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Towards Better Management of Flood Losses: Flood Insurance in a Wetter World

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Abstract

Flood is the most frequent and costly of U.S. natural disasters with losses expected to increase due to climate change. The National Flood Insurance Program (NFIP) mandates flood insurance purchase for properties with federally-backed mortgages in the 100-year floodplain. We propose that mandatory flood insurance purchase be extended to all property in the 500-year floodplain. Following flood events, payments would be directly provided for more properties that suffer flood loss, reducing federal disaster aid spending. The mandate could put more pressure on local governments to increase their Community Rating System score, such as through infrastructure investments and management practices that reduce flood risk. The expanded requirement would not address the inaccuracies of maps used to price flood insurance (and used by local governments to make long-term planning decisions) but may impact floodplain development by making more explicit the costs and risks of building and living in high risk areas.

Introduction

Among natural disasters, flooding is the most frequent and costly in the United States. Climate change will increase the frequency and severity of flooding due to several factors including more frequent and violent storms, extreme precipitation events, accelerating sea level rise, and greater storm surge, resulting in increased flooding and subsequently flood losses. In this Commentary, we focus on the role of flood insurance in mitigating flood-induced losses and in encouraging investment in protective infrastructure that increases resilience and reduces vulnerability. In 2017, the U.S. experienced three hurricanes, eight intense storms, and two massive inland floods, resulting in the costliest year on record for U.S. weather and climate disasters (Smith, 2018).

The Federal Emergency Management Agency (FEMA) manages the National Flood Insurance Program (NFIP), which is not just a post-loss risk financing program, but also provides incentives for flood mitigation[1] at the individual and community levels (Fan & Davlasheridze, 2016; Kousky, 2017). Since being founded in 1968, the NFIP has employed multiple tactics to increase the flood insurance participation rate[2], such as subsidizing premiums, providing generous commissions to insurance companies and their agents to sell flood insurance, and requiring certain high flood risk properties to purchase flood insurance. The policies in-force did steadily increase until peaking in 2009 at 5.70 million (Federal Emergency Management Agency, 2018e), but then decreased to 5.06 million policies in-force as of January 31, 2018 (National Flood Insurance Program, 2018), an 11.2 percent decrease. The number of housing units in the US increased by

[1] In the context of this Commentary, our focus is on flood mitigation, not climate mitigation. Flood mitigation is defined as efforts "to reduce loss of life and property by lessening the impact of disasters" (Federal Emergency Management Agency, 2018f).

[2] Participation rate (also referred to as penetration rate) means the percent of residences that have purchased flood insurance in a specific area, such as a SFHA or a county.

more than 6 million from 2009 to 2017 (Statista, n.d.), which, coupled with the decrease in flood insurance policies in-force, implies that the participation rate has decreased nationally over the same period. Considering the increased frequency and severity of flooding, this suggests that fewer households in high risk areas are protected by flood insurance.

A low flood insurance participation rate is a root cause of both the NFIP's debt and its ineffectiveness in managing flood losses and reducing federal flood disaster payments. Increased participation could reduce the burden on taxpayers in several ways. Any payment by an NFIP policy for flood losses directly reduces the amount of disaster assistance the policyholder can receive. In addition, after a flood loss, an NFIP policyholder can receive funds to pay for mitigation to reduce the severity of losses in future flood events. Increasing the number and risk diversity of properties covered by the NFIP would create a more sustainable risk pool[3] that limits further NFIP debt and reduces both the amount of federal disaster aid paid and non-covered losses borne by flood victims.

The focus of this paper is on the flood insurance participation rate and making the case for expanding the mandatory purchase requirement beyond the 100-year floodplain to include the 500-year floodplain. Currently, the only property owners required to have flood insurance are those with federally-backed mortgages in Special Flood Hazard Areas (SFHAs), also known as the 100-year floodplain, which are areas that have at least a one percent chance of flooding annually. Properties in the 500-year floodplain have at least a 0.2 percent likelihood of flooding annually.

[3] In insurance terminology, the risk pool, sometimes called the insurance pool, is the group of policyholders that the insurer bundles together to reduce risk. The insurer estimates losses of the entire pool to determine how much to charge policyholders. The insurance conception of risk is similar to Knight's (1921) distinction between risk and uncertainty. Risk is quantifiable to some degree in terms of known outcomes and their likelihoods, whereas uncertainty is "not susceptible to measurement." Furthermore, while risk can be quantified and priced into insurance rates, uncertainty cannot because the outcomes and the likelihoods of outcomes are unknown.

We use the term "participation rate" in this Commentary interchangeably with other commonly used terms such as "take up rate" and "penetration rate".

We argue that such an expansion is an important step in stabilizing the NFIP, substituting insurance for federal disaster aid payments, and improving flood loss recovery for property owners. If the purchase of flood insurance is voluntary, the expectation of receiving disaster aid can crowd out the demand for flood insurance (Browne & Hoyt, 2000; Kousky, Michel-Kerjan, & Raschky, 2013; Lewis & Nickerson, 1989; Raschky, Schwarze, Schwindt, & Zahn, 2013; Raschky & Weck-Hannemann, 2007). Even those who purchase flood insurance after a flood loss tend to let coverage lapse after two to four years (Michel-Kerjan, Lemoyne de Forges, & Kunreuther, 2012).

In addition, expanding the purchase requirement to property in the 500-year floodplain would provide more incentive for property owners to pressure their local government to participate in the Community Rating System (CRS) and for those communities participating to try to increase their CRS Class rating, which results in flood insurance discounts for the entire community. A community's CRS rating can be improved in various ways, including investments in infrastructure improvements or infrastructure management and planning that reduce flood risk. An expanded flood insurance purchase mandate could also alleviate problems caused by inaccurate Flood Insurance Rate Maps (FIRMs), which result in underestimating property risk and not purchasing flood insurance. The current FIRMs appear to drastically underestimate the number of properties that are in the 100-year flood zone (Department of Homeland Security Office of Inspector General, 2017; Wing et al., 2018).

