	(3)	(4)	(5)	(6)
At least one claim in t	1.416***	1.388***	1.420***			
At least one claim in t-1				1.016	0.999	1.004
SFHA status		1.149***	1.096***		1.127***	1.089***
Monthly mortgage payment (logs)			2.521***			2.302****
Adjusted monthly effective income (logs)			0.527***			0.574***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0310***	0.0299***	0.0085***	0.0312***	0.0302***	0.0081***
No. of observations	350,253	350,253	319,535	252,398	252,398	230,229

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Notes: The symbols ***, **, and * represent significance values of $p \leq 0.01$, $p \leq 0.05$, and $p \leq 0.1$, respectively.

This result persists even when accounting for the SFHA status of the property, the monthly mortgage payments on the FHA-insured property, and the adjusted monthly effective income of the borrower (column [2-3]). Unlike North Carolina, in Florida, the SFHA status of the property has a statistically significant impact on the relative likelihood of default in the next year. The relative likelihood of default in the next year is 1.1 times larger when the FHA-insured property is inside the SFHA than when it is outside the SFHA. This result is statistically significant at a 99-percent confidence level.

Columns (4) to (6) of exhibit 3.20 examine the effect of having at least one flood insurance claim in the previous year on the relative likelihood of default in the next year (in other words, 2 years after the year of the flood insurance claim). Columns (4) through (6) of exhibit 3.20 show that for Florida, having a flood insurance claim in a year does not have a statistically significant relationship with the relative likelihood of default 2 years after the year of the claim.

In summary, for both North Carolina and Florida, the relative likelihood of defaulting in the next year is larger when an FHA-insured property has at least one flood insurance claim in the current year than when the FHA-insured property has no flood insurance claims in the current year. This result is statistically significant at a 90 percent confidence level. The result holds even when controlling for factors such as SFHA status, monthly mortgage payment, and monthly effective income of the borrower. However, the results for North Carolina and Florida differ when investigating whether the impact of a flood insurance claim on the likelihood of default persists over a longer time lag. For North Carolina, having a claim in a given year has a statistically significant relationship with the relative likelihood of default 2 years after the year of the claim. In Florida, this relationship is not statistically significant.

The analysis presented in exhibits 3.19 and 3.20 above is restricted to FHA-insured properties with active flood insurance policies. In addition to mortgage payments, borrowers with FHA-insured mortgages that have active flood insurance policies also make flood insurance premium payments. The study team investigated the relationship between flood insurance premiums and loan performance of the FHA-insured property. The results of the analysis are presented in exhibits 3.21 and 3.23 below.

Exhibit 3.21 presents the results for North Carolina. The first column of exhibit 3.21 shows that the relative likelihood of default in the next year is 1.3 times larger for a 1 percent higher flood insurance premium. The relationship is statistically significant at a 99-percent confidence level. The magnitude of this positive association between flood insurance premium and default in the next period remains stable even when accounting for other factors such as the SFHA status of the FHA-insured property, whether a flood insurance claim was made in the current year, the mortgage payment and the adjusted monthly effective income of the borrower. The result is statistically significant at a 95-percent confidence level. In column (6) of exhibit 3.21, when accounting for monthly effective income, monthly mortgage payment, and flood insurance premium amount, the relationship between having a claim in the current year and a default event in the next year is statistically significant at a 90-percent confidence level.

Exhibit 3.21 | North Carolina: Flood Insurance Premiums and Loan Performance

North Carolina						
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	1	2	3	4	5	6
Premium amount (logs)	1.264***	1.251***	1.232**	1.242**	1.222**	1.222**
At least one claim in t			1.746**	1.793**	1.538	1.585*
SFHA status		1.035	1.023	1.009	0.991	0.982
Monthly mortgage payment (logs)				0.91		1.781***
Adjusted monthly effective income (logs)					0.641***	0.476***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.00561***	0.00591***	0.00633***	0.0111***	0.216	0.0456**
No. of observations	15,450	15,450	15,450	15,046	13,342	13,334

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Notes: The symbols ***, **, and * represent significance values of $p \leq 0.01$, $p \leq 0.05$, and $p \leq 0.1$, respectively.

The results presented in exhibit 3.21 do not establish a causal relationship between flood insurance premium amount and the event of default in the next year. They do indicate that further investigation is required in the manner in which flood insurance is set and whether and how this impacts the likelihood of default. The study team also investigated whether a default event in the next year is associated with a change in the flood insurance premium (from the current year to the next year). In North Carolina, there were a total of 359 default events of FHA-insured properties with active flood insurance policies. Of these, 78 percent had a premium change. Details are provided in exhibit 3.22 below. The number of FHA-insured properties is too few for reliable regression estimates to be estimated; however, for reference, the results of the logistic regression model analyzing the relationship between percent change in premium amounts and loan performance are presented in exhibit C.13 in appendix C. The relationship between flood insurance premium change and default event for FHA-insured properties in North Carolina is not statistically significant.

Exhibit 3.22 | North Carolina: Premium Change and Default Event

	Number of properties	Percent of properties
Number of properties that had a premium change in the next year (between t and t+1)	280	78
Number of properties that did not have a premium change in the current year (between t and t+1)	79	22
Total number of FHA-insured properties with active flood insurance policies that defaulted in the next year (t+1)	359	100

FHA = Federal Housing Administration.

