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Understanding the motivations of coastal residents to voluntarily purchase federal flood insurance

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Federally-backed flood insurance is the primary mechanism by which residents in the United States (US) prepare for and recover from floods. While there is a growing literature on the general uptake of flood insurance, little work has been done to address the factors motivating residents to voluntarily buy and maintain federally-based insurance policies. We address this issue by conducting a survey of coastal residents in four localities in Texas and Florida. Based on survey responses, we quantitatively examine the factors influencing whether residents located outside of the 100-year floodplain obtain insurance policies when it is not required. Using two-sample *t*-tests and binary logistic regression analysis to control for multiple contextual and psychological variables, we statistically isolate the factors contributing most to the decision to purchase insurance. Our findings indicate that a resident located outside the 100-year floodplain who has voluntarily purchased federal flood insurance can be characterized, on average, as more highly educated, living in relatively expensive homes, and a long-time resident who thinks about flood hazard relatively infrequently but who, nonetheless, thinks flood insurance is relatively affordable. Unexpectedly, the physical proximity of a respondent to flood hazard areas makes little or no discernible difference in the decision to obtain flood insurance.

Keywords: insurance; floodplain; purchase decision; Texas; Florida

Federally-backed flood insurance remains the primary mechanism by which residents in the United States (US) recover from flood impacts. Current federal mandates require property owners to purchase flood insurance if they are located within special flood hazards areas (i.e. 100-year floodplain) and have federally-backed mortgages. This and other requirements of the National Flood Insurance Program (NFIP) have resulted in a significant increase in the number of policies over the past several decades. By 2010, for example, there were over 5.6 million policies in force in the US, the majority of which were located in Texas and Florida (FEMA 2010). Although federal requirements have boosted the number of insured policies across the nation, particularly in coastal areas, voluntary purchases are also on the rise

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(based on spatial analysis of NFIP policies from 1999 to 2009). Rapid development in flood-prone areas, an increasing number of floods, and a heightened sense of flood vulnerability have spurred residents to purchase flood insurance even if they are located outside the regulatory floodplain (SFHA) or own their home outright and, thus, are not required to purchase insurance. Nonetheless, of the $33.5 billion in federally-insured losses nationwide from 1999 to 2009, approximately a quarter of these flood claims were located outside the 100-year floodplain. In some communities along the Gulf of Mexico coast, where the majority of policies are in place, the number of losses outside the floodplain exceeded 50%.

A fair amount of research has been done to better understand the factors contributing to the decision to purchase hazard insurance (Baumann and Sims 1978; Kunreuther 1996). This work has focused primarily on understanding the actual and perceived barriers that dissuade residents from purchasing and maintaining coverage for properties that are required to have flood insurance. However, little empirical work has been done to address the factors motivating residents to voluntarily purchase and maintain FEMA-based insurance policies. In response, we turn previous research questions on the barriers to insurance uptake on their head and ask: *why would someone purchase insurance for a residential structure located outside of the 100-year floodplain?* In 2009, for example, over 60% of policies purchased in Texas and 22% in Florida were located outside the FEMA-defined 100-year floodplain (SHFA) in areas where insurance coverage is voluntary.

Based on survey responses from a representative sample of coastal residents in four localities in Texas and Florida, we quantitatively examine the factors influencing whether residents located outside of the floodplain purchase policies through the NFIP. Two-sample *t*-tests comparing residents with and without flood insurance outside the 100-year floodplain allow us to begin to identify the characteristic profile of those voluntarily purchasing outside the commonly used risk zone. Using binary logistic regression analysis, we control for multiple geographic, socioeconomic, psychological, and institutional variables to identify the factors contributing most to the decision to purchase insurance in the X-zone (areas outside of the 1-percent annual chance (or 100 year) of flooding). Our findings provide some new insights into why homeowners voluntarily purchase insurance policies when they are located outside of regulatory risk zones.

The following section briefly describes the NFIP and then reviews the literature on factors influencing flood insurance purchase. Next, we describe the research methods for the study, including the survey sample, specific variables, and data analysis. We then report the results of two-sample *t*-tests and logistic regression analyses, and discuss their implications for both flood insurance research and policy-making. Finally, we conclude with a summary of the findings and suggestions for future research.