Federal flood insurance is available for properties in communities that have qualified for participation in the NFIP. To qualify, the community must submit a floodplain management plan

that at least meets the minimum NFIP requirements. Currently, about 22,000 U.S. communities participate in the NFIP (Marsh LLC, 2015). An NFIP-qualified community can participate in the CRS and work to improve its CRS Class rating to earn flood insurance premium discounts for its residents. The CRS rating reflects the degree to which the community (i.e., the locality) has undertaken floodplain and watershed management activities that exceed the minimum NFIP requirements. Flood insurance premium discounts for residents range from 5 percent for a Class 9 rating to 45 percent for a Class 1 rating.

The CRS is the only program "designed to encourage communities to proactively reduce their flood risks" (100 Resilient Cities, 2017, p. 5). However, the CRS is a voluntary program and there are significant barriers to entry for many localities. Currently, about six percent of NFIP communities participate in the CRS (Environmental Defense Fund, 2017) and only one community has achieved the highest CRS Class 1 rating, receiving an average flood insurance premium discount in the SFHA of $963 (Federal Emergency Management Agency, 2017a).

CRS rewards localities for activities that reduce flood hazards while protecting the natural and beneficial functions of flood-prone land (Federal Emergency Management Agency, 2015a). The CRS rating can be increased by investing in infrastructure improvements that increase resilience to flooding. For example, CRS rewards investments in preservation and restoration of natural infrastructure (like wetlands and vegetated shorelines) and investment in green infrastructure (such as bioswales, permeable pavements, cisterns, or stormwater planters) that offer protection against damage from flooding and reduce flood losses (Environmental Protection Agency, 2015).[4]

[4] Highfield and Brody (2017)find that communities participating in the CRS experience more than a 40% reduction in flood claims relative to communities that do not participate.

Green infrastructure uses natural features and processes, and engineered controls to reduce runoff volume through infiltration, evapotranspiration, or rainwater harvesting (Environmental Protection Agency, 2015).Green infrastructure involving open space, wetlands, floodplains, and woodlands, and/or using such green infrastructure to support natural floodplain functions contribute to higher CRS ratings. Preserving or restoring floodplains such as through natural floodwater storage can also contribute to improved CRS ratings.

CRS also encourages infrastructure management that minimizes future flood damages such as by preserving open space, protecting national floodplain functions, and regulating development in the floodplain and in the watershed. Localities can improve their CRS rating by focusing on planning and development functions that emphasize infrastructure-related decisions to reduce flood losses in existing development. They may include improving drainage system maintenance efforts, addressing repetitively-flooded properties, and adopting higher building code standards and stormwater management regulation.

In the next section, we document recent flood losses in the U.S. and the related increase in NFIP debt and disaster aid spending, followed by a section that describes the low flood insurance participation rate with case studies of two recent flood disasters that illustrate the low participation rate, amounts of flood insurance and disaster aid paid, and uncovered losses borne by homeowners. The subsequent section describes decades of attempts by the NFIP to increase the participation rate and argues for expanding the mandatory purchase requirement beyond the current high risk zone. The final section discusses the benefits of expanding the mandatory flood insurance purchase requirement. We conclude with a brief discussion of the policy landscape and how flood insurance policy changes may come about to improve flood resilience in a world made wetter due to climate change and sea level rise.

Flood Losses in the U.S., NFIP, and Disaster Aid

Flood is the most frequent and costly among natural disasters in the U.S. From 2008 until 2017, 73 percent of FEMA disaster declarations were flood related (Federal Emergency Management Agency, 2018a; Lightbody & Tompkins, 2018). The U.S. federal government is exposed to flood losses mainly through federal disaster assistance and the NFIP. For example, in the case of Hurricane Sandy in 2012, Congress appropriated $50 billion to be administered by 19 federal agencies for recovery efforts (U.S. Government Accountability Office, 2015). Additionally, the NFIP paid almost $8.3 billion in claims, increasing the NFIP deficit by about $6.25 billion to a total $24 billion. The NFIP repaid $1 billion in principal in December 2014, which was the first repayment of principal since 2010 (U.S. Government Accountability Office, 2015). The hurricane damaged about 650,000 homes resulting in 144,000 NFIP claims being submitted, which indicates most homes did not have flood insurance and that tremendous losses were borne by property owners (Government Accountability Office, 2015). The 2017 season included Hurricane Harvey in August, which hit Houston; Hurricane Irma in September, which swept across southern Florida; and Hurricane Maria a few days later, which resulted in the devastation of Puerto Rico. These hurricanes and other major storms in 2017 increased NFIP debt past borrowing limits, resulting in Congress forgiving $16 billion of the program's debt and allowing for additional NFIP borrowing to pay for flood losses, which increased NFIP debt beyond $20 billion (100 Resilient Cities, 2017; Casey, 2017). Table 1 shows NFIP claims for major flood events after Hurricane Sandy (through 2016).

Table 1. NFIP claims payments for major flood losses since Hurricane Sandy in 2012.

Flood Location	Date	NFIP Claim Payments
Illinois	Apr 2013	$89,543,129
Colorado	Sep 2013	$69,478,876
Florida	Apr 2014	$111,314,399
Texas	May 2015	$466,789,452
South Carolina	Oct 2015	$138,680,941
Midwest	Dec 2015	$97,676,179
Louisiana, Arkansas, Texas, Mississippi	Mar 2016	$282,577,207
Texas	Apr 2016	$468,472,097
Louisiana	Aug 2016	$2,452,588,855
SE U.S. Coast (Hurricane Matthew)	Oct 2016	$162, 000,000

*Data as of November 30, 2017

Source: Federal Emergency Management Agency (2018c), data for SE U.S. Coast (Hurricane Matthew) from "NFIP Payouts to Matthew Victims Top $162M" (2016)

Federal flood recovery spending is not just a coastal occurrence. For the 2013 Colorado floods, about $415 million was paid out in federal disaster aid and more than $68 million in NFIP claims (Federal Emergency Management Agency, 2013). From 2008 to 2017, of the ten states that suffered the most flood-related disaster declarations, eight were non-coastal states (Federal Emergency Management Agency, 2018a; Lightbody & Tompkins, 2018). Furthermore, over the last 40 years, property damage caused by flooding has increased approximately 54 times (Brody, Highfield, & Kang, 2011).