Exhibit 3.23 presents the results of the analysis of the relationship between flood insurance premiums and loan performance for FHA-insured properties in Florida. Unlike North Carolina, in the case of Florida, the relationship between flood insurance premium amounts paid and the relative likelihood of default is not statistically significant. However, columns (4) through (6) of exhibit 3.23 show that when accounting for flood insurance premium amounts, the relationship between having a flood insurance claim in the current year and a default event in the next year is statistically significant at a 99-percent confidence level. The relative likelihood of default in the next year is 1.4 times larger for an FHA-insured property with a flood insurance claim in the current year than for an FHA-insured property without a flood insurance claim in the current year when accounting for the premium amount paid, flood zone status of the FHA-insured property, mortgage payment and income.

Exhibit 3.23 | Florida: Flood Insurance Premiums and Loan Performance

	Florida					
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	1	2	3	4	5	6
Premium amount (logs)	1.025	0.988	0.985	0.975	0.988	1.007
At least one claim in t			1.395***	1.436***	1.386***	1.417***
SFHA status		1.152***	1.152***	1.149***	1.133***	1.095***
Monthly mortgage payment (logs)				1.448***		2.522***
Adjusted monthly effective income (logs)					0.905***	0.527***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0268***	0.0321***	0.0326***	0.00236***	0.0742***	0.00817***
No. of observations	350,251	350,251	350,251	346,370	319,665	319,533

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Notes: The symbols ***, **, and * represent significance values of $p \leq 0.01$, $p \leq 0.05$, and $p \leq 0.1$, respectively.

The study team also investigated the relationship between a change in the flood insurance premium and default event in the next year for FHA-insured properties in Florida. Exhibit 3.24 shows that of the total number of FHA-insured properties with active flood insurance policies that defaulted, 75 percent experienced a premium change. Results of the logistic regression analyzing the relationship between flood insurance premium change and default events are presented in exhibit C.14 in appendix C. The result is statistically significant at a 99-percent confidence level. However, the estimate is equal to 1, implying that the relative likelihood of defaulting in the next year is the same for FHA-insured properties

whose flood insurance premium changed compared to FHA-insured properties whose flood insurance premium did not change.

Exhibit 3.24 | Florida: Premium Change and Default Event

	Number of properties	Percent of properties
Number of properties that had a premium change in the current year (between t and t+1)	7,578	75%
Number of properties that did not have a premium change (between t and t+1)	2,561	25%
Total number of FHA-insured properties with active flood insurance policies that defaulted in the next year (t+1)	10,139	100%

FHA = Federal Housing Administration.

4 SUMMARY AND CONCLUSIONS

In a time of increasing flood and flood-related disaster risk, HUD seeks to understand the exposure of its asset portfolios to flood risk and the extent to which homeowners with homes in SFHA's carry the requisite flood insurance policies. Consequently, the overarching objective of this study was to better understand the flood risk exposure of FHA single-family homes and compliance with flood insurance requirements. Using data from HUD's FHA single-family property database, the Federal Emergency Management Agency's (FEMA) property-level National Flood Insurance Program (NFIP) database, and FEMA's Special Flood Hazard Area (SFHA) status, this study provides information to support HUD's efforts to prudently manage its portfolio. This chapter highlights the key findings of the study, discusses the limitations of the study, and identifies topics for additional research.

Summary of the Findings

The findings from this study fall into three categories based on the study's objectives: (1) extent of flood risk to FHA single-family properties; (2) extent of properties with FHA-insured mortgages in compliance with the requirement to carry flood insurance; and (3) relationship between NFIP claims, insurance coverage, and FHA loan performance.

EXTENT OF FLOOD RISK FOR FEDERAL HOUSING ADMINISTRATION SINGLE-FAMILY PROPERTIES

In addressing this objective, the study team examined the number of FHA single-family properties inside and outside SFHAs; the number of FHA single-family properties within 600 meters of an SFHA; annual changes in the number of FHA single-family properties located within an SFHA; and the number of nonperforming loan properties inside and outside an SFHA, by year. Our results indicated that the proportion of properties with FHA-insured mortgages inside SFHAs in both North Carolina and Florida was relatively small compared to the proportion outside of SFHAs, although exposure to flood risk in 2019 was much higher in Florida (approximately 20 percent) than in North Carolina (approximately 5 percent). In both Florida and North Carolina, properties with FHA-insured mortgages inside an SFHA were mostly in zone A areas, which have a lower level of risk than zone V. It is important to note, however, that the proportion of properties with FHA-insured mortgages in both Florida and North Carolina that are within 600 meters of an SFHA was much larger than the proportion that was inside an SFHA in 2019. Approximately 80 percent and approximately 54 percent of properties with FHA-insured mortgages in Florida and North Carolina, respectively, were within 600 meters of SFHAs. Regarding annual changes in the number of properties inside an SFHA, our estimates indicate that both North Carolina and Florida experienced dramatic increases in the total number of active mortgages for 2011 through 2019. The proportion of properties inside an SFHA or within 600 meters of an SFHA, however, remained relatively stable during this time. Our findings on loan performance inside and outside of an SFHA indicated similar default rates for properties inside and outside SFHAs in most years. It is important to note, however, that the default rates appeared much higher for Florida and North Carolina in 2017 and 2018 respectively, which can be attributed mainly to two major hurricanes that caused extensive flooding and wind damage in these states: Hurricane Irma in Florida in 2017 and Hurricane Florence in North Carolina in 2018.