The National Flood Insurance Program

Established in 1968, the NFIP has become the primary vehicle for providing flood insurance to residents and businesses. Before this time, the only way for the federal government to assist flood victims was through post-disaster loans and grants. However, the increased burden on the federal treasury caused policy-makers to embrace the concept of insurance policies against flood losses as an alternative to federal aid (Pasterick 1998). The prevailing logic was that a government-based program could

successfully offer insurance to homeowners where the private industry could not because it could pool risks more broadly, spread losses over time, potentially borrow money from the federal government if there was a deficit for a given year, and most importantly, subsidize the true costs of the policies (Michel-Kerjan and Kousky 2010).

Currently, FEMA writes or underwrites flood insurance for participating NFIP communities in the US. Individuals can purchase flood insurance directly through authorized FEMA representatives or through a traditional private insurer in what is known as the 'Write Your Own' program. Residents in non-participating NFIP communities do not have the opportunity to purchase insurance through the NFIP. Several characteristics distinguish the NFIP from the private insurance industry. First, flood insurance purchasers are held to a 30-day waiting period before the flood insurance coverage goes into effect. This policy effectively eliminates the possibility that a party can purchase flood insurance when there is an imminent risk of flooding. Second, the residential coverage amount is capped at $250,000 for buildings and $100,000 for contents. Finally, there is a requirement to purchase flood insurance for structures located within the 100-year floodplain that have federally-secured mortgages. As a result of homeowners' habitual noncompliance, this requirement has been more forcefully implemented through lenders and loan servicers, requiring them to document whether a structure is in the 100-year floodplain and ensure that the mortgager maintains flood insurance throughout the life of the loan.

Since community and individual participation in the NFIP were completely voluntary until 1974, the rates of purchase before that time were quite low. However, the Flood Disaster Protection Act in 1973 strengthened the NFIP so that participation of communities in the NFIP became a condition for certain types of federal assistance. The passage of this Act sparked greater involvement in the NFIP. For example, until 1973, about 2200 communities had joined the program voluntarily; by 1977, participation had swelled to approximately 15,000 communities (FEMA 2002). Despite changes to the program, the uptake of flood insurance remained low in many flood-prone areas (Kriesel and Landry 2004; Tobin and Calfee 2005). In response, FEMA further tightened restrictions after the Midwest floods of 1993, and launched programs to raise awareness beginning in the mid-1990s. The number of insurance policies increased, particularly in response to major storm events; at the end of 2013, the NFIP had over 24,700 participating communities and approximately 5.48 million flood insurance policies in force (slightly down from 2010) covering over $1.28 trillion in assets (FEMA 2014).

One important component of the NFIP is the Community Rating System (CRS), which was established in 1990 as a way to encourage communities to exceed the NFIP's minimum standards for floodplain management. Communities participating in the CRS receive federal flood insurance premium discounts (except for preferred risk policies) in exchange for adopting various flood mitigation measures. The non-structural orientation of the CRS program categorizes planning and management activities into four series containing 18 mitigation activities. Credit points are aggregated into classes, where communities awarded a higher CRS class have implemented a larger number and scope of flood mitigation measures. Insurance premium discounts range from 5% in Class 9 to 45% in Class 1 (FEMA 2007).

The NFIP has resulted in a number of significant achievements in floodplain management, including more widespread public awareness of flood hazards and reduced development in many floodplains (Holway and Burby 1990; U.S. Interagency Floodplain Management Review Committee 1994). However, increasing risk

exposure or 'moral hazard' coupled with adverse selection, pricing failure to cover tail events, and repetitive losses have led to payouts from the NFIP that consistently exceed its income. However, a combination of payouts from large disasters and the lack of actuarially-sound rates have forced FEMA to regularly borrow money from the federal treasury to cover its deficit. By August 2013, the NFIP's debt had reached approximately $24 billion (Kousky and Kunreuther 2013). These fiscal troubles led to the passage of the Flood Insurance Reform Act in 2012, which raised premiums based on actuarial risk in an effort to help the program become more financially sound. Additional work is also being done to better understand the factors contributing to the decision to purchase flood insurance in hopes that this information can be used to reduce adverse selection by increasing the diversity of flood risk levels in the insurance pool.