Since Hurricane Sandy, historic or near historic wide-spread flood events have occurred in Louisiana, West Virginia, Maryland, Texas, Arkansas, Mississippi, Utah, New Jersey, Missouri, Kansas, Oklahoma, South Carolina, Kentucky, Michigan, New York, Arizona, New York, Florida, New Mexico, and Colorado (Federal Emergency Management Agency, 2018c; U.S. Geological Survey, 2017). More recently Hurricane Matthew in 2016; Hurricanes Harvey, Irma, and Maria in 2017; and four nor'easters in March 2018 have caused significant flood losses. With rising sea level, increased potential for more intense hurricanes, and heavy precipitation events (both coastal and inland), flood losses can be expected to increase over time (Melillo, Richmond, & Yohe,

2014), inflating losses for property owners and governments at all levels and increasing the likelihood that taxpayers will end up footing the bill.

Federal funding for response and recovery comes from the Disaster Relief Fund managed by FEMA and from disaster aid programs of other participating federal agencies. The federal contribution to total loss payments has increased in recent years, from 23 percent for Hurricane Hugo in 1989, to 50 percent for Hurricane Katrina in 2005, 69 percent for Hurricane Ike in 2008, and more than 80 percent in 2012 for Hurricane Sandy (Kunreuther & Michel-Kerjan, 2013). This trajectory of increasing federal disaster aid is not sustainable (Englander, 2013). We argue that increasing the number of properties required to purchase flood insurance is preferable to disaster aid for financing recovery after flood loss and also promotes more sustainable rebuilding.

Low Flood Insurance Participation Rates

This section documents low flood insurance participation rates and presents case studies of the South Carolina flooding of October 2015 and Hurricane Harvey in August 2017, further illustrating low participation rates and the relative amount of flood insurance claims and disaster aid paid and losses borne by affected property owners.

Even with a variety of NFIP efforts since the program began in 1968, participation in NFIP has remained low. The devastating Missouri and Mississippi River floods of 1993 revealed that only about ten percent of flood damaged structures were covered by flood insurance (Kousky & Kunreuther, 2010). The NFIP mandates flood insurance purchase for properties with federally-backed mortgages in SFHAs. For the 1998 floods in Vermont, only about 16 percent of damaged properties had flood insurance even though insurance should have been mandatory for 45 percent of the properties (Michel-Kerjan et al., 2012). The estimated participation rate for single-family

homes in the SFHAs of St. Louis County, Missouri in 2000 was about 15 percent (Kousky & Kunreuther, 2010). An investigation of properties within 1,000 feet of the coast in seven hurricane-prone counties found that 49 percent have flood insurance (Kriesel & Landry, 2004). A national 2006 study by the Rand Corporation estimates that the participation rate is about 50 percent in SFHAs and one percent outside SFHAs, and concludes that 20 to 25 percent of single family homes that are subject to the mandatory purchase requirement do not have flood insurance (Dixon, Clancy, Seabury, & Overton, 2006). In areas flooded by Hurricane Sandy in 2012, less than 20 percent of residential buildings in areas hit by Sandy had flood insurance (Michel-Kerjan et al., 2015). Kousky (2017) uses county-level data for all Gulf and Atlantic coast states and calculates average participation rate of three percent.[5] In Houston, the percent of property covered by flood insurance dropped by nine percent in the five years preceding the historic Hurricane Harvey flooding in August 2017 (Spencer & Hoyer, 2017).

The following discussion presents two case studies—the South Carolina floods of October 2015 and Hurricane Harvey of August 2017—to illustrate the low flood insurance participation rates and the amount of NFIP flood claims and disaster aid paid out. The low participation rate of flood insurance purchase in high risk residential markets indicate that few homeowners are protecting their assets by purchasing flood insurance policies and subsequently need to rely on disaster aid.

Case 1: October 2015 South Carolina Flooding

We focus on low flood insurance participation rates by investigating the case of the South Carolina flooding that happened in early October 2015. Historic rainfall of more than 20 inches

[5] Kousky (2017) calculates the participation or penetration rate as the "number of policies-in-force in a given county divided by the total housing units in that county."