EXTENT OF FEDERAL HOUSING ADMINISTRATION PROPERTIES IN COMPLIANCE WITH REQUIREMENT TO CARRY FLOOD INSURANCE

Dixon et al. (2006) estimated that approximately 50 to 60 percent of single-family homes in SFHAs are subject to the mandatory purchase requirement. Of the homes subject to the mandatory purchase requirement, Dixon et al. (2006) estimated approximately 78 percent compliance in the country as a whole, with minor geographical variations. In this study, we presented the results for flood insurance coverage rates under two different methods—moderate and conservative²⁸—of classifying FHA-insured properties as being inside or outside an SFHA. Generally, on an average (of all years and under both flood zone status classifications), the flood insurance coverage rate was significantly larger for properties with FHA-insured mortgages inside an SFHA (approximately 37 percent in North Carolina and approximately 59 percent in Florida) than for those outside an SFHA (approximately 1 percent in North Carolina and approximately 11 percent in Florida). Our results further revealed variation in estimated compliance rates across the two study states and by flood status classification method. In both states, the flood insurance coverage rate for FHA-insured properties inside an SFHA was larger under the conservative method than under the moderate method. In North Carolina, the conservative estimate for compliance rates ranged from approximately 48 percent to approximately 55 percent, compared to estimates under the moderate method which ranged from approximately 21 percent to approximately 24 percent. Similarly, in Florida, the compliance rate for properties with FHA-insured mortgages inside an SFHA ranged from approximately 65 percent to approximately 69 percent under the conservative method, while the moderate estimate ranged from approximately 47 percent to approximately 54 percent. It is important to note that this analysis may not capture the entire picture. A property located inside an SFHA may not require flood insurance due to property improvements, such as elevation. As such, the property would be in compliance with FHA’s regulations without carrying flood insurance.

The study team also examined annual changes in FHA-insured properties with active flood insurance policies from 2011 through 2019. We found that the percentage of FHA-insured properties with active flood insurance policies, for properties inside an SFHA and overall, grew over time for both Florida and North Carolina, but at a decreasing rate. In particular, the two states experienced substantial growth in the number of FHA-insured properties in 2011 through 2012 for all FHA properties and for properties inside an SFHA. We also examined the factors driving the annual changes in the number of properties with FHA-insured mortgages by analyzing the flood insurance policy take-up rate and policy drop rate. For flood insurance policy take-up rates, our estimates indicated a relatively faster-growing trend, on average, for all FHA-insured properties compared to the trend for FHA-insured properties inside an SFHA in North Carolina. The flood insurance policy take-up rates in Florida fluctuated over time; however, the take-up rates for all FHA-insured properties were higher than the rates for the FHA-insured properties inside an SFHA. This fact was likely due to the requirement for properties with FHA-insured mortgages in SFHA to have flood insurance at sale closing. In addition, the flood insurance policy drop rates consistently decreased from 2012 through 2019 for all FHA-insured properties and for FHA-insured properties inside an SFHA in North Carolina. The FHA-insured properties inside an SFHA in Florida

²⁸ The moderate method uses the inaccurate latitude and longitude coordinates to determine SFHA status, and assumes properties are within SFHAs if their parcels intersect with SFHAs. Under the conservative method, any FHA-insured properties with inaccurate latitude and longitude coordinates are classified as being outside the SFHA. In addition, FHA insured properties are considered to be outside the SFHA if their parcels intersect with SFHAs, but the building footprints do not.

showed a decreasing trend similar to that in North Carolina. The study team also examined FHA single-family properties that had flood insurance continuously. Our estimates indicated that Florida had a much larger percentage of all FHA properties that were insured continuously compared to North Carolina. However, this share in Florida decreased slightly from 2011 through 2019, while the share in North Carolina remained constant across all years. Meanwhile, the proportion of FHA-insured properties inside an SFHA that were continuously insured slightly increased for both North Carolina and Florida.

RELATIONSHIP BETWEEN FLOOD INSURANCE COVERAGE STATUS, NATIONAL FLOOD INSURANCE PROGRAM CLAIMS, AND FEDERAL HOUSING ADMINISTRATION LOAN PERFORMANCE

The final aspect of the analysis explored the relationship between flood insurance coverage status, NFIP claims, and FHA loan performance. In conducting this exploration, we first explored the relationship between the next-year default rate of FHA-insured single-family properties by flood insurance coverage and SFHA status. We calculated the default rate as the share of FHA-insured properties inside the SFHA with flood insurance coverage in the current year that default in the next year. Generally, our results show that flood insurance coverage does not significantly matter when determining default rates for FHA-insured properties inside or outside an SFHA. On average (of all years), the difference between the next year default rate of FHA-insured properties with flood insurance in the current year and of those without flood insurance in the current year, irrespective of flood zone status, was less than 0.5 percentage points in both Florida and North Carolina. It is important to note, however, that the average next year default rate is highest for FHA-insured properties inside the SFHA with flood insurance coverage in the current year (average of 3.21 percent in Florida and average of 2.61 percent in North Carolina).

We also examined the average number of claims per policy year for all flood-insured FHA single-family properties and for those inside SFHA. We calculated claim rates as the share of flood-insured FHA-insured properties that made at least one claim in that year. Our estimates indicate low claim rates for all FHA-insured properties for both North Carolina and Florida in most years. Unusually high claim rates, however, were observed in 2011, 2016, and 2018 for North Carolina, and in 2017 for Florida. Preliminary research on this phenomenon suggested that strong hurricanes were the major contributors to high claim rates in those years. For example, the high claim rate in Florida in 2017 corresponded to the occurrence of Hurricane Irma in 2017. The results also indicate that FHA-insured properties inside an SFHA were slightly more likely to file claims in both Florida and North Carolina. On average (of all years), the claim rates for FHA-insured properties in an SFHA were 0.2 percentage points and 3.3 percentage points higher than the claim rates for FHA-insured properties outside an SFHA in Florida and North Carolina, respectively.