Factors contributing to flood insurance purchase

A large amount of research has been conducted on the predictors of households' adoption of hazard adjustments, including the purchase of insurance under the NFIP (Grothmann and Reusswig 2006; Lindell 2013; Lindell et al. 1997). Early work on insurance preferences showed that individuals choose to protect themselves against high-probability low-loss events over low-probability high-loss events, which ran counter to the expected utility model often assumed by economists (Kunreuther et al. 1978; Schoemaker and Kunreuther 1979; Slovic et al. 1977). Researchers found that individuals do not make purely rational decisions, but are instead influenced by multiple physical, biological, and social systems (White 1972). People typically follow a heuristic processing model when making such decisions during which they often act based on superficial processing of information rather than engaging in the deliberate processing assumed by conventional economic assumptions about rational decision-making (Attanasi and Karlinger 1979; Kunreuther 1984; Lindell 2014).

These studies expanded the scope of economic research on hazard insurance purchasing decisions by considering a host of geographic, socio-demographic, psychological, and institutional variables contributing to household flood hazard adjustment. Although nearly every study of flood insurance purchase examines households *within* the floodplain or in designated flood-prone areas, these studies only provide a starting point for understanding motivations for purchases *outside* the floodplain, which in some cases can be upwards of 45% of all policies in effect (Highfield, Norman, and Brody 2013).

One of the most-studied factors influencing hazard adjustment in general, and flood insurance purchase in particular, is the perceived risk of personal consequences from being inundated. Residents who believe they are more likely to be flooded will be the first to protect their valuables (Kunreuther 1996). For example, Preston, Taylor, and Hodge (1983) reported a significant correlation between flood risk perception and home modifications. More recently, Blanchard-Boehm, Berry, and Showalter (2001) found that expected personal damage was positively correlated with flood insurance purchase, as did Browne and Hoyt (2000). Also, in a study of 66 households hit by a flood in 1997, Zaleskiewicz, Piskorz, and Borkowska (2002) showed that insurance purchase was related to a few basic psychological factors associated with risk perception. Kunreuther, Pauly, and McMorrow (2013) asserted that people were more likely to purchase flood insurance if they understood the

flood risk prior to moving into the community, if they knew someone who purchased a policy, and if they had discussed insurance with friends and family. In fact, in a survey of 2000 individuals in 43 different flood-prone areas, approximately 70% of flood insured individuals knew someone who had flood insurance. Most recently, Lindell and Hwang (2008) reported significant correlations between homeowners' expectations of property damage and their flood insurance purchases.

Previous experience with flooding is another major factor influencing flood insurance purchase and household adjustment in general. For the most part, the more recent, frequent, and severe the hazard impacts have been, the more likely a household is to take protective action (Hsee and Kunreuther 2000; Hung 2009). For example, Baumann and Sims (1978) and Laska (1990) all found significant correlations between flood experience and flood insurance purchase. Blanchard-Boehm, Berry, and Showalter (2001) also reported increased insurance purchases after a flood, with the percentage of insurance-bearing households increasing from 52% at the time of the flood to 62% at the time of their survey 6 months later. Similarly, Browne and Hoyt (2000) found that flood insurance purchases were highly correlated with the level of flood losses the previous year. Zahran et al. (2009) confirmed this previous research in their study of NFIP flood insurance purchase in Florida, where both previous flood frequency and flood damage predicted the number of policies across the state from 1999 to 2005. The longer the interval between experienced storms, the less likely previous experience will influence purchase behavior (Kriesel and Landry 2004). Lindell and Hwang (2008) found that, as they predicted, flood experience had an indirect effect on flood insurance purchase that was partially mediated by risk perception.

Another relevant predictor of household flood insurance purchase is hazard proximity. Although hazard proximity is a potentially important explanatory variable, it is frequently ignored by many researchers because it has been difficult to measure (Lindell 2013). The increasing availability of geographical information systems (GISs) and spatial data has reduced this impediment. An early study by Waterstone (1978) took a spatial approach by measuring households' horizontal distances from streams and the 100-year floodplain. The results indicated an inverse relationship of distance from the nearest stream and floodplain with insurance adoption. Montz (1982) examined hazard proximity in a study of residents in Broome County, NY. She confirmed a decreasing rate of insurance purchase with increasing distance from the 100-year floodplain, but in contrast found higher levels of insurance adoption farther away from the nearest stream. Lindell and Hwang (2008) controlled for multiple demographic and household characteristics in their assessment of geographical effects, finding that proximity to inland flood and coastal hurricane hazards was significantly related to flood insurance purchase independent of other variables. Landry and Jahan-Parvar (2011) also found increasing insurance purchase corresponded with geographic flood risk. Somewhat unexpectedly, Kousky (2010) found that insurance uptake increased outside of the 100-year floodplain and these homeowners consistently selected more comprehensive coverage. None of these studies, however, have focused exclusively on explaining insurance adoption outside of designated risk zones, such as the 100-year floodplain.