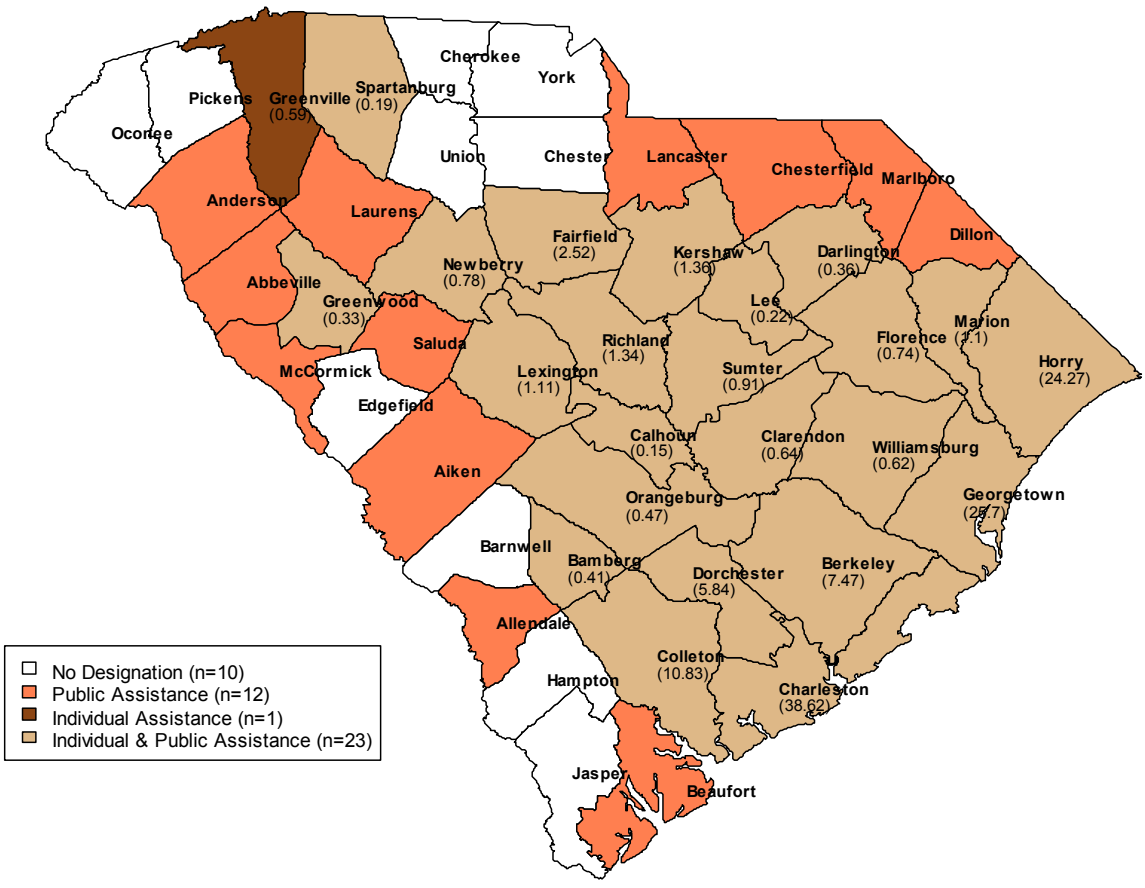
fell over much of the state in a four-day period leading to unprecedented flooding. An estimated 33,000 residences were inundated with at least 12 inches of water according to the South Carolina Disaster Recovery Office (SCDRO, 2016). As a result of that flood, 36 out of 46 South Carolina counties were declared eligible for federal assistance. Of the 36 counties, 23 were eligible for both individual assistance (IA) and public assistance (PA), 12 for PA only, and one for IA only (Federal Emergency Management Agency, 2015b). Individual assistance covers "disaster housing for displaced individuals, grants for needs not covered by insurance, crisis counseling, and disaster-related unemployment assistance" and public assistance provides resources to help "communities absorb the costs of emergency measures such as removing debris and repairing or replacing structures such as public buildings, roads, bridges, and utilities" (Balonon-Rosen, 2017).

As of September 30, 2015, South Carolina had 198,885 NFIP policies in force in the whole state, reflecting only 4.10 percent of housing units in the state with flood insurance coverage. Figure 1 shows NFIP policies as a percent of total housing units in the 24 counties declared eligible for federal IA. The average percentage for these 24 counties was 5.76 percent. Nearly 91 percent of NFIP policies were in the five coastal counties. The 20 non-coastal counties eligible for individual disaster assistance had an average participation rate of only 1.36 percent. In particular, many of the counties that sustained the most damage had very low percentages of NFIP policies relative to housing units.

We focus on the 24 counties that were eligible for IA to compare the amount of housing recovery funding provided by disaster assistance and flood insurance. According to the SCDRO (2016), the total losses are estimated at almost $894 million, of which $721 million are housing-related losses. SCDRO also reported that the Small Business Administration (SBA) provided 3,090 low interest home loans amounting to $76 million with an average loan of about $25,000, and the

NFIP had allocated $132.4 million to 3,864 claimants with average payments of $34,261. After accounting for insurance and various other types of assistance, such as SBA loans but not including IA, the non-covered housing losses amount to $521 million (South Carolina Disaster Recovery Office (SCDRO) of the South Carlina Department of Commerce, 2016). The very low percentages of households with flood insurance in these 24 counties means that most of the flood victims are uninsured for flood losses.

Figure 1. NFIP policies as a percent of total housing units in the 24 counties declared eligible for federal Individual Assistance in the South Carolina floods, October 2015.



Note: Percentages shown reflect the ratio of the number of total flood insurance policies in the county to the total housing units in the county.

Data sources: FEMA 2016 Policy Statistics provides flood insurance policy count by county (http://bsa.nfipstat.fema.gov/reports/1011.htm#SCT)
Factfinder 2014 Selected Housing Characteristics provides housing unit count by county (http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_DP04&src=pt)

As shown in Table 2, just over 101,560 people applied for IA in the 24 eligible counties compared to only 3,864 who received flood insurance claim payments for the whole state. Since most flood insurance policies are purchased for residences in SFHAs, the large number of IA applications relative to flood insurance claims implies that a substantial percentage of the IA claims were for residences outside SFHAs.

Of the non-covered $521 million in housing losses, IA allocated around $96.8 million to 22 of the 24 counties (South Carolina Disaster Recovery Office (SCDRO) of the South Carlina Department of Commerce, 2016). Additionally, the Department of Housing and Urban Development set aside funds for the other two IA counties: $23.5 million for Richland County (plus an additional $20.0 million for the City of Columbia which is in Richland County) and $16.3 million for Lexington County. This totals to about $156 million for the 24 counties that qualified for IA. Factoring in this funding leaves non-covered housing losses at an estimated $365 million to be borne by homeowners and renters, which is about 50 percent of the estimated $721 million of housing-related losses.

