Communicating Hurricane Warnings: Factors Affecting Protective Behavior

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Abstract: We examine the influence of multiple factors –type of warning message, sociodemographic characteristics, worldviews, perceived risk and vulnerabilities, experience and prior protective actions, motivations and barriers, and information sources – on intended protective evacuation behavior for approaching hurricane threats. We develop a series of regression models on survey data collected in May 2012 in the Miami-Dade area (n=460) and the Galveston-Houston area (n=348) on stated evacuation likelihood given different information conditions (i.e., saw a forecast that a hurricane would affect their area or received an evacuation order). We find that when measures of evacuation motivations and barriers are included in the analysis, several factors correlated with evacuation decisions in prior work (such as sociodemographic characteristics and perceived location in an evacuation zone) are less robust predictors. Contrary to expectations based on work in other risk contexts, we find that worldview (individualist or egalitarian) is not a strong predictor of evacuation intent in the information conditions presented. We also find people's expectations of likely conditions and impacts associated with a hurricane are not strong predictors of evacuation intent. Evacuation intent was found to be higher among those with higher perceptions of hurricane risk controllability, those with prior hurricane evacuation experience, and those with higher anticipated frequency of use of official sources of information in hurricane threats. Further analysis will examine these initial findings in greater depth, and seek to interpret how the results can be used to help identify key risk misperceptions that contribute to ineffective protective decisions when a hurricane threatens.

Keywords: Hurricane evacuation intentions; Risk information; Warning decisions

1. Introduction

Hurricanes represent a substantial and recurring risk to a significant portion of the population of the United States, as well as to many other countries around the world. Hurricanes Katrina in 2005 and Sandy in 2012 exemplify multiple events in recent years that have entailed significant loss of life and major societal and economic impacts. While some research indicates that improvements in hurricane forecasting can be credited with reductions in loss of life from these events, other research suggests that there is no downward trend in fatalities when non-coastal areas are included in the impact analysis (Czajkowski et al. 2011; Rappaport 2013). Although many people take timely protective actions such as evacuation when a hurricane approaches, some do not, leading to adverse outcomes.

Recognizing the importance of better understanding the entire warning process, the Subcommittee on Disaster Reduction highlighted promoting "risk-wise" behavior, particularly with respect to forecasts and warnings, as one of the six grand challenges facing the science and technology research community (SDR 2005, see also SDR 2008). Likewise, the National Science Board, in its 2007 report entitled *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative* emphasized the urgent need for investments in evacuation planning research "to better characterize the reactions of both the general public and government officials to hurricane-related information and the manner in which such information is most effectively processed and shared" (NSB 2007:20).

The manner in which individuals receive, understand, and respond to hurricane information can contribute to—as well as mitigate—harmful behaviors (e.g., non-evacuation from evacuation zones or evacuation from safe areas). Research has shown that people's perceptions of and responses to hurricane risk are multi-dimensional and influenced by a variety of factors, ranging from prior experience to vulnerability to risk preferences (e.g., Dash and Gladwin 2007; Zhang et al. 2007; Lazo et al 2010). Moreover, the creation and communication of hurricane risk information is a complex scientific-social process across multiple institutions and jurisdictions (Demuth et al. 2012), resulting in a range of hurricane information sources, which can also influence people's response behaviors.

This study is part of a broader research effort that examines the scientific and societal dimensions of warning decisions in extreme weather events from the perspectives of forecasters, media, public

officials, and the public. The larger project included in-person mental models interviews about people's perceptions of hurricane risks and warning decisions, which helped guide the study presented here. In this paper we seek to build understanding of why different people respond to the risk of an approaching hurricane in the ways that they do, and what can be done to improve people's decisions about protective actions. We do so by examining how different risk information (e.g., forecasts vs. hurricane evacuation orders) and other factors (e.g., worldviews, perceptions) affect how members of the public in the Miami, Florida and Houston-Galveston, Texas areas intend to respond to a potential hurricane threat, using analysis of data from an online survey implemented using Knowledge Networks (KN) KnowledgePanel® in May of 2012.[1]

Along with results from our broader research efforts (e.g., Bostrom et al. in preparation a, b; Demuth et al. 2012; Lazrus et al. 2012; Lazrus in preparation; Morss et al. et al. submitted), we use the findings from this study to provide suggestions for improvements to hurricane risk communication to reduce ineffective protective responses, and for research to identify and resolve gaps in the risk communication process.

2 Explaining Individual Evacuation Decisions

Prior work on hurricane evacuations and in related risk contexts has shown that people's protective action decisions and behaviors are influenced by a variety of factors, including warning-related information, individual and household characteristics, and environmental and social cues. Information sources and channels together influence what people attend to and understand, which influences their appraisal of the situation and thus their decisions and actions. Situational facilitators and barriers also motivate or inhibit actions.

In the first phase of this project we developed a model of the forecast and warning system, derived from interviews with hurricane forecasters, public officials (emergency managers) and broadcasters (Bostrom et al, in preparation a). Figure 1 shows a top-level view of this model, which illustrates the importance of several types of influences on individual mitigation actions

1. The survey sampling, programming, and implementation was contracted with Knowledge Networks (now GfK Knowledge Networks) (Rodkin and Lawrence, 2012).