Hazard intrusiveness – the frequency of thought, information receipt, and discussion about a hazard and adjustments to that hazard – is an important component of the protective action decision model (Lindell and Perry 2004, 2012) that has been shown to be significantly correlated with hazard adjustment in the few studies where it has been measured (Ge, Peacock, and Lindell 2011; Lindell and Prater 2000;

Lindell and Whitney 2000). This variable is related to, but distinct from, risk perception, which typically assesses people's perceptions of the likelihood of an event or the likelihood that such an event will inflict severe personal impacts on them within a specified time period. Hazard intrusiveness has the potential for adding to our understanding of protective behavior by indicating that the frequency of people's thought and discussion about a hazard might be as important as their perceptions of the certainty, severity, and immediacy of personal consequences.

Other studies have shown that perceptions of the attributes of hazard adjustments such as flood insurance are important predictors of adoption at the household level, especially: (a) perceived effectiveness in protecting persons, (b) effectiveness in protecting property, and (c) utility for other purposes (Lindell, Arlikatti, and Prater 2009; Lindell and Prater 2002; Terpstra and Lindell 2013). These studies found that hazard insurance was rated low on all three of these attributes as well as being rated high in cost and relatively low in adoption intentions. These results are supported by other research reporting that the perceived high price of flood insurance has been noted as a purchasing barrier in several studies (Browne and Hoyt 2000; Kriesel and Landry 2004; Michel-Kerjan and Kousky 2010).

Finally, demographic characteristics have also been used to predict household hazard adjustments, although the direction and significance of the findings are mixed (Lindell 2013). Factors such as gender, age, education, income, ethnicity, marital status, homeownership, and community tenure may all factor into a resident's decision to take protective actions such as insurance purchase. Wealth, or ability to pay, can be an especially important motivating factor. For example, Austin and Fischhoff (2010) found that the decision to purchase collision insurance was driven by budget constraints more than risk aversion. Similarly, Sherden (1984) found that automobile insurance demand increased with income. Lee (2007) noted that demand for insurance purchase depends on income. Beenstock, Dickinson, and Khajuria (1988) also found that more property–liability insurance is purchased as national income increases. Hung (2009), on the other hand, found that demand for flood insurance purchase was both income and price inelastic. Other variables used in the literature to explain flood hazard adjustments include: personal efficacy (Laska 1990), community context (Bollens, Kaiser, and Burby 1988), and existing flood mitigation programs (Bollens, Kaiser, and Burby 1988; Zahran et al. 2009).

Research methods

Sample selection

We selected four communities for analysis – two communities on the Texas Gulf coast (Friendswood and League City) and two on the Florida Gulf coast (Sarasota and Fort Meyers) – see Figure 1. These jurisdictions were selected based on their class rating within the FEMA CRS, which serves as an indicator of the degree of hazard adjustments and flood mitigation. Each state contains one community with a comparatively high CRS score (Friendswood and Sarasota, class 5) and another community with a comparatively low CRS score at the time of the survey (League City and Fort Meyers, class 7). These jurisdictions have roughly equivalent population sizes between 20,000 and 100,000 and share similar hydrology, elevation/slope, and flood risk profiles associated with being located on the Gulf coast.

We then selected a stratified random sample of 500 parcels from the property tax assessor files within each community using the following flood zones: (1) within the