Table 2. Number of Individual Assistance (IA) Applicants in the 24 Eligible Counties after the October 2015 Flooding

County in South Carolina	**Number of Applicants for Individual Assistance**
Bamberg	510
Berkeley	5,635
Calhoun	874
Charleston	9,929

Clarendon	3,964
Colleton	1,892
Darlington	2,848
Dorchester	4,081
Fairfield	607
Florence	6,364
Georgetown	4,318
Greenville	330
Greenwood	472
Horry	5,797
Kershaw	1,773
Lee	1,946
Lexington	5,603
Marion	1,031
Newberry	688
Orangeburg	6,391
Richland	20,447
Spartanburg	344
Sumter	9,925
Williamsburg	5,791
Total:	**101,560**

Data source: (South Carolina Disaster Recovery Office (SCDRO) of the South Carlina Department of Commerce, 2016)

Case 2: Hurricane Harvey in August 2017

We also use the case study of Hurricane Harvey, which caused significant flooding in Texas in August 2017. According to National Oceanic and Atmospheric Administration (NOAA), the 7 days of rainfall (ending August 31, 2017) during Hurricane Harvey saw 6.9 million residents experiencing more than 30 inches of rain, 1.25 million experiencing more than 45 inches of rain, and 11,000 residents receiving in excess of 50 inches of rain (NOAA National Centers for Environmental Information, 2018). This historic rainfall generated more than 19 trillion gallons of rainwater, accompanied by 140 mph winds (Federal Emergency Management Agency, 2017b). Hurricane Harvey was the most costly natural disaster of 2017, causing damages of $125 billion

(Mooney & Dennis, 2018) and losses of $85 billion (Tabuchi, 2018). Nearly 80,000 homes were inundated by 18 inches of rainwater, more than 28 percent of which experienced more than 5 feet of rainwater (Federal Emergency Management Agency, 2017b).

According to FEMA data as of January 16, 2018, 41 counties were designated as eligible for IA and 53 counties declared eligible for PA (Federal Emergency Management Agency, 2018d). The volume of applications for disaster assistance was one of the highest in FEMA history (Federal Emergency Management Agency, 2017b). Across the state of Texas, 91,000 flood insurance claims were filed and an estimated $8 billion paid in NFIP advance payments and claims, along with $3 billion in SBA loans (Federal Emergency Management Agency, 2018d).

According to FEMA (2017b), the Houston area (in Harris County) "experienced the largest amount of rainwater ever recorded in the continental United States from a single storm (51.88 inches)." In Harris County alone, FEMA data as of January 12, 2018 (Federal Emergency Management Agency, 2018b) show that the NFIP had paid more than $2.9 billion to 47,035 flood insurance claimants. The SBA provided $1.2 billion in low-interested loans. 117,533 applications for IA were submitted, with $717 million paid for housing and other expenses.

The data on NFIP claims, SBA loans, and individual assistance show only a portion of flood losses from Hurricane Harvey are covered. It also illustrates that while flood insurance claims cover some of the flood losses, there were more IA applications than there were NFIP claims. Like for the South Carolina case, the greater number of IA applications than flood insurance claims illustrates that the majority of residences with potential to flood are not buying insurance. Whether willingly taking this risk or due to lack of knowledge, homeowners would have been in a better position if they were mandated to purchase flood insurance.

In August 2016, Harris County had 240,350 NFIP policies in force, for an overall flood insurance participation rate of 15 percent and a 28 percent participation rate in high risk areas (Insurance Information Institute, 2017). However, statistics show that before Hurricane Harvey there was a significant drop in the number of flood insurance policies, likely the result of increases in the annual premium costs due to Biggert-Waters Flood Insurance Reform Act of 2012 (Condon, Donn, Hoyer, & Sweet, 2017). While Congress later repealed the 2012 flood insurance premium hikes (in 2014), the repeal did not generate a substantive increase in insurance policy purchase. In June 2017, there were nearly 250,000 policies in force in Harris County, compared to 275,000 policies in force at the end of 2012. The number of policies in the City of Houston fell from 133,000 to 119,000, consistent with the trend in Harris County and nationally.

Hurricane Harvey also highlighted an important problem with FIRMs – the maps do not take into account flooding from under-capacity of drainage sewers and ditches, or from water flowing toward a sewer or bayou. More than half of the flooding in Harris County over the years has been due to such problems, according to the Harris County Flood Control Districts (Condon et al., 2017).

A preferred participation rate measure for these cases would use total housing units within the SFHA in the denominator instead of total housing units in the county. We did not have access to the SFHA numbers for these cases. The cases do illustrate that the overall adoption numbers are a cause for concern. The South Carolina case indicates the large number of people who applied for Individual Assistance relative to those who received flood insurance claim payments. The Hurricane Harvey case indicates the worrisome trend that the number of homeowners buying flood insurance is decreasing in recent years, even in flood prone areas.

Attempts to Increase the Flood Insurance Participation Rate

A higher flood insurance participation rate would alleviate important issues described in this Commentary. This section describes attempts made to increase the participation rate, leading us to propose a mandate to expand the flood insurance risk pool in response to the failure of these other methods.

Hurricane Betsy made landfall in Louisiana in 1965 to become the first U.S. storm to cause losses in excess of $1 billion (Knowles & Kunreuther, 2014). Congress passed the Hurricane Disaster Relief Act resulting in an unprecedented amount of federal aid flowing to the victims (Michel-Kerjan, 2010). With private insurers unwilling to offer flood coverage, Congress created the National Flood Insurance Program (NFIP) in 1968 with a main goal of using the insurance mechanism to provide post-loss financing to reduce federal spending on flood disaster aid (Knowles & Kunreuther, 2014). To attain this goal, however, flood insurance participation needs to be substantial.