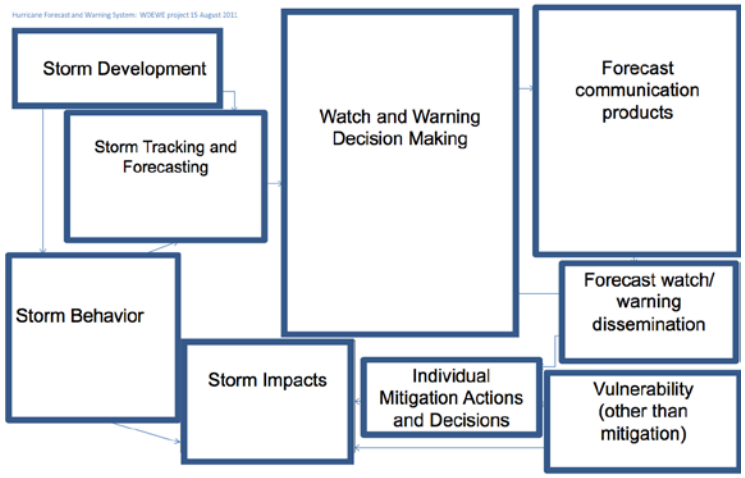

Figure 1. Hurricane Forecast and Warning Process (from Bostrom et al, in prep a)

Derived from this model and informed by our interviews with individual residents of the Miami-Dade area (Bostrom, in prep b) as well as other prior research (e.g., Dow and Cutter, 2000; Dash and Gladwin 2007; Lazo et al. 2010; Morss and Hayden 2010; Lindell and Perry, 2012; Lindell 2012; Sherman-Morris 2013), Figure 2 illustrates in more detail how we theorize that warning messages and other factors influence evacuation decisions and actions.

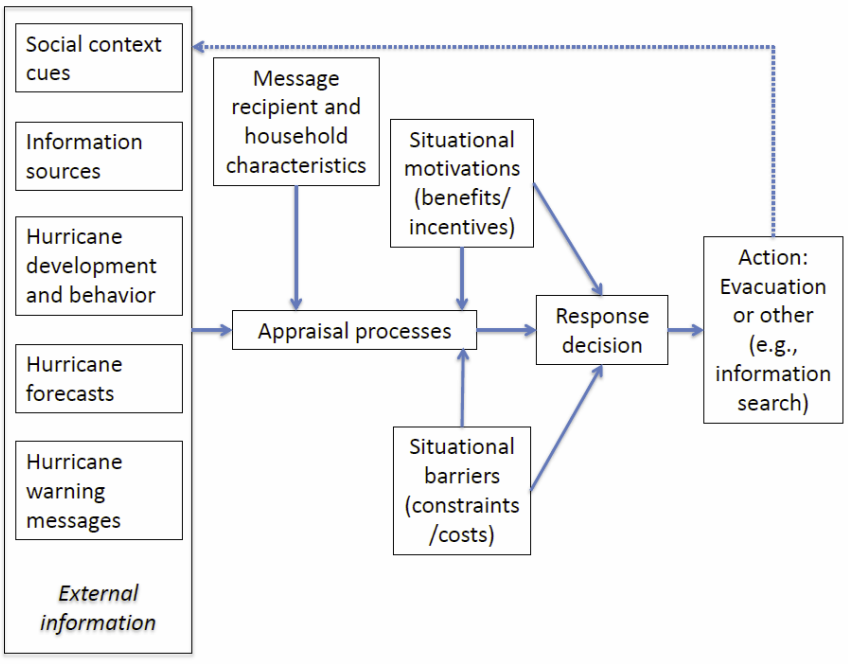

Figure 2. Hurricane information appraisal and response model investigated in this paper.

The dependent variables in our analysis are evacuation intentions given different information conditions, which we use as a proxy for evacuation decisions and actions. Survey responses in general are suspected of overestimating hurricane evacuation. However, in one recent study in which respondents were presented with a hypothetical storm that matched the characteristics of a recent actual storm, stated hypothetical evacuation actually underestimated reported actions in the real storm, and the majority of stated responses (68%) were consistent with reported actions (Gudishala and Wilmot 2010).

Although we assessed stated evacuation intent in 5 different information conditions (section 4.1), we focus primarily on responses to two types of warning messages: seeing a hurricane forecast, and receiving an evacuation order. Our analysis incorporates other influencing factors in different stages (see Appendix B), to examine the importance and value of including each in explaining intended evacuation. Independent variables are introduced roughly from left to right in the model, beginning with receiver characteristics, discussed below under socio-demographics and cultural theory (sections 2.1 and 2.2), followed by threat perceptions, discussed as perceived hurricane risk and vulnerabilities (section 2.3). Based on previous findings in hurricane and other disaster research as well as our mental models research, we postulate that attention, comprehension and perceptions of potential protective actions, and thus protective action decision making, are influenced by prior hurricane experience and prior hurricane response and preparations (section 2.4). Situational facilitators and impediments that appeared in our mental models work and previous related research are assessed in section 2.5, as motivations or barriers to evacuation. Finally, since we theorize that people selectively use and attend to information sources based on cultural and situational factors that appear earlier in our model through attentional processes as part of appraisal, we also examine how evacuation intent is influenced by the types of information sources respondents would use under hurricane threat (section 2.6).