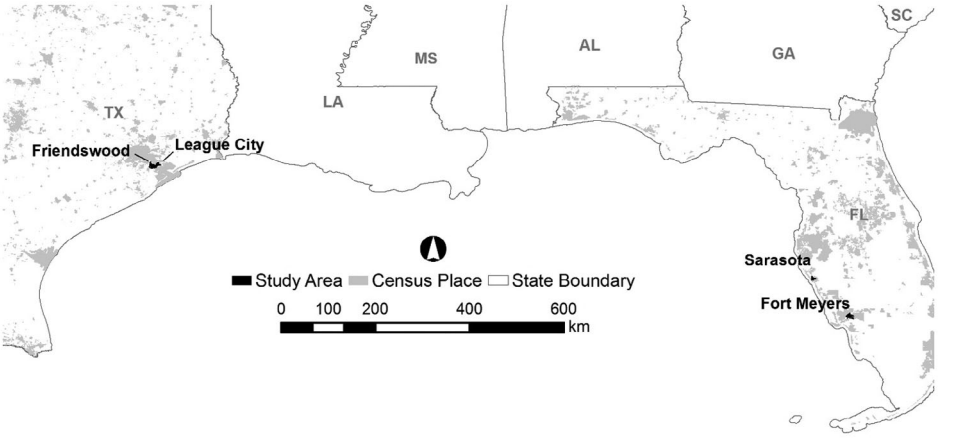

Figure 1. Study area.

100-year floodplain, (2) within the 500-year floodplain, and (3) within the X-zone, which generated a total sample of 2000 households. The administration of the survey followed the procedures specified by Dillman (1999). In total, three complete waves of surveys were mailed to households in the sample, plus a reminder post card after the first wave. The response rate was approximately 18% overall: 12.0% for Sarasota, 15.6% for Fort Meyers, 24.4% for Friendswood, and 17.5% for League City. The overall sample thus consisted of respondents from 351 households. Among these respondents, we selected 99 for this analysis because they reported living outside of the 100-year floodplain. We also calculated respondents' floodplain location based on FEMA-derived boundaries, but used survey responses in the analyses below because our goal is to predict personal motivations to purchase flood insurance.

Concept measurement

The dependent variable for the study was a dichotomous measure of whether each respondent reported that they presently have NFIP flood insurance. The independent variables comprised four categories: geographical, socioeconomic, psychological, and institutional variables (see Table 1). For the geographical variables, we measured distance to the coast, distance to the nearest stream, and distance from the 100-year floodplain for each respondent within a GIS. Each variable was measured as the straight-line distance from the centroid of the household's parcel to each of the three geographical features – coast, stream, and floodplain boundary. Floodplains were measured using FEMA-digitized mapping products, which were the most detailed available data covering the entire study area. Coastline and stream segment features were calculated using the National Hydrography Data-set (NHD) assembled by the United States Geological Survey.

We measured three socioeconomic variables, the first of which was the assessed property value (log transformed) for each respondent's address (property tax parcel). Monetary amounts commonly have skewed distributions that should be log transformed to approximate normality. Second, respondents reported their education level

Table 1. Sample descriptive statistics.

Variable	*N*	*M*	SD	Range	Source
High CRS	99	0.55	0.49	0–1	FEMA
Coast distance	99	9836.31	5399.30	0–19154.66	NHD
Floodplain distance	99	1233.90	2123.88	0–8532.40	FEMA
Stream distance	99	388.72	290.12	0–1171.38	NHD
Log (house value)	99	13.38	1.50	10.36–15.77	Appraisal district
Education	99	3.95	0.93	2–5	Survey
Housing tenure	99	12.13	11.31	1–58	Survey
Flood experience	99	0.27	.44	0–1	Survey
Risk perception	99	2.06	0.78	1–4	Survey
Hazard intrusiveness	98	5.35	1.79	4–12	Survey
Insurance efficacy	97	3.44	1.30	1–5	Survey
Insurance costs	97	2.83	1.04	1–5	Survey
Insurance purchase	98	0.62	0.48	0–1	Survey

on a scale from 1 to 5 (1 = *less than high school*, 2 = *high school*, 3 = *some college*, 4 = *college graduate*, and 5 = *graduate school*). Finally, respondents reported housing tenure as the number of years the respondents they had lived in their present homes.

Several psychological variables measured perceptions of flood risk and flood insurance. First, respondents reported how likely they thought a flood would cause major damage to their homes in the next ten years (1 = *not at all* and 5 = *to a very great extent*). We measured flood hazard intrusiveness by combining four separate items (on the same 1–5 extent scale described above; Cronbach's $\alpha = 0.78$) and assessing the frequency and extent to which respondents thought about flood hazard during their everyday activities (think about floods frequently, have vivid thoughts about floods, thoughts about floods last for a long time, many other thoughts remind you of floods). We measured perceptions of flood insurance using two items that were also rated on the 1–5 extent scale. The first item assessed the extent to which respondents thought purchasing flood insurance would protect property effectively; the second item assessed the extent to which respondents thought purchasing flood insurance would cost a lot of money or is perceived to be affordable.