Finally, using a logistic regression model, the study team explored the relationship between flood insurance claims, flood insurance premiums, and loan performance. More specifically, we analyzed the effect of a flood insurance claim and premium amounts on loan performance of the FHA-insured property, accounting for the SFHA status of the FHA-insured mortgage, the monthly mortgage payment on the FHA-insured property, the monthly effective income of the borrower, and the ratio of the monthly mortgage payment to monthly effective income. Our measure of loan performance is a dummy variable indicating the first time an FHA-insured mortgage is in default. Our results differ in the two states. In North Carolina, the logistic regression models consistently show that higher flood insurance premium amounts increase the likelihood of defaulting in the next year. The odds of defaulting in the next year are also higher if an FHA-insured property in North Carolina has a flood insurance claim, but

only in models that do not account for monthly effective income. Also, there is some evidence that FHA-insured properties in North Carolina that defaulted experienced a premium change (78 percent of properties that defaulted experienced a premium change). In Florida, the logistic regression models consistently show that having a flood insurance claim increases the odds of defaulting in the next year, while the premium amount has no statistical relationship with the odds of defaulting. Similar to North Carolina, most properties that defaulted did experience a premium change (75 percent). In both states, having a flood insurance claim in the previous year did not matter as much as having a flood insurance claim in the current year for the likelihood of defaulting in the next year.

Premiums mattering more in North Carolina may be due to the fact that flood insurance is generally more expensive in North Carolina (see exhibit 3.10), especially inside an SFHA. Therefore, higher premium amounts may place more burden on homeowners in North Carolina than in Florida. Regardless, there is clear evidence that flood insurance expenses, either a premium change, premium amount, or having a claim, are associated with an increased likelihood of default for FHA-insured properties.

Limitations and Further Work

There are three main data limitations of this study. First, the study is limited to two states and should, therefore, be considered as a pilot study. However, the research team gained a lot of knowledge in working with the data that is transferable to HUD and other researchers that will make studies of more states or even of the entire country much easier than before this pilot. Second, the determination of FHA properties being in/out of the SFHA relies on the latest SFHA geographic definition. To the extent that the boundaries change over time, the findings may be different using temporally consistent boundary files. However, our analysis of the potential changes in the boundary demonstrated that this was a minor consideration for these two states. It could be more significant in other areas. Third, the study relied on address matching to determine if FHA properties have flood insurance. Finding a way to avoid address matching would likely increase the accuracy of the analysis. One possibility would be to capture some type of NFIP policy number along with other closing information on the FHA data. This would make analyses of drop rates and claims much easier and more accurate. For properties in the SFHA, presumably, this would be relatively easy as flood insurance is required for closing. For other properties, there would need to be an administrative link between FHA and FEMA to facilitate the tracking of insurance.

There are also several open questions that the limited analysis in this report did not answer. First, the present study does not investigate how the flood risk exposure of FHA-insured properties compares to other properties. Although results from this study provide insight into the extent of flood risk FHA's portfolio is facing, it is important to place such analysis into context to capture a more complete picture of the extent of the risk. Depending on data availability, future research could help generate a better understanding of the extent of the risk by comparing FHA rates of properties in SFHAs with national trends, government-sponsored enterprises (GSEs), and conventional mortgages. This will create the basis to compare FHA risk and that of the broader market.

Similarly, the current study has focused mainly on the loan performance of FHA-insured properties. While we included the findings from the General Accounting Office (GAO) reports on this topic, which showed even lower rates historically, future research could extend this analysis by comparing loan

performance of FHA-insured properties to the performance of other non-FHA mortgages inside an SFHA, such as the GSEs or the Mortgage Bankers Association (or other national groups).

Third, the report does not fully explain why default rates are so similar, and in fact slightly higher, for FHA-insured properties with flood insurance in an SFHA when compared to FHA-insured properties in an SFHA without flood insurance. The logistic regression results suggest that flood insurance premium amounts, changes in the flood insurance premium, and having a flood insurance claim are positively associated with the likelihood of default. It may be the case that flood insurance does not adequately cover the cost of damages or that resulting increases in premiums are too burdensome for homeowners. Future work could examine default rates of FHA-insured properties with and without flood insurance before and after a major flooding event to investigate this issue further.

Fourth, although this report estimates the number and percentage of FHA-insured properties that are within an SFHA and have flood insurance, it is unclear how many of these properties are truly not compliant with the requirement to carry flood insurance. Future research could work to obtain more detailed data on elevation, changes in SFHA boundaries over time, and other factors that may impact the requirement to have flood insurance. Likely, completing these analyses is more feasible at a smaller geographic level (such as a single county or metropolitan area) to increase the ease of accessing more detailed data. An ideal candidate for this work should have evidence of significant changes in the SFHA boundary since SFHA status is a major factor impacting a homeowner's decision to purchase flood insurance.

Finally, while the analysis focused on SFHA as a risk indicator, it may be beneficial in the future to examine areas outside of the 100-year flood plain that are impacted by floods and may still be at risk. As this study has shown, while the SFHA boundary is small and only contains a few FHA-insured properties, several other FHA-insured properties are located within a 600-meter buffer of the SFHA boundary. One broad risk to the FHA portfolio is that floods are impacting areas outside of SFHAs, but the regulatory requirements (including requirements to have flood insurance) do not cover these homes in the 500-year flood plain. However, the risk of flooding is still higher in the 500-year flood plain than outside of a flood plain.²⁹ Consequently, future analysis may involve analysis of risk and performance in the 500-year flood plain as well. This is relevant because the results may impact policies regarding flood insurance requirements.