2.1 Socio-demographics

A variety of previous work suggests that socio-demographics, in particular gender and ethnicity, may explain differences in hurricane responses. For example, among the most-studied findings in risk research are gender differences, subsumed under the white male effect: women as well as men of color tend to perceive greater risk than their white male peers (e.g., Bord and O'Connor 1997; Finucane et al., 2000; Flynn et al 1994). Explanations for this effect tend to appeal to power

differentials and social inequality. Significant correlations between risk perceptions and interactions of sociodemographics with worldviews have been interpreted by Kahan et al (2007) as demonstrating that the white male effect stems from identity-protective motivated reasoning, or "cultural cognition" (see section 2.2). Indeed, in Sweden, where gender equality is high but newly immigrated ethnic groups have encountered discrimination, research has demonstrated an absence of the White Male Effect, but a strong correlation of ethnicity with perceived risk (Oloffsson and Rashid, 2011).

2.2. Cultural Theory

As noted in section 2.1, a significant body of work suggests that risk perceptions may be the product of cultural beliefs, that is, beliefs about ideal social structure and legitimate social priorities. Such beliefs have been described as the networks between individuals, or the degrees of insulation, autonomy, control, and competition between individuals (referred to as characteristics of grid, or how prescribed society is), and social ties within groups (referred to as characteristics of group, or how tightly people affiliate themselves with the group) (Douglas, 1970 cf Spickard 1989; Douglas, 1978; Douglas and Wildavsky, 1982). One approach to understanding how culture influences risk perception is the cultural theory of risk which holds that social structure is, in Spickard's words "logically prior to….beliefs" (Spickard p 159). Thus, someone who values autonomy and free competition would perceive risks arising from any phenomena or hazards that might warrant federal intervention, leading to greater control. In the most widely used interpretation of cultural theories of risk—grid-group theory—social structure drives people into four distinct worldviews representing ideals about how society should be organized (Dake, 1992). These worldviews are considered idealistic: "This typology is a heuristic device; few individuals should be expected to hold to these extreme positions consistently" (Jaeger et al. 1998: 191).

Here, following Leiserowitz et al. (2012) and Smith and Leiserowitz (2013), we examine how two worldviews –individualist and egalitarian– interact with evacuation decisions. According to the cultural theory of risk, people with more egalitarian worldviews are expected to perceive higher environmental (and technological) risk while individualists will perceive lower risk. We measure worldviews using the same nine items as Smith and Leiserowitz (2013), which they found characterize individualism and egalitarianism on two distinct scales.

These scales were derived from a 15-item scale initially developed by Leiserowitz (2003, based on

Dake 1991, 1992 and Peters and Slovic, 1996) with the intent to measure all four world views (Leiserowitz 2003), but the hierarchism and fatalism measures failed to achieve satisfactory reliability. After checking for reliability, which was high, Leiserowtiz created his individualism and egalitarianism scales by summing responses over the items within each scale (Leiserowitz 2003; Smith and Leiserowitz 2013) Very similar scales, however, are used by other researchers and described as measures of the grid and group axes that define the four quadrants representing the four worldviews (e.g., see Kahan 2012).

2.3. Perceived risk and vulnerability

Frameworks for appraisal of risks (Fig. 2) include appraisal of affect, certainty, human agency and personal control (Smith and Ellsworth, 1985; Ellsworth and Smith 1988; Ellsworth and Scherer 2003), which correspond to findings in risk perception research on the primacy of affective responses to risk (, e.g., Finucane et al, Slovic et al), the role of uncertainty, and the importance of controllability (e.g., Fischhoff et al 1978; Slovic 2000) as well as cognitive responses. Further, based on previous related work on hurricanes and other hazards, we postulate that appraisal processes result in perceived risk from or vulnerability to hurricanes. Thus, to assess the influence of these different types of constructs on evacuation decision making, we measured respondents' perceptions of 1) whether they reside in an evacuation zone, 2) likely conditions and impacts during a hurricane (based in part on findings from our mental models research; Bostrom et al. in preparation b), 3) catastrophic potential and controllability of hurricane risks, and 4) the likelihood of a hurricane occurring in the next year in the respondent's area.

2.4. Prior Experience and Preparatory Actions

There are mixed findings from the extant literature regarding the relationship between past personal experience with a hurricane and evacuation behaviors. Past experience with a hazard is generally thought to influence one's recognition that a risk exists and increases motivation to protect oneself. Some studies in the hurricane context have revealed this positive relationship (Morss and Hayden 2010; Zhang et al, 2007). Other studies, however, have revealed no or a negative relationship between past experience and evacuation behaviors (e.g., Baker, 1991; Dow and Cutter, 1998; Lazo, Waldman, Morrow, and Thatcher, 2010; Lindell, Lu, and Prater, 2005). As Lindell et al. (2005) note, a potential reason for the mixed empirical findings is because past hurricane experience has been measured in many different ways. Here, we include two measures of respondents' past hurricane experience—(1) whether one has past experience evacuating or leaving their residence to go someplace safe, (2) and how severe one's impacts of hurricane experiences have been.