Over the decades, FEMA has attempted to increase flood insurance participation rates in various ways (American Institutes for Research, The Pacific Institute for Research and Evaluation, and Deloitte and Touche LLP, 2002; Kousky, 2017):

- subsidizing flood insurance premiums
- making flood insurance mandatory for structures in SFHAs with mortgages from federally-backed lending institutions
- providing incentives for private insurance companies and agents to promote flood insurance purchase
- requiring flood insurance as a condition for receiving disaster aid in some cases
- sponsoring media efforts to reduce the confusion of those who think their homeowners'

insurance covers flood loss

Flood insurance premiums were heavily subsidized with the goal of increasing participation for years after the program began. Hurricane Camille in 1969 resulted in substantial flood damage and brought attention to how few people had purchased flood insurance, as only two communities were participating in NFIP at the time (Knowles & Kunreuther, 2014). For the 1972 Hurricane Agnes, less than one percent of insurable damages were covered by flood insurance (Anderson, 1974). In Pennsylvania, the hardest hit state, some of the most flooded areas had no NFIP policies and there were less than 700 policies in force in the entire state (Anderson, 1974).

To increase flood insurance purchases, flood insurance premiums were reduced in 1972 by almost 40 percent, even though they were already below actuarially fair value (American Institutes for Research, The Pacific Institute for Research and Evaluation, and Deloitte and Touche LLP, 2002). However, because insurance should send an appropriate risk-based pricing signal, the goal of the NFIP since 1981 has been to gradually eliminate the subsidization of flood insurance premiums. With subsidization being phased out, the NFIP focused on other methods to increase the participation rate.

Congress passed the Flood Disaster Protection Act in 1973. The act mandated the purchase of flood insurance for all properties with mortgages from federally-regulated lenders in SFHAs (Knowles & Kunreuther, 2014). Even with this mandate, only about 60 percent of these properties have flood insurance (American Institutes for Research, The Pacific Institute for Research and Evaluation, and Deloitte and Touche LLP, 2002). Evidence suggests that even when they are required to have flood insurance, some homeowners let their insurance policies lapse. Data from NFIP show that between 2001 and 2009 the median NFIP policy tenure was between two and four years, compared to the average seven years for residential tenure (Michel-Kerjan et al., 2012).

Mortgage lenders can be fined for failing to require flood insurance purchase, but many do not, either because they believe they are unlikely to be fined or because loans are typically sold off, repackaged, securitized and fall between the cracks (Knowles & Kunreuther, 2014; Spencer & Hoyer, 2017).

The NFIP also provides an incentive to motivate private insurers and their agents to market flood insurance, with the main goal of increasing the participation rate. In 1981, the NFIP started negotiating with the private flood insurance industry about its involvement with flood insurance. This eventually became the Write Your Own (WYO) program after an agreement was reached in 1983 between the NFIP and private insurers who agreed to sell and service flood insurance policies (American Institutes for Research, The Pacific Institute for Research and Evaluation, and Deloitte and Touche LLP, 2002; Fier, Gatzlaff, & Pooser, 2014). The insurance companies receive a commission on the sale of a flood insurance policy (to cover marketing and administrative costs, and operating expenses) but play no risk-bearing role (Fier et al., 2014; King, 2005). However, the participation rate increase was relatively modest in the ten years after the WYO program began.

The low participation rate may also be due to the expected flow of flood disaster aid, which is explained by a type of moral hazard known as "charity hazard" (Browne & Hoyt, 2000; Kousky et al., 2013; Raschky et al., 2013; Raschky & Weck-Hannemann, 2007). Homeowners may rationally decide not to insure against natural disaster, such as flood, because they expect "free" help will come, particularly in the form of disaster aid. Over the last few decades, large-scale natural disasters followed by massive flows of federal disaster aid to damaged regions have promulgated this expectation. Recognizing that the demand for flood insurance can be crowded out by expected aid, the NFIP has made attempts to link the receiving of disaster aid to the purchase of flood insurance. However, various studies find that enforcement and compliance is low

(American Institutes for Research, The Pacific Institute for Research and Evaluation, and Deloitte and Touche LLP, 2002). The political consequences of denying aid for certain individuals in a region devastated by a natural disaster are likely to trump efficient enforcement (Healy & Malhotra, 2009).

In addition, the U.S. participation rate for flood insurance is low because insurance coverage is fragmented and confusing. Homeowners' insurance, which does not include flood coverage, is only available from private insurers and flood coverage is generally only available from the NFIP.[6] After every major flood disaster, the media documents cases of property owners who assumed that their homeowners' insurance covered flood damage or that they cannot purchase flood insurance unless their property is in a high flood risk zone (Feinman, 2013; Stempel, 2013). Extensive public education campaigns do not appear to have alleviated this confusion to any significant extent.

Even after decades attempts to increase the flood insurance participation rate, the number of in-force policies decreased by 11.2 percent between January 1, 2009 and January 31, 2018 (Federal Emergency Management Agency, 2018e). Since incentives do not appear to be effective in encouraging NFIP participation, we propose expanding the flood insurance purchase requirement beyond the 100-year floodplain (with a one percent likelihood of annual flooding) to the 500-year floodplain, which encompasses properties with a 0.2 percent likelihood of flooding annually. This requirement would apply to all properties within the 500-year floodplain, not just those with a federally-backed mortgage.

This proposal would be consistent with the changes introduced in 2015 in Executive Order

[6] In a few states, private insurers also offer flood insurance separate from the NFIP, either in addition to the NFIP or in place of it.

(EO) 13690: Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input.[7] EO 13690 established a Federal Flood Risk Management Standard (FFRMS) that adopted a higher flood standard for future federal investments affecting floodplains to allow for impacts of climate change. Flood elevations and hazard areas under the FFRMS were required to be increased either to two or three feet in elevation above the 100-year flood elevation or to the 500-year flood elevation. Although EO 13690 did not require FEMA to incorporate the expanded floodplain delineation or elevated flood heights into FIRMs, we argue that the South Carolina flooding and Hurricane Harvey case studies discussed previously suggest that expanding the NFIP mandate to correspond with the FFRMS would reduce federal disaster aid by requiring more properties to have flood insurance.