²⁹ Almost three-quarters of the more than 204,000 homes and apartment buildings in Harris County, Texas, that were damaged by Hurricane Harvey were outside the federally regulated 100-year flood plain.

<https://www.houstonchronicle.com/news/article/In-Harvey-s-deluge-most-damaged-homes-were-12794820.php>.

APPENDIX A: DETAILS OF THE DATA MERGING PROCESS

In order to conduct the analysis for research objective 2, the study team needed to merge three separate datasets: the Federal Housing Administration (FHA) property data, the flood insurance policy data from the National Flood Insurance Program (NFIP), and the flood insurance claim data. Details of the merge exercise are provided below.

MERGING THE FEDERAL HOUSING ADMINISTRATION PROPERTY DATA AND THE NATIONAL FLOOD INSURANCE PROGRAM POLICY DATA

The study team undertook the merge between the FHA property data and NFIP policy data using the address fields available in both datasets. In total, the study team was able to merge 202,081 properties with FHA-insured mortgages in Florida and 9,432 properties with FHA-insured mortgages in North Carolina with the NFIP policy data. This accounts for 30 percent of all properties with FHA-insured mortgages in Florida and 4 percent of all properties with FHA-insured mortgages in North Carolina.

In the FHA property data, the *case number* variable uniquely identifies each application for a specific property's mortgage insurance. The study team anticipated that the same property could be listed under different case numbers if there were different applications for mortgage insurance on the property. This situation could arise if property ownership changed, resulting in multiple entries for the same property in the FHA data. The study team undertook the merge of the FHA property data with the NFIP data by creating a list of addresses present in both files and merging them. Then, FHA case numbers were matched to an NFIP policy if both shared an address and were active in the same year. If an address had more than one NFIP policy in a single year, the policy information we use in the analysis was aggregated (for example, the total number of claims in a year for property across all NFIP policies).

The merge between the FHA property-level data and the NFIP policy data was undertaken in four rounds, with different combinations of location and address variables used in each round. In the first round, the study team used the latitude and longitude coordinates provided in each file (in some cases the study team re-geocoded addresses; see approach to research objective 1 above) to map addresses to parcels. If an FHA address and NFIP address shared the same parcel, they were merged together. As discussed in the methods section on the approach to research objective 1 above, several properties had unreliable latitude and longitude coordinates. Any property the study team identified as having unreliable latitude and longitude coordinates were not matched to the parcel. For these remaining addresses, the study team merged on address names. This process resulted in 103,220 properties with FHA-insured mortgages in Florida and 4,104 properties with FHA-insured mortgages in North Carolina being merged to the NFIP policy data.

After matching addresses with reliable latitude and longitudes based on parcel information, the study team performed standardizations on the city variable in the remaining unmatched addresses in the NFIP policy data by removing phrases such as "TOWN OF" or "CITY OF" and leaving only the city name. The second-round merge between the FHA and NFIP policy data was then undertaken using the street address, ZIP Code, and standardized city name variables. The study team created a list of the unique combinations of address, ZIP Code, and standardized city name from both files and merged them using a

one-to-one merge. This process resulted in 46,138 FHA-insured properties in Florida and 2,641 FHA-insured properties in North Carolina being merged with the NFIP policy data.

The study team found that several addresses in the NFIP policy data were missing city names. The third-round merge was between the FHA and NFIP policy data that were unmerged in the first and second rounds. The third-round merge was undertaken using the address line and ZIP Code variables only. The study team created a list of the unique combinations of addresses and ZIP Codes from both files and merged them together using a one-to-one merge. This process resulted in a larger number of merges than the second round, for both Florida and North Carolina. In Florida, 51,753 FHA properties were merged with the NFIP policy data, and in North Carolina, 2,674 FHA properties were merged with the NFIP policy data.

Exhibit A.1 | Data Merge of Properties with Federal Housing Administration-Insured Mortgages with National Flood Insurance Program Policy Data

Merge by	Florida	North Carolina
	Merged FHA properties	
parcel information	103,150	4,104
zip-city-street address	46,138	2,641
zip-street address	51,057	2,640
standardized street address	1,736	47
Total FHA properties merged	202,081	9,432
Total FHA properties (N)	668,599	247,343

FHA = Federal Housing Administration.

The final round merge was undertaken using the remaining FHA and NFIP policy data. In both datasets, the study team performed standardizations using the address line variable, by removing street suffixes such as “LN,” “DR,” and “CIR” and leaving the house number and street name. The study team created a list of the unique combinations of the standardized addresses and ZIP Codes from both files and merged them using a one-to-one merge. This process resulted in 970 FHA-insured properties being merged in Florida and 13 FHA-insured properties being merged in North Carolina.

MERGING THE NATIONAL FLOOD INSURANCE PROGRAM POLICY DATA AND THE NFIP CLAIMS DATA

The data on flood insurance policies and claims were provided to the study team as two separate files. In order to tabulate the average number of claims per policy year for all flood-insured FHA single-family properties, the study team undertook the merge of the policy data with the flood insurance claims data. To merge the policy data with the claims data, the study team used a combination of address variables (ZIP Code, street address, and city), and the start year of the policy. The study team anticipated the possibility of multiple claims made against a single flood insurance policy. The first step in the merge exercise was to keep only those policies that were unique in address, policy premium, policy start, and policy end date combinations. After dropping duplicates, the team retained 99.8 percent of the policies in Florida and 99.9 percent of the policies in North Carolina. The address variables, policy premium, policy start, and policy end date variables were used to merge the policy data with the claims data using the one-to-many merge. Similarly, 99.9 percent of claims in Florida and 99.9 percent of claims in North Carolina were matched to flood insurance policies. The next step was to merge the policy claims data to FHA policy data using a unique identity variable generated as a combination of the ZIP Code, address, policy start dates, and policy end dates in a many-to-one merge.