The model also included a dichotomous variable measuring previous experience with flood impacts in which respondents were asked whether their family's property had been damaged in a flood during the past five years. Last, we used a dichotomous variable distinguishing high and low FEMA CRS Classes to indicate the strength of mitigation measures in each jurisdiction. Friendswood, TX and Sarasota, FL are both Class 5 jurisdictions and are considered to have relatively high levels of mitigation. In contrast, League City, TX and Fort Meyers, FL are assigned to Class 7, which is lower on the mitigation spectrum.

Data analysis

We analyzed the data in two phases. First, we used *t*-tests to assess the differences for respondents outside the floodplain that had purchased insurance and those that did not across all independent variables described above. Second, we used binary logistic regression models to predict the odds of a respondent outside of the 100-year floodplain purchasing flood insurance. Independent variables in the four

categories of variables were added sequentially as blocks to the model. Variables that were statistically significant at the .05 level were carried forward to a final, fully specified model. This data-driven approach allowed us to reduce the number of predictor variables analyzed relative to the sample size of 99 respondents. Because we randomly sampled residents within only a subset of primary sampling units (i.e. cities), we assumed statistical errors were correlated within each of the four selected cities, leading us to analyze the logistic models using clustered standard errors as is typical with this type of study design (Kish 1965). Also, based on statistical tests for multicollinearity, we eliminated the education variable from regression analyses (this variable was too highly correlated with assessed home value). It is important to note that there are several limitations in using survey research to measure how individuals make decisions that could affect the statistical results. Response rate, response bias, framing of the questions, etc. can all impact the reliability of the data.

Results

Independent two-sample tests of means indicate that residents with federal flood insurance outside the floodplain are quantitatively different than those choosing not to purchase on a number of dimensions (Table 2). Among proximity variables, respondents with insurance are located significantly closer to the FEMA-defined 100-year floodplain boundary ($p < .01$) with a mean difference of over 1382 m, which is approximately 52% closer than non-purchasers.

Socioeconomic characteristics showed even stronger statistical differences between the two groups. For example, survey respondents who had voluntarily purchased flood insurance are, on average, significantly more likely to own more expensive homes ($p < .000$) and have higher levels of education ($p < .05$). In fact, home values for insurance holders are a full standard deviation higher than those without a policy.

In contrast, perception of flood risk does not distinguish insurance holders as a group outside the floodplain. Flood intrusiveness is also a statistically insignificant variable among the two respondent groups. The perceived cost of insurance, however, appears to be a primary motivator for acquiring a federal policy. Respondents with policies are far less concerned with the expense of insurance ($p < .000$) compared to those without policies, which tracks well with the results for assessed home value. Contextual control variables are also important distinguishing factors for voluntary purchase of flood insurance. Policy holders are, on average, 18% more likely to have had previous experience with flood impacts ($p = .05$). Respondents living in jurisdictions with higher CRS scores are also significantly more likely to purchase FEMA-based flood insurance ($p < .001$), with a mean difference of over 36%. The bulk of the points accrued for the CRS in these high-scoring communities come from education and awareness activities on the risks of flooding. These activities include: outreach projects, hazard disclosure, and flood protection information.

Binary logistic regression models with reported odds ratios (OR) further indicate which factors are most influential in the voluntary decision to purchase federal flood insurance outside of the designated SFHA while holding all other variables constant (see Table 3; odds-ratios are reported for each variable with standard errors below in parentheses). For risk proximity variables, only distance from the floodplain boundary is statistically significant for the first model, corroborating the two-sample *t*-test

Table 2. Two-sample t-tests for insurance policy holders and non-holders outside of the 100-year floodplain.