We also measured whether respondents had performed seven types of preparatory actions (e.g., put up or close hurricane shutters, tie down loose objects in yard, completed structural modifications to home), based again in part on preparatory actions discussed by individuals in our mental models research (Bostrom et al. in preparation b). Accounting for these preparatory hazard adjustments can offer insight into why some people might be less inclined to take protective responses, such as evacuating, when a hazard threatens. For our analysis of influences on evacuation intention, we created a summed index that represents the number of preparatory actions that respondents have taken.

2.5. Motivations and barriers to evacuation

As often emphasized in disaster and emergency response research, context and specific knowledge about actions are important in risk response (NRC 2011; Eiser et al 2012). Thus, we included in the survey a number of items on motivations and barriers people consider in evacuation decisions (section 4.5), based on prior items used in Lazo et al. (2010) as well as the detailed perspective provided by our in-depth mental models interviews with Miami-Dade residents (Bostrom et al in preparation b), and permitted us to develop items to assess specific considerations.

2.6 Information sources

Prior research has shown that many individuals follow hurricane threats via various information sources, consider the safety of their home and family, and then weigh their evacuation options (Gladwin et al. 2001; Zhang et al 2007). Lindell et al. (2005) found that evacuation decisions were more strongly correlated with reliance personal information sources (peers and local authorities than with local news media. Thus we elicited information on likely sources of hurricane information to assess the relation to evacuation intentions.

In sum, we expect evacuation intentions to be greater for those higher on egalitarianism, lower for those higher on individualism; greater for those who perceive higher risk from hurricanes (i.e., higher likelihood, worse consequences, less controllability); greater for those with prior hurricane experience and response; and greater for those who perceive fewer barriers and/or more positive motivations to evacuate. Lastly, we expect that information sources people would use in a situation where they were threatened by a hurricane would influence evacuation intentions, but did not have priors on how this would work.

3 Survey Methods and Implementation

3.1 Survey Development

The survey was developed based on objectives of the current project and the prior literature discussed in section 2. Survey questions also drew on our related prior and concurrent research, including work on the sources, communication, perceptions, uses, and value of hurricane information using stated preference valuation methods (Lazo and Waldman 2011; Lazo, Waldman, Morrow, Thacher. 2010); our mental modeling work in Miami on hurricanes and Boulder, CO on flash floods as part of the larger project (Bostrom et al. in preparation a, b; Morss et al. submitted; Lazrus et al. in preparation); and work in another project on communicating hurricane information (Demuth et al. 2012; Lazrus et al. 2012).)

3.2 Programming and pre-testing

The survey was pretested by conducting three cognitive interviews using a hard copy of the draft survey with individuals in Boulder who had previously lived in Miami. Many of the questions were also adopted from previous surveys, which drew on focus groups and cognitive interview pretests. Following revisions based on the cognitive interviews, the survey was programmed online by Knowledge Networks (KN) and pretested with 33 individuals using a random subset of the full sample. A review of data from the pre-test determined that the survey was ready for full implementation. Given that a significant portion of the sample area population is primary Spanish speaking, the survey was translated into Spanish by KN and offered in English and Spanish to all respondents.

3.3 Sampling and implementation, geo-location of respondents, and data cleaning

The target population consists of 18 year old and older residents of the three Florida counties (Broward, Miami-Dade, Palm Beach) in the Miami area and four Texas counties (Brazoria, Galveston, Harris, Matagorda) in the Houston-Galveston area. To sample the population, KN sampled households from its KnowledgePanel, a probability-based web panel designed to be representative of the United States (see Rodkin and Lawrence 2012 for details on KnowledgePanel® panel recruitment methodology). While the current analysis is not attempting to generalize to the population, KnowledgePanel is a probability-based web panel designed to be representative of the United States with sampling weights which that allow generalizations to the study area population.

The survey was implemented from May 4, 2012 through May 24, 2012. Email reminders to non-responders were sent on day three of the field period. Of a total 1,311 KnowledgePanel panelists invited to the survey, 808 undertook the survey for a survey completion rate of 61.6%. The median time for survey completion was 26 minutes. 21.6% of the respondents completed the survey in Spanish (30.0% of those in Florida and 10.7% of those in Texas). KN provided all data in electronic file format as well as demographic profile data for all respondents. Additional socio-demographic information of specific interest for our work (e.g., length of residence in a hurricane-vulnerable area) was elicited at the end of the survey.

Using latitude-longitude information provided by KN (randomly shifted by up to 100 meters, with respondent ID masked), we used GIS to geolocate each respondent and determine their elevation and distance from coast and whether or not they were located in an official evacuation zone. Figure 3 shows respondents' approximate locations as well as the official evacuation zones for the relevant counties in Florida and Texas.