We recognize that expanding the flood insurance purchase mandate would face intense opposition from those who perceive they have little or no flood risk. However, between 2010 and 2015, all fifty states experienced floods, and over 25 percent of NFIP claims and one-third of disaster assistance funds were for properties outside mapped high-risk flood areas. Over 85 percent of all Presidential Disaster Declarations (PDD) are for floods and 86 percent of all U.S. counties experienced at least one PDD flood between 1990 and 2007 (Gallagher, 2014). From 2008 until 2017, about 73 percent of FEMA disaster declarations were flood related. From 2008 to 2017, eight of the ten states that suffered the most flood-related disaster declarations were landlocked states. In addition, a substantial amount of flood losses occur outside SFHAs. Looking at Hurricane Harvey in August 2017, an estimated 60 percent of flood insurance claims in Houston and Harris

[7] EO 13690 was revoked by President Donald Trump on August 15, 2017 by Executive Order 13807: Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure.

County were for properties outside SFHAs (Federal Emergency Management Agency, 2018a; Lightbody & Tompkins, 2018; Staletovich, 2018).

Benefits of an Increased Participation Rate

This Commentary proposes to expand the NFIP flood insurance requirement beyond properties with federally-backed mortgages in the 100-year floodplain to include all property in the 500-year floodplain. This expansion will result in beneficial effects such as alleviating the NFIP debt problem and reducing federal disaster aid payments and out-of-pocket losses by flood victims. We also expect that expanded flood insurance requirements will generate pressure for localities to participate in the Community Rating System (CRS) and make infrastructure improvements and management decisions that increase flood resilience. While our proposed expansion of the flood insurance purchase requirements is unlikely to correct the problem of inaccurate or outdated FIRMs, it may impact development within the floodplain by making more explicit the costs and risks of building and living in high risk areas.

NFIP Debt, Federal Disaster Aid, and Out-of-pocket Losses by Flood Victims

The NFIP was created to provide flood insurance in the U.S., which was not being offered by the private market, with the understanding that communities would take proactive steps to guard against future flood damage. The only property owners required to have flood insurance are in SFHAs A national study by RAND found that only about one percent of homeowners outside SFHAs purchase flood insurance (Dixon et al., 2006). The result is a risk pool with an unsustainable proportion of high flood risk policies. This is analogous to a health insurance risk pool with only older, less healthy policyholders. Insurance companies have always faced the

adverse selection problem: individuals and entities with higher risk exposures tend to purchase more insurance coverage. The goal of insurance underwriting is to overcome the adverse selection problem by screening potential policyholders and creating a risk pool not dominated by higher risk exposures. By design, the NFIP pool will be unbalanced because the only properties required to purchase NFIP policies are in high risk areas. In effect, the current NFIP structure mandates adverse selection.

Increasing the number and risk diversity of properties covered by the NFIP through an expansion of the flood purchase requirement would create a more sustainable risk pool that limits further NFIP debt and reduces both the amount of federal disaster aid paid and non-covered losses borne by flood victims. Homeowners facing flood losses with no flood insurance are left in dire straits. Even with the federal government paying out in disaster aid, entire communities can take lengthy periods to recover. Another benefit of flood victims having coverage is Increased Cost of Compliance,[8] which can pay for mitigation for the property that will reduce the severity of losses in future flood events. With flood insurance required for more properties, more homeowners would be incentivized by lower flood insurance premiums to pursue property improvements, such as installation of flood vents, that reduce vulnerability and the severity of future flood losses.

Community Rating System (CRS)

Another benefit of making the flood insurance purchase mandatory for all properties in the 500-year floodplain is that it will incentivize more localities to participate in the CRS and for those

[8] Properties covered by an NFIP policy that are damaged by flood may be required to reduce future flood damage before repairing or rebuilding. Policyholders can get up to $30,000 in Increased Cost of Compliance coverage to help pay costs to bring the property into compliance with their community's floodplain ordinance.

already participating to improve their CRS Class rating. If more property owners are required to purchase insurance, then more residents will pressure their local governments to improve the CRS rating to reduce flood insurance premiums for the entire community. CRS ratings improvements generally require investment by the city, and is a cost borne by the city that benefits property owners in the form of lower flood insurance premiums, but does not directly benefit the city itself. As such, pressure to improve CRS ratings needs to come from those who will benefit, since city government mainly sees it as an expense (100 Resilient Cities, 2017).

Flood Insurance Rate Maps (FIRMs)

A major problem facing the NFIP is inaccurate FIRMs which are used to price flood insurance. FIRMs are based on historical flood data and have become outdated in many communities, as NFIP flood risk mapping has had a "history of haphazard technical updates" (Knowles & Kunreuther, 2014, p. 344). As a result, FIRMs do not accurately represent current or future flood risks (100 Resilient Cities, 2017; Hayat & Moore, 2015; Revkin, 2017). The Biggert-Waters Act directed FEMA to improve mapping of flood risks, and by 2015 FEMA indicated that 94 percent of the country's population lived in an area with an updated FIRMs, compared to 68 percent in 2008 (Government Accountability Office, 2016).[9] However, "not all updated maps include modern, laser-generated data, which dramatically improve the quality of elevation and

[9] Note that the impact of improved FIRMS on true flood risk is unknown, and this may be an important area for future research. However, the expanded purchase requirement proposed in this Commentary does not address the inaccuracies of maps used to price flood insurance (and in turn used by local governments to make long-term planning decisions), but rather may impact floodplain development by making more explicit the costs and risks of building and living in high risk areas.

topographic information that is crucial to estimating flood risk" (Congressional Budget Office, 2017, p. 27).