	Insurance policy	*N*	Mean	Standard deviation	Standard mean error	Mean difference	*t*	*p*
Distance to coast	0	37	10,661	6393	1051	1171	1.053	0.295
	1	61	9490	4592	588			
Distance to stream	0	37	408	314	52	28	0.472	0.638
	1	61	380	279	36			
Distance to floodplain	0	37	2104	2804	461	1382	3.261	0.002
	1	61	722	1379	177			
Assessed value	0	37	12.479	1.594	0.262	−1.497	−5.516	0.000
	1	61	13.976	1.091	0.140			
Education	0	37	3.676	0.973	0.160	−0.472	−2.484	0.015
	1	61	4.148	0.872	0.112			
Tenure	0	37	10.216	10.155	1.669	−3.259	−1.389	0.168
	1	61	13.475	11.879	1.521			
Flood will cause damage to home	0	37	2.108	0.809	0.133	0.075	0.459	0.647
	1	61	2.033	0.774	0.099			
Think about floods	0	37	5.595	2.088	0.343	0.378	1.002	0.319
	1	60	5.217	1.606	0.207			
Flood insurance protects property	0	36	3.250	1.180	0.197	−0.283	−1.031	0.305
	1	60	3.533	0.177	0.177			
Flood insurance is expensive	0	36	3.417	1.079	0.180	0.917	4.553	0.000
	1	60	2.500	0.873	0.113			
Immediate family experienced flood damage	0	37	0.162	0.374	0.061	−0.182	−1.975	0.051
	1	61	0.344	0.479	0.061			
Live in high CRS community	0	37	0.324	0.475	0.078	−0.364	−3.720	0.000
	1	61	0.689	0.467	0.060			

Table 3. Binary logistic regression models predicting insurance purchase outside of the 100-year floodplain.

	Proximity		Socioeconomic		Perception		Fully specified	
	Coef/SE	OR	Coef/SE	OR	Coef/SE	OR	Coef/SE	OR
Distance to coast	0.00003	1.000						
	(0.0001)							
Distance to stream/river	0.00014	1.001						
	(0.0010)							
Distance to floodplain	−0.0003*	.9996					−0.00008	.9999
	(0.0002)						(0.0001)	
Assessed value			0.7797***	2.1809			0.5207***	1.6834
			(0.3568)				(0.1583)	
Housing tenure			0.0374***	1.0381			0.0195**	1.0197
			(0.0059)				(0.0073)	
Insurance efficacy					0.1581	1.1713		
					(0.1487)			
Perceived insurance affordability					−0.9355**	0.3924	−0.7703**	0.4628
					(0.1239)		(0.1307)	
Risk perception					−0.1398	0.8695		
					(0.2737)			
Flood experience					0.9427**	2.5671	0.6987**	2.0113
					(0.8201)		(0.5223)	
Hazard intrusiveness					−0.1460	0.8641		
					(0.1170)			
High CRS							0.8530***	2.3468
							(0.2173)	
Constant	1.8488		−0.0000***		34.4242*		−0.0076**	
	(1.2453)		(0.0001)		(57.3100)		(0.0115)	
n	98		98		95		96	
AIC	125.9363		108.5259		109.196		94.2158	
BIC	133.6912		116.2808		116.8576		101.9088	

Notes: Standard errors are shown in parentheses; Coef = unstandardized coefficient; OR = odds ratio.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

results above. However, the statistical effect is negated in the full model that loads additional independent variables.

In general, socioeconomic variables have a significant impact on flood insurance purchase and hold their effects in the fully specified logistic model (model 4). Both assessed home value and housing tenure are statistically significant in the block and full models ($p < .01$). A respondent with a higher valued home is 1.68 times more likely to voluntarily purchase insurance ($p < .01$). Respondents living in their home for longer periods of time are approximately 1.02% more likely to be insured against floods.

Among perception-based survey variables, cost has a significant impact on the decision to acquire flood insurance. An increase in the extent to which respondents believe that purchasing insurance would cost a lot of money leads to a 46% decrease ($p < .01$) in the likelihood they will have insurance. Prior experience is an even stronger predictor ($p < .01$), where respondents who have been damaged by a flood are over two times more likely to purchase flood insurance. Among contextual controls, living in a high-scoring CRS community has a significant effect in the fully specified model ($p < .01$). In fact, respondents are over 2.3 times more likely ($p < .001$) to have an insurance policy if they reside in a jurisdiction with a lower CRS class (i.e. higher score).

Discussion

Based on the results of these analyses, a resident located outside the FEMA 100-year floodplain who has voluntarily purchased federal flood insurance can be characterized, on average, as more highly educated, living in relatively expensive homes (often a measure of wealth), and a long-time resident who has had previous family experience with flooding, and thinks flood insurance is relatively affordable. First, among all variables examined, socioeconomic characteristics are as a group the strongest predictors of insurance purchases in the X-zone. Principally, residents who have the financial capacity to invest in more expensive homes are most likely to take actions that protect their investment, which confirms several previous studies described above. Also, when these residents have lived in their homes for longer periods of time, they are more apt to obtain insurance – possibly because they have had more time to absorb information about flood risks from the local officials, news media, and peers (friends, relatives, neighbors, co-workers). It is also possible that the respondents might have been able to observe the adverse impacts of floods in nearby areas that influenced their purchasing decisions.