Following compilation of the data set, we quality controlled the data and assessed summary statistics and missing values. For the current analysis, missing values have been replaced with the median, mean value, or more conservative response category as appropriate.[2]

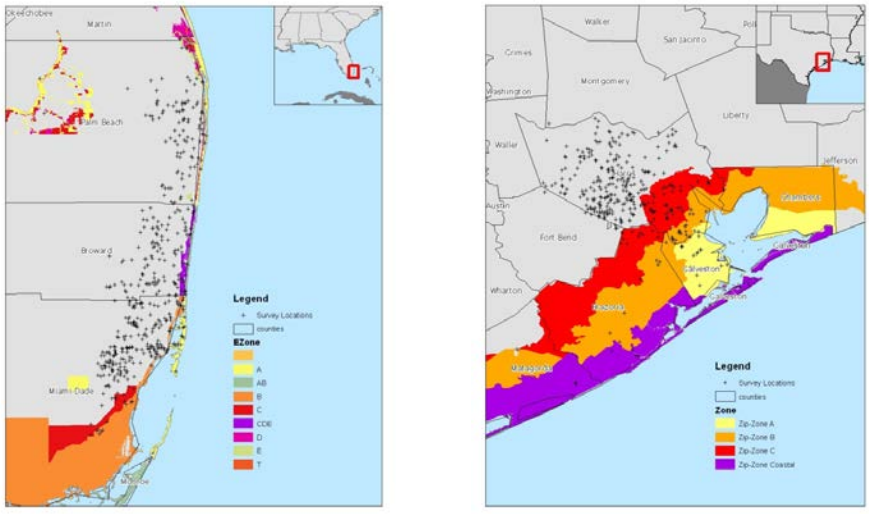

Figure 3: Map of Respondents (+) and evacuation zones in Florida (left) and Texas (right).

2. 83 out of the 149 items measured had less than than 1% missing data, and none had greater than 5% missing data.

3.5 Sample characteristics

Table 1 presents the socio-demographic summary statistics of the sample. Except for "total years residing in hurricane vulnerable areas" and "took survey in Spanish," all socio-demographic measures are part of the KN panel data and were not directly elicited as part of the survey.

Table 1: Socio-Demographics of Sample
(n=804)

Characteristic	Mean	Std Dev	Min	Max
Age (Years)	51.8	17.0	18	88
Total Years Residing in Hurricane Vulnerable Area	26.6	18.8	0	86
Education (Years)	14.5	2.8	4	22
Income (Thousands)	57.8	43.9	5	175
Characteristic Summary statistics				
Gender (Coded: Female=-1; Male=+1)	Female= 486 (60.4%); Male=318 (39.6%)			
Own Residence (Coded: No=-1, Yes=+1)	No=251 (31.2%), Yes=553 (68.8%)			
Children in House (Coded: No=-1, Yes=+1)	No=549 (68.3%), Yes=255 (31.7%)			
Took Survey In Spanish (Coded: No=-1, Yes=+1)	No=630 (78.4%), Yes=174 (21.6%)			
House Type (Coded: Other=-1, Single Family Detached=+1)	Other=343 (42.7%), Single Family Detached=461 (57.3%)			

4. Results

We seek to understand the variables that are associated with respondents' evacuation intentions under different information conditions. We do this by conducting hierarchical regression analyses (reported in Section 5) with different sets of variables, including socio-demographics, cultural worldviews; perceived hurricane risk and vulnerability; prior hurricane experience and preparatory actions; evacuation motivations and barriers; and hurricane information sources. In this section, we perform data analysis to describe and synthesize each of the sets of variables (excepting the socio-demographics) prior to their use in the hierarchical regression models.

4.1 Likelihood of Evacuation

We asked respondents "How likely is it that you would evacuate (leave your residence for somewhere safer) if…" and presented five randomized information conditions: (1) you received a hurricane warning; (2) you received a hurricane watch; (3) you received an evacuation order; (4) your neighbors evacuated; and (5) you saw a forecast that a hurricane would hit where you live. Respondents were asked to respond on a five-point scale labeled "Extremely Unlikely"=1; "Somewhat Likely"=3; and "Extremely Likely"=5.