APPENDIX B: GENERAL FEDERAL EMERGENCY MANAGEMENT AGENCY TERMS

Exhibit B.1 | Federal Emergency Management Agency Terms and Definitions

FEMA Term	Definition
BFE	Base Flood Elevation. Computed elevation to which flood waters are anticipated to rise during the base year (1 percent annual probability, also called 100-year flood) flood event. These elevations are rounded to the nearest whole foot. The relationship between the BFE and the structure's elevation determines flood insurance premiums.
FHA	Federal Housing Administration. Provides mortgage insurance on loans made by FHA-approved lenders.
Fill	Earthen fill is sometimes placed in an SFHA to reduce flood risk to the filled area.
FIRM	Flood Insurance Rate Map.
Floodway	Regulatory floodway, channel, or river and adjacent land that must be reserved in order to discharge the base flood without raising water surface elevation above its designated height.
LOMA	Letter of Map Amendment. Subset of LOMC.
LOMC	Letter of Map Change. A letter that reflects an official change to a FIRM that is in effect.
LOMR	Letter of Map Revision. Subset of LOMC.
MFHA	Moderate Flood Hazard Area. Area that has between 0.2 percent and 1 percent annual risk of flood event. Also known as 500-year flood area.
MinFHA	Minimal Flood Hazard Area. Area that has less than a 0.2 percent annual risk of flood event.
MSC	Map Service Center.
NFIP	National Flood Insurance Program. For public/private structures. Congress mandated federally regulated or insured lenders to require flood insurance or mortgaged properties in locations of high flood probability.
SFHA	Special Flood Hazard Area. Area that has an annual, less-than-or-equal-to 1 percent risk of flood event. Also known as a 100-year flood area.

Exhibit B.2 | Definitions of Federal Emergency Management Agency Flood Zone Designations

SFHA Zone	Definition
A	Areas subject to inundation by the 1 percent-annual-chance flood event, generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AO	Areas subject to inundation by 1 percent-annual-chance shallow flooding (usually sheet flow on sloping terrain), in which average depths are between 1 and 3 feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply. Some AO zones have been designated in areas with high flood velocities such as alluvial fans and washes.
AH	Areas subject to inundation by 1 percent-annual-chance shallow flooding (usually areas of ponding), where average depths are between 1 and 3 feet. BFEs derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.
A1–A30	Areas subject to inundation by the 1 percent-annual-chance flood event determined by detailed methods. BFEs are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AE	Areas subject to inundation by the 1 percent-annual-chance flood event determined by detailed methods. BFEs are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
A99	Areas subject to inundation by the 1 percent-annual-chance flood event but that will ultimately be protected upon completion of an under-construction federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protection system (such as dikes, dams, and levees) to consider it complete for insurance rating purposes. Zone A99 may only be used when the flood protection system has reached specified statutory progress toward completion. No BFEs or depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection. Mandatory flood insurance purchase requirements and floodplain management standards apply.
V	Areas along coasts subject to inundation by the 1 percent-annual-chance flood event with additional hazards associated with storm-induced waves. Because detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
VE	Areas subject to inundation by the 1 percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
V1-V30	Areas subject to inundation by the 1 percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

APPENDIX C: ADDITIONAL EXHIBITS

Exhibit C.1 | North Carolina: Federal Housing Administration-Insured Single-Family Properties with Flood Insurance

Year	Moderate Definition of SFHA			Conservative Definition of SFHA		
	Total	Inside SFHA	Outside SFHA	Total	Inside SFHA	Outside SFHA
2011	586	308	278	586	235	276
2012	1,232	632	600	1,232	492	597
2013	1,780	900	880	1,780	695	875
2014	1,879	970	909	1,879	760	904
2015	2,307	1,217	1,090	2,307	969	1,084
2016	2,559	1,406	1,153	2,559	1,121	1,147
2017	3,049	1,584	1,465	3,049	1,274	1,456
2018	3,620	1,800	1,820	3,620	1,450	1,806
2019	3,978	1,912	2,066	3,978	1,544	2,040

SFHA = Special Flood Hazard Area.

Exhibit C.2 | Florida: Federal Housing Administration-Insured Single-Family Properties with Flood Insurance

Year	Moderate Definition of SFHA			Conservative Definition of SFHA		
	Total	Inside SFHA	Outside SFHA	Total	Inside SFHA	Outside SFHA
2011	14,391	6,690	7,701	14,391	5,175	7,635
2012	28,538	13,683	14,855	28,538	10,619	14,742
2013	42,036	20,662	21,374	42,036	16,089	21,193
2014	49,721	25,534	24,187	49,721	20,239	23,972
2015	57,746	32,561	25,185	57,746	26,693	24,941
2016	58,859	37,492	21,367	58,859	31,872	21,181
2017	65,268	42,201	23,067	65,268	36,291	22,842
2018	69,620	45,952	23,668	69,620	39,875	23,414
2019	68,023	47,276	20,747	68,023	41,590	20,421

SFHA = Special Flood Hazard Area.