Second, we unexpectedly found that the physical proximity of a respondent to flood hazard areas makes little or no discernible difference in the decision to obtain flood insurance. We explain this result as a general lack of awareness or misperception of physical risk. This notion is supported by the overall survey responses for which 42% of respondents do not know if they are in or outside of a 100-year floodplain boundary. Furthermore, 60% of these respondents do not know whether they are less than 0.25 miles or more than 3 miles from the FEMA designation floodplain boundary (respondents actually live, on average, 0.75 miles from the boundary). However, proximity to a floodplain can be a critical factor in determining the probability of property damage. For example, in a study of the Clear Creek watershed on the upper Texas coast (which contains League City and Friendswood), the average insured loss was approximately a quarter of a mile from the 100-year floodplain boundary (Brody et al. 2014). Again, awareness must be raised so that homeowners

are more sensitive to their locational flood risk, even though FEMA treats residents outside the floodplain the same, whether they live one foot or 100 miles from the boundary.

Last, living within a high scoring CRS community appears to be a major determinant of an individual's decision to purchase flood insurance. In fact, the odds of a resident buying a policy are approximately 2.4 times higher than in a locality with a lower CRS class, probably due to increased education and awareness efforts. This finding is noteworthy because it is an important signal for local jurisdictions to increase information, assistance, and outreach related to understanding flood risks. A national study of 450 communities participating in the CRS program further corroborates the importance of educating residents in flood-prone areas (Highfield and Brody 2013). This analysis found that flood protection information dissemination (CRS activity 350) significantly increases the number of NFIP policy holders. Specifically, a one-point increase in this activity is equivalent to, on average, 3.7 additional NFIP policies per community. Based on the average number of points accrued for flood protection information dissemination among communities in 2009 (the final year of the study period), the total increase in the number of policies per year for this activity is equivalent to, on average, an additional 355 policies per community.

CRS participation could also be a proxy for perceived flood risk. Residents located within CRS communities may presume that if their local government is investing effort into flood mitigation, the risk of inundation is high and that purchasing insurance is a prudent response, even though it is not required. Finally, the CRS variable could be indirectly capturing perceived cost. Residents of a CRS community located in the 100-year floodplain will pay lower NFIP insurance premiums (up to a 45% discount). Residents located in the X-zone or are not required to purchase insurance may notice others more readily acquiring NFIP policies and be incentivized to do the same.

Conclusion

This study analyzes household-level data to identify the major factors influencing coastal residents to voluntarily purchase federally subsidized flood insurance for homes located outside of the 100-year floodplain. Results can provide guidance to decision-makers at multiple governmental levels on how to encourage individuals to take protective actions in the face of increasing flood risks. Although this is one of the first studies to evaluate voluntary insurance purchase using multiple geographic, socioeconomic, psychological, and institutional variables, it should only be considered as a starting point for investigating the topic. First, we analyze a relatively small sample of respondents across only four communities in two states. Future research should examine a larger number of jurisdictions over a wider geographic region. Larger samples would increase statistical power. Larger samples would also provide a sounder basis for proposing and testing multi-stage, multi-equation models that more explicitly model the mediating mechanisms that intervene between exogenous variables such as hazard proximity and house value, on the hand, and the ultimate endogenous variable – flood insurance purchase (Lindell 2012). Second, the addition of other socioeconomic and psychological variables to the models may provide further insights into insurance purchase decisions.

Third, this study is cross-sectional; it examines insurance uptake during only one point in time. Future work should track insurance purchase decisions over time and

compare coverage rates outside and inside floodplain boundaries. Such a design could provide a better understanding of the problem of homeowners discontinuing their policies after 2–4 years of coverage (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2012). Finally, our results indicate the importance of CRS effort in increasing the number of X-zone policies. Additional research should be conducted on which specific CRS mitigation activities have the greatest effect on stimulating household insurance purchase and other hazard adjustments. Also, future work that involves follow-up qualitative interviews would lead to a better understanding of what it means to residents living in a high or low CRS community.

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