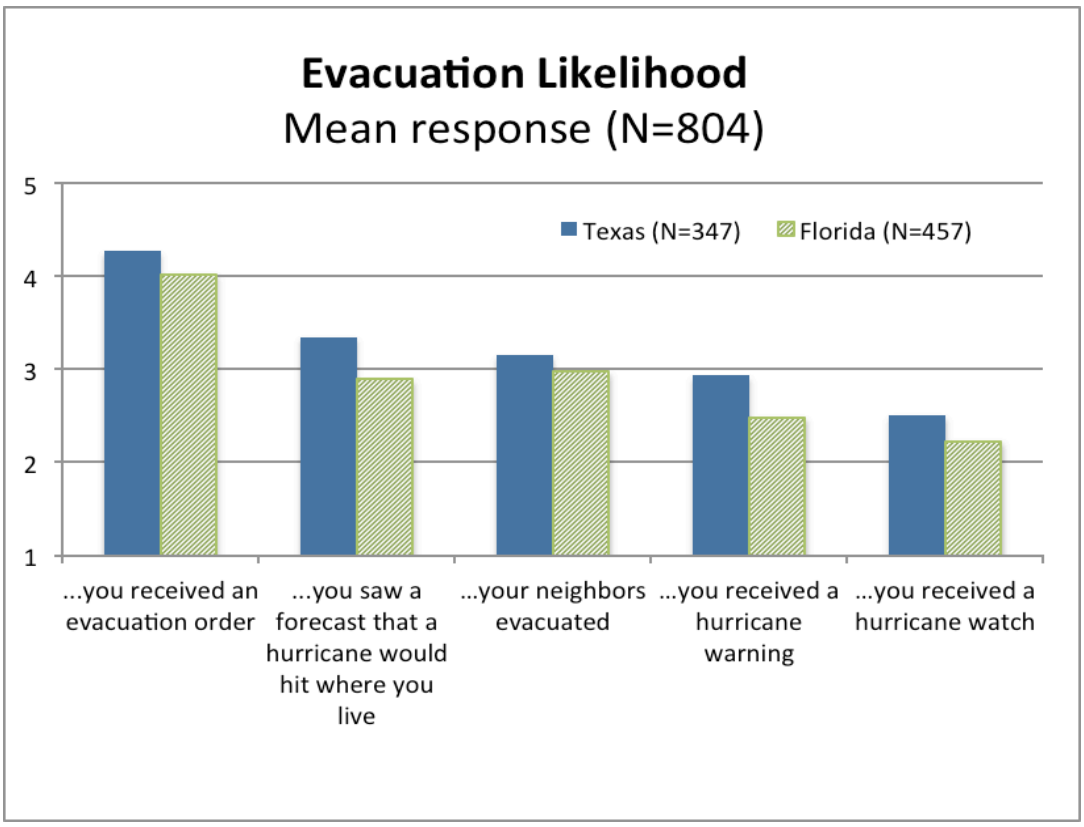

Figure 4: Mean likelihood of evacuation under different information conditions.

Mean responses to the information conditions are provided in Figure 4. In the regression analysis reported in the subsequent section, we utilize two of these items—evacuation intention if one *"received an evacuation order"* and *"saw a forecast…"*—as the dependent variables. We focus on *"received an evacuation order"* because past research shows it strongly associated with evacuation rates (Sherman-Morris, 2013); moreover, additional analysis (not reported here) shows it is least correlated with the other four information conditions. We focus on *"saw a forecast"* because it is highly correlated (not shown) with receiving a hurricane watch and warning, and is a broader concept than those information conditions.

For all information condition, respondents in TX indicated a significantly higher likelihood of evacuating than those in FL (Mann-Whitney tests between states were all significant at less than 10% level (and four of the five at the 1% level)). Moreover, respondents in evacuation zones indicated a higher mean likelihood of evacuating than those not in an evacuation zone – but this difference was only statistically significant for those receiving warnings, watches, or seeing a forecast.

4.2 Cultural Worldviews

The cultural worldview items adopted from Smith and Leiserowitz (2013) stated "The following statements provide us information about your thoughts about society and government" and provided the nine statements presented in Table 2 for which individuals indicated their level of agreement on a five-point scale (Strongly Disagree=1, Disagree=2, Neither Agree nor Disagree=3, Agree=4, Strongly Agree=5). Missing observations were replaced with median values (only 0.76% of all responses were imputed).

We conducted principal components analysis (PCA) on responses to the nine items. PCA was used to extract the factors.[3] A scree test revealed a large break between Factor 2 and Factor 3 suggesting that two factors should be retained. Following a varimax orthogonal rotation, the factor pattern solution displayed a simple structure and proved to be interpretable. The rotated factor pattern appears in the rightmost two columns of Table 2. An item was said to load on a given factor if the relevant loading in the rotated pattern matrix was $\geq \pm$ 0.40 (highlighted in bold). Using this criterion, Items E, F,G, and H loaded on Factor 1 (labeled *Individualist*) and Items A, B, C, and D loaded on Factor 2 (labeled *Egalitarian*). Item I loaded almost equally on both factors (with opposite signs). This is consistent with verbal reports when this question was implemented in individual interviews as part of another study on environmental risk perceptions conducted by one of the authors (Lazrus forthcoming). Results from the analysis were used to create normalized scores on each factor and retained for subsequent regression analysis.

3. For all PCA and factor analysis reported in this paper, Kaiser's Overall Measure of Sampling Adequacy (MSA) was 0.68 or larger (values greater than 0.5 are considered adequate) indicating that patterns of correlations are relatively compact and factor analysis should yield distinct and reliable factors.