Exhibit C.3 | Policy Take-Up Rate by Year for North Carolina and Florida for all Federal Housing Administration-Insured Single-Family Properties and for Properties within a Special Flood Hazard Area, 2011–2019

Year	North Carolina		Florida	
	Policy Take-Up Rate		Policy Take-Up Rate	
	Total	Inside SFHA	Total	Inside SFHA
2011	-	-	-	-
2012	3.3	0.8	3.0	2.9
2013	5.2	1.3	3.9	2.5
2014	4.2	0.9	4.4	3.7
2015	5.1	1.4	3.1	2.7
2016	6.3	1.5	3.3	1.9
2017	11.8	2.2	6.5	2.6
2018	12.9	5.0	6.0	2.7
2019	8.9	2.7	2.4	1.3

SFHA = Special Flood Hazard Area.

Exhibit C.4 | Number of Federal Housing Administration Properties that Took Up Flood Insurance Policy in Year without Having Had It the Previous Year for North Carolina and Florida, 2011–2019

Year	North Carolina		Florida	
	Policy Take-Up		Policy Take-Up	
	Total	Inside SFHA	Total	Inside SFHA
2011	-	-	-	-
2012	41	4	842	305
2013	92	9	1,645	409
2014	79	7	2,163	755
2015	118	14	1,811	720
2016	161	17	1,956	591
2017	359	28	4,241	949
2018	467	72	4,198	1,094
2019	353	41	1,636	525

SFHA = Special Flood Hazard Area.

Exhibit C.5 | Policy Drop Rate by Year for North Carolina and Florida for all Federal Housing Administration-Insured Single-Family Properties and for Properties within a Special Flood Hazard Area, 2011–2019

Year	North Carolina		Florida	
	Policy drop rate		Policy drop rate	
	Total	Inside SFHA	Total	Inside SFHA
2011	-	-	-	-
2012	11.77	3.83	12.20	5.45
2013	10.47	3.46	9.29	4.52
2014	12.02	3.60	8.26	3.32
2015	11.23	3.68	12.86	3.64
2016	11.96	3.41	17.10	3.40
2017	8.71	2.41	9.38	2.91
2018	7.51	2.35	8.75	2.96
2019	7.46	2.90	10.18	3.44

SFHA = Special Flood Hazard Area.

Exhibit C.6 | Number of FHA Properties that Dropped Flood Insurance Policy in Year After Having Had it the Previous Year for North Carolina and Florida, 2011–2019

Year	North Carolina		Florida	
	Policy drop		Policy drop	
	Total	Inside SFHA	Total	Inside SFHA
2011	-	-	-	-
2012	69	9	1,756	282
2013	129	17	2,651	480
2014	214	25	3,474	534
2015	211	28	6,394	737
2016	276	33	9,873	908
2017	223	27	5,522	928
2018	229	30	5,714	1,075
2019	270	42	7,084	1,370

SFHA = Special Flood Hazard Area.

Exhibit C.7 | Federal Housing Administration Properties that Have Had Flood Insurance Continuously, Overall and Inside a Special Flood Hazard Area, 2011–2019

Year	North Carolina		Florida	
	Total	Inside SFHA	Total	Inside SFHA
2011	375	207	8,493	4,297
2012	815	437	17,194	8,947
2013	1,177	615	25,537	13,712
2014	1,302	683	30,634	17,205
2015	1,636	875	38,010	22,978
2016	1,896	1,023	43,413	27,995
2017	2,163	1,164	48,397	32,053
2018	2,518	1,292	53,437	35,589
2019	2,936	1,403	58,956	38,585

SFHA = Special Flood Hazard Area.

Exhibit C.8 | Summary Statistics of Monthly Mortgage Payment, Adjusted Monthly Effective Income, Adjusted Mortgage to Income Ratio of Federal Housing Administration-Insured Properties and Policy Premiums (with Adjusted Income Amounts)

	No. of Observations	Mean	25th Percentile	50th Percentile	75th Percentile
North Carolina					
Monthly mortgage payment	220,657	1,054	759	1,006	1,322
Inside SFHA	3,693	1,113	780	1,063	1,418
Outside SFHA	207,314	1,054	760	1,006	1,321
Adjusted monthly effective income	220,657	4,381	2,541	4,001	6,028
Inside SFHA	3,693	4,545	2,656	4,167	6,138
Outside SFHA	207,314	4,379	2,541	4,000	6,030
Adjusted ratio of mortgage payment to income	187,507	0.24	0.18	0.23	0.30
Inside SFHA	3,197	0.25	0.18	0.24	0.31
Outside SFHA	176,113	0.24	0.18	0.23	0.30
Policy premium amount	4,803	503.97	310.50	356.67	515.00
Inside SFHA	1,914	664.83	337.50	473.83	815.00
Outside SFHA	2,371	380.18	295.00	345.00	375.00
Florida					
Monthly mortgage payment	581,979	1,345	955	1,275	1,676
Inside SFHA	77,209	1,568	1,143	1,516	1,940
Outside SFHA	452,528	1,298	925	1,231	1,612
Adjusted monthly effective income	581,979	4,873	3,040	4,428	6,336
Inside SFHA	77,209	5,290	3,397	4,854	6,763
Outside SFHA	452,528	4,772	2,975	4,333	6,235
Adjusted ratio of mortgage payment to income	527,846	0.28	0.21	0.28	0.35
Inside SFHA	70,826	0.30	0.24	0.30	0.37
Outside SFHA	409,939	0.28	0.21	0.27	0.34
Policy premium amount	116,205	447	299.5	348	428
Inside SFHA	52,796	545.22	298.00	380.00	627.00
Outside SFHA	51,409	353.20	299.00	345.33	374.00

SFHA = Special Flood Hazard Area.

Note: The statistics presented above are calculated after adjusting low income amounts in the data. For North Carolina, income amounts between the 14th and 15th percentiles are set to zero. For Florida income amounts between the 8th and 9th percentile are set to zero.