Furthermore, a 2017 report by the Department of Homeland Security (DHS) estimates that almost 60 percent of FIRMs inaccurately identify the level of flood risk (Department of Homeland Security Office of Inspector General, 2017). Based on current FIRMs, about 13 million Americans live in the 100-year floodplain. Applying new technology to investigate flood risk, Wing et al. (2018) estimate that the actual number is 41 million, more than three times higher. In effect, FIRMs are not sending accurate risk signals to millions of property owners who actually have significant flood risk. Requiring flood insurance to be purchased for more properties will not improve the accuracy of FIRMs, but will benefit owners who suffer flood loss and would not have had flood insurance without the requirement. In addition, owners of a properties required to purchase flood insurance will invest more in modifications that lower the flood risk for a specific property to receive premium discounts for that specific property and push their local government to make efforts to increase the CRS score, which reduces flood risk and premiums for the community.

At the local government level, expanded NFIP requirements would also better manage development within the floodplain by making more explicit the costs and risks of building and living in high risk areas. FIRMs have been used beyond their stated purpose of pricing flood insurance, being used instead for making decisions with much longer-term consequences, such as infrastructure investment and land-use decisions (100 Resilient Cities, 2017). When FIRMs are outdated and inaccurate, decision makers (local government, developers, residents) have inadequate information about their current and future exposure to risks, and as a result may make under-informed decisions about where to allow development, where and how to build, or where to buy property (Hayat & Moore, 2015). "[D]evelopers and individuals are using imperfect

information to make choices about where to buy and develop. Many homeowners are not adequately informed about the risk of flooding when making decisions about purchasing a home or whether to carry flood insurance after their mortgages are paid off" (100 Resilient Cities, 2017, p. 8). Furthermore, when such information remains skewed in favor of development in the floodplain, the result has ripple effects in terms of where roads, cables and wires, pipelines and other infrastructure need to be built (Revkin, 2017).

Getting to Policy Change

Increasing the NFIP mandate would involve substantial policy change, which will likely require a tipping point, or a confluence of actors, options, and events that raise the saliency of the NFIP issue beyond 'business as usual.' Such a tipping point can be driven by a focusing event, for example, a large-scale disaster, that amplifies attention to a problem. If we think about the policy situation using Kingdon's (1995) multiple streams framework, the focusing event then needs to be coupled with a policy window, which in turn requires an agreed-upon problem, identifiable solution, and political climate that encourages action.

Flooding and its associated social and economic impacts can serve as focusing events, but there is little evidence that recent floods have opened a policy window. The South Carolina flooding and Hurricane Harvey have focused attention on the consequences of flooding, but this visibility has not been associated with policy entrepreneurs, actors with the knowledge, connections, political power, tenacity and even luck to be able to exploit windows of opportunity for policy change and heightened levels of attention to specific problems to promote their policy solutions (Mintrom & Norman, 2009; Mintrom & Vergari, 1996), who can connect the problem with solutions and political capital. Creating and taking advantage of the policy window can be

problematic because disaster relief, and not flood insurance, is the consistent issue raised after a flooding event. The policy domain contains a loose community of actors who are involved only episodically and are dominated by local and state interests and preferences for disaster relief writ large, regardless of source (e.g., NFIP or disaster aid). The lack of an organized and coherent advocacy coalition[10] means there are few voices to push for alternative pre-disaster solutions such as increased reliance on flood insurance, and not simply the delivery of aid post-disaster.

Better management of flood losses requires a shift in post-disaster policy mobilization away from disaster relief toward proactive flood loss mitigation, including improved insurance programs and investment in protective infrastructure. This can be addressed by coalescing a stronger advocacy coalition, which can include technical experts, floodplain managers, planning organizations, emergency management professionals, and others. The coalition may draw policymakers at all levels (local, state, federal) by capitalizing on existing concerns regarding the ballooning cost of disaster aid and the size of the NFIP debt, in addition to playing to the concerns or sympathies of policymakers who have had 'bad experiences' with federal flood disaster aid. What is lacking, however, is a policy entrepreneur with the political capital to pull a coalition together. One possibility may be a leading legislator from a recently flood ravaged state who steps up and leads the charge, given the currency of the issue being experienced with the recent, wide-spread flooding. Floodplain managers, as a group of professionals and technical experts, could also become policy entrepreneurs.

[10] An advocacy coalition is a group of actors that interact with an element of constancy in a specific policy domain, e.g. hurricanes or flood disasters. Members of the coalition often share the same belief system and the common goal of changing policy or government action and/or bringing about policy reform (Sabatier, 1988; Sabatier & Pelkey, 1987).

Our proposal to increase flood insurance participation rate offers a possible policy solution to address the problem of flood loss. Having strong policy solutions in advance of the focusing event can help couple the tipping point and policy window, but solutions will need to be technically and politically feasible. Academics and practitioners can work in tandem to address the technical feasibility issue. Political feasibility may hinge on support from an advocacy coalition.

Previous experience with Biggert-Waters Flood Insurance Reform Act of 2012 and Homeowner Flood Insurance Affordability Act of 2014 has shown that even a fiercely partisan Congress can act quickly in response to pressure from constituents. The recent historic and near historic floods in many states, including Hurricanes Sandy, Irma and Harvey may create wider concern about who bears the cost of flooding, but not sufficiently to generate the groundswell needed for major policy change to the NFIP. Building a coherent, organized advocacy coalition and testing the technical and political feasibility of different policy solutions will take time. The next major flood event may serve as a focusing event—but a policy window can also be opened by changes in political climate and context.

The NFIP was last reauthorized in 2012 when President Obama signed the Biggert-Waters Flood Insurance Reform Act of 2012 (P.L. 112-141) into law. The NFIP was set to expire on September 30, 2017 but Congress has since seen a series of short-term extensions (December 8, 2017; December 22, 2017; January 19, 2018; February 9, 2018; March 23, 2018; and July 31, 2018) to the program as it continues to consider potential changes as part of the reauthorization process. As of the time of this article's writing, the NFIP's authorization was extended to November 30, 2018. The uncertainty over NFIP reauthorization in the current political climate may also offer an opportunity to couple a flood insurance policy solution with the problems of

significant flood losses and the need for proactive investment in flood mitigation, which may open a policy window.

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