Table 2: Rotated Factor Pattern Principal Components Analysis (PCA) (n=804)			
Item	**Statement**	**Factor1 Individualist**	**Factor2 Egalitarian**
H	Government regulation of business usually does more harm than good.	**0.83**	-0.10
E	If the government spent less time trying to fix everyone's problems, we'd all be a lot better off.	**0.82**	-0.18
G	The government interferes too much in our everyday lives.	**0.80**	-0.23
F	Our government tries to do too many things for too many people. We should just let people take care of themselves.	**0.77**	-0.28
I	People should be allowed to make as much money as they can, even if it means some make millions while others live in poverty.	**0.49**	**-0.48**
A	The world would be a more peaceful place if its wealth were divided more equally among nations.	-0.13	**0.82**
B	In my ideal society, all basic needs (food, housing, health care, education) would be guaranteed by the government for everyone.	-0.17	**0.75**
C	I support government programs to get rid of poverty.	-0.29	**0.73**
D	Discrimination against minorities is still a very serious problem in our society.	-0.15	**0.69**
Variance Explained by Each Factor		2.97	2.67

4.3 Perceived Hurricane Risk and Vulnerability

We elicited several measures of respondents' perceived risk and vulnerability to hurricane risks (Table 3). One measure was respondents' perceptions of whether they live in an evacuation zone. 42% of respondents selected "yes", 39% selected "no", and 19% selected "didn't know." The actual proportion of the sample that is in an evacuation zone is 22%; in both Texas and Florida more respondents thought they were in an evacuation zone than actually were, and overall only 4% of those who were in an evacuation zone thought they were not. We combined the "no" and "don't know" responses to create a dummy variable for the regression analysis "Perceived to live in Evac Zone." Past research suggests that people's perceptions of their exposure to a risk are better predictors of their protection behaviors than their actual exposure. Initial analysis (not shown) of our data with respondents' actual evacuation zones suggest this as well, thus here we focus on examining the influence of respondents' perceptions rather than their actual exposure.

We also asked respondents about their perceptions of the likely conditions and impacts if a major hurricane were to hit the general area where they live. The list of possible conditions and impacts included in the survey was informed by the a priori expert and public mental model interviews. Of the likely conditions, respondents perceived high winds and blowing objects as most likely. Inland

flooding was considered the next most likely condition, followed by storm surge, which was considered only somewhat likely on average. Respondents considered being killed or injured by the storm as somewhat likely, on average, and looting as less likely to occur.

Two additional measures of respondents' hurricane risk perceptions are drawn from the psychometric paradigm (Fischhoff et al, 1978)—that is, respondents' perceptions of the (2) chronic versus catastrophic nature of hurricane risks, and (2) degree of personal control to prevent oneself from harm due hurricanes. On average, respondents consider hurricanes as more likely to kill large numbers of people at once, and they consider themselves to have lower personal control over harm.

Table 3: Measures of Perceived Hurricane Vulnerability
(n=804)

Variable	**Scale**				
Perceived to live in Evac Zone	(No or Don't Know=-1, Yes=+1)	42.4% Yes; 38.7% No; 18.9% Don't Know			
Variable	**Scale**	**Mean**	**Std Dev**	**Min**	**Max**
Likely Conditions - High Winds and Objects Blowing	5 point scale: Extremely Unlikely=1, Somewhat Likely =3, Extremely Likely=5	4.29	1.03	1	5
Likely Conditions - Storm Surge	5 point scale: Extremely Unlikely=1, Somewhat Likely =3, Extremely Likely=5	3.11	1.47	1	5
Likely Conditions - Inland Flooding	5 point scale: Extremely Unlikely=1, Somewhat Likely =3, Extremely Likely=5	3.78	1.25	1	5
Likely Impacts - Mortality and Morbidity	5 point scale: Extremely Unlikely=1, Somewhat Likely =3, Extremely Likely=5	3.20	1.02	1	5
Likely Impacts – Looting	5 point scale: Extremely Unlikely=1, Somewhat Likely =3, Extremely Likely=5	2.82	1.19	1	5
Hurricane Risks – Catastrophic	5 point scale: Chronic (kills people one at a time)=1 to Catastrophic (kills large numbers of people at once = 5	3.82	1.12	1	5
Hurricane Risks – Controllability	5 point scale: No personal control=1 to Total personal control	2.29	1.34	1	5
Likelihood of Hurricane in Next Year	0% to 100% Likelihood	45.77	23.57	0	100

Finally, we asked respondents how likely (on a scale from 0-100% chance) they think it is that a major hurricane will occur in the general area where they live in the next year. On average, respondents believe there is a 46% chance of hurricane occurrence.

4.4 Past Hurricane Experience and Preparatory Actions

Two measures were used to assess respondents' past hurricane experience (Table 4). One measure asked simply whether or not respondents or anyone in their household has ever evacuated or left their residence to go someplace safer? This is coded as the dummy variable "Prior Response – Evacuated" with -1 if never evacuated (60.4% of respondents) and +1 is someone had evacuated

(39.6% of respondents). The next item measured respondents' interpretations of their past experiences by asking them to rate the severity of the impacts of their hurricane experience(s) (on a five-point scale, where 1="Not at all severe", 3="Moderately severe", 5="Extremely severe"). This item mirrors the "threat experience appraisal" measure used by Grothmann and Reusswig (2006) in the context of floods. Respondents with no prior experience were coded as "1=Not at all severe". On average, respondents deem the severity of their past experience as less than moderately severe.