Exhibit C.9 | North Carolina: Flood Insurance Claims and Loan Performance (with Adjusted Income)

	North Carolina							
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)							
	1	2	3	4	5	6	7	8
At least one claim in t	1.896***	1.848**	1.694*	1.675*				
At least one claim in t-1					1.722	1.726	2.135**	2.092**
SFHA status		1.081	1.029	1.030		0.994	0.870	0.871
Monthly mortgage payment (logs)				1.783***				1.832***
Adjusted monthly effective income (logs)				0.472***				0.428***
Adjusted monthly mortgage payment to income ratio		20.610***				25.680***		
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0223***	0.0218***	0.00743** *	0.161	0.0273***	0.0273***	0.0111***	0.477
No. of observations	15,451	15,451	13,343	13,335	10,839	10,839	9,332	9,326

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Note: The estimates presented above are calculated after adjusting low income amounts in the data. For North Carolina, income amounts between the 14th and 15th percentiles are set to zero. For Florida income amounts between the 8th and 9th percentile are set to zero.

Exhibit C.10 | Florida: Flood Insurance Claims and Loan Performance (with Adjusted Income)

	Florida							
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)							
	1	2	3	4	5	6	7	8
At least one claim in t	1.416***	1.388***	1.403***	1.420***				
At least one claim in t-1					1.016	0.999	0.985	1.004
SFHA status		1.149***	1.100***	1.096***		1.127***	1.088***	1.089***
Monthly mortgage payment (logs)				2.521***				2.302***
Adjusted monthly effective income (logs)				0.527***				0.574***
Adjusted monthly mortgage payment to income ratio		9.460***				7.305***		
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0310***	0.0299***	0.0153***	0.0085***	0.0312***	0.0302***	0.0167***	0.0081***
No. of observations	350,253	350,253	319,667	319,535	252,398	252,398	230,333	230,229

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Note: The estimates presented above are calculated after adjusting low income amounts in the data. For North Carolina, income amounts between the 14th and 15th percentiles are set to zero. For Florida income amounts between the 8th and 9th percentile are set to zero.

Exhibit C.11 | North Carolina: Premium Amounts, Flood Insurance Claims and Loan Performance (with Adjusted Income)

North Carolina						
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	1	2	3	4	5	6
Premium amount (logs)	1.264***	1.251***	1.232**	1.242**	1.222**	1.222**
At least one claim in t			1.746**	1.793**	1.538	1.585
SFHA status		1.035	1.023	1.009	0.991	0.982
Monthly mortgage payment (logs)				0.91		1.781***
Adjusted monthly effective income (logs)					0.641***	0.476***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.00561***	0.00591***	0.00633***	0.0111***	0.216	0.0456**
No. of observations	15,450	15,450	15,450	15,046	13,342	13,334

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Note: The estimates presented above are calculated after adjusting low income amounts in the data. For North Carolina, income amounts between the 14th and 15th percentiles are set to zero. For Florida income amounts between the 8th and 9th percentile are set to zero.

Exhibit C.12 | Florida: Premium Amounts, Flood Insurance Claims, and Loan Performance (with Adjusted Income)

Florida						
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	1	2	3	4	5	6
Premium amount (logs)	1.025	0.988	0.985	0.975	0.988	1.007
At least one claim in t			1.395***	1.436***	1.386***	1.417***
SFHA status		1.152***	1.152***	1.149***	1.133***	1.095***
Monthly mortgage payment (logs)				1.448***		2.522***
Adjusted monthly effective income (logs)					0.905***	0.527***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0268***	0.0321***	0.0326***	0.00236***	0.0742***	0.00817***
No. of observations	350,251	350,251	350,251	346,370	319,665	319,533

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Note: The estimates presented above are calculated after adjusting low income amounts in the data. For North Carolina, income amounts between the 14th and 15th percentiles are set to zero. For Florida income amounts between the 8th and 9th percentile are set to zero.

Exhibit C.13 | North Carolina: Percentage Change in Premium Amounts and Loan Performance

	North Carolina					
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	1	2	3	4	5	6
% change in premium amount	1.003	1.003	1.002	1.002	1.002	1.002
At least one claim in t			1.976***	2.054***	1.756**	1.752**
SFHA status		1.166*	1.145	1.122	1.104	1.105
Monthly mortgage payment (logs)				0.903		0.98
Monthly effective income (logs)					0.879***	0.880***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0198***	0.0188***	0.0182***	0.0345***	0.0401***	0.0457***
No. of observations	13,829	13,829	13,829	13,453	12,038	12,030

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

Exhibit C.14 | Florida: Percentage Change in Premium Amounts and Loan Performance

	Florida					
	Dependent Variable: Loan Performance (= 1 if FHA property defaults in t+1, 0 otherwise)					
	1	2	3	4	5	6
% change in premium amount	1.001***	1.001***	1.001***	1.001***	1.001***	1.001***
At least one claim in t			1.393***	1.429***	1.375***	1.393***
SFHA status		1.193***	1.192***	1.185***	1.179***	1.168***
Monthly mortgage payment (logs)				1.471***		1.569***
Monthly effective income (logs)					0.994	0.908***
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0309***	0.0293***	0.0293***	0.00177***	0.0303***	0.00250***
No. of observations	307,785	307,785	307,785	304,285	281,793	281,667

FHA = Federal Housing Administration. SFHA = Special Flood Hazard Area.

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U.S. Department of Housing and Urban Development
Office of Policy Development and Research
Washington, DC 20410-6000



November 2020