In addition, we asked respondents to indicate whether or not they had performed seven types of prepartory actions to prepare for a hurricane threat in the past (Table 4). The seven actions were: put up or closed hurricane shutters; tied down loose objects in yard; trimmed trees; installed hurricane proof glass; completed structural modifications to your home or residence; developed an evacuation plan; and gathered emergency supplies. "Not applicable" responses (e.g., for those without a house or yard) were coded as No. We created the "Prior Preparations - Total of Q9 Actions" variable as a summed index of the number of ""Have done in the past" responses. On average, respondents had undertaken between 3 and 4 preparatory actions.

Table 4: Measures of Prior Experience and Preparation
(n=804)

Variable	Label	Mean	Min	Max
Prior Experience Severity Scale	Recoded Q3 with "No Experience" coded as "1"	2.76	1	5
Prior Preparations Total of Q9 Actions	Sum of Prior_Prep_Q9 Dummy Variables	3.63	0	7
Prior Response – Evacuated	Dummy (-1 and +1)	60.4% never evacuated / 39.6% have evacuated		

4.5 Evacuation Motivations and Barriers

We elicited respondents' potential barriers and motivations with respect to evacuation in the event of a hurricane. First, we asked "For each of the following statements, please indicate how strongly you agree or disagree for your own personal situation. If a hurricane threatened, I would evacuate..." and listed eight motivations for evacuating, and we asked respondents to indicate their level of agreement or disagreement for each. Six of these are included in the analysis and are listed in Table 5. The next question asked "For each of the following statements, please indicate how strongly you agree or disagree for your own personal situation. If a hurricane threatened, I would shelter in place, and would NOT evacuate, because…" and listed nine potential barriers to

evacuating, and we asked respondents to indicate their level of agreement or disagreement with each (see Table 5).

Table 5: Evacuation Motivations and Barriers
(n=804) (Principle Component Analysis with Varimax rotation)
(Strongly Disagree=1; Disagree=2; Neither Agree nor Disagree=3; Agree=4; Strongly Agree=5)

Item	Barriers and Motivations	Mean (N=804)	Factor1 *Motivations*	Factor 2 *Barriers*	Factor 3 *House Safe*
Q13_F	… because a hurricane could injure or kill me	3.53	**0.81**	-0.00	-0.156
Q13_D	… because I want to keep my family safe	3.98	**0.81**	-0.08	-0.00
Q13_A	… because I trust hurricane warnings and forecasts	3.57	**0.80**	-0.09	0.07
Q13_E	… so I would not be stuck in the area after the hurricane	3.33	**0.74**	0.03	-0.23
Q13_C	… because my house is vulnerable to hurricane winds	2.98	**0.63**	0.16	**-0.46**
Q13_B	… because my house is vulnerable to hurricane storm surge	2.63	**0.55**	0.25	**-0.44**
Q14_H	… my health or disabilities make it difficult to evacuate	1.71	0.01	**0.79**	0.03
Q14_I	… I have a family member whose health/disability makes it difficult to evacuate	1.73	0.06	**0.76**	-0.02
Q14_F	… I lack transportation	1.61	0.10	**0.75**	-0.02
Q14_C	… I do not know how to evacuate	1.71	0.10	**0.62**	0.035
Q14_E	… I distrust hurricane warnings and forecasts	1.99	-0.15	**0.59**	0.04
Q14_D	… my pet(s) make it difficult to evacuate	2.10	-0.08	**0.53**	0.21
Q14_G	… I need to protect my home or business	2.62	-0.01	**0.48**	0.40
Q14_B	… my house is safe from hurricane storm surge	3.16	-0.17	0.08	**0.82**
Q14_A	… my house is safe from hurricane winds	2.86	-0.12	0.20	**0.79**

An exploratory factor analysis was performed on responses to the fifteen items presented in Table 5. Principle component analysis was used to extract the factors. A scree test revealed a large break between Factor 3 and Factor 4 suggesting that three factors should be retained. Following a varimax rotation, the factor pattern solution displayed a simple structure and proved to be interpretable. The rotated factor pattern appears in the rightmost three columns of Table 5. An item was said to load on a given factor if the relevant loading in the rotated pattern matrix was $\geq \pm 0.40$ (highlighted in bold).

Using the criterion, all of the motivation items loaded on Factor 1 (labeled *Motivations*), and most of the barriers items (labeled C through I) loaded on Factor 2 (labeled *Barriers*). Two barriers (labeled A and B) loaded on a third factor. Because these items capture beliefs that one's house is safe, we labeled this third factor *House Safe.* Two of the motivation items concerning one's house also loaded negatively on this third factor (labeled C and B). Results from the analysis were used to

create optimally weighted estimates for each of the three factors and retained for subsequent regression analysis.

4.6 Sources of Information

We asked respondents how often they would use 13 potential sources and channels "to get information about the risk of an approaching hurricane." Given our interest in the influence of source usage on protective action (section 2; Figure 2), here we focus on the 6 items that most closely correspond to information sources. Respondents indicated they would rely most on NWS and National Hurricane Center information (NHC) (almost always for these sources). Respondents in Florida indicated a significantly greater reliance on the NHC than did those in Texas (mean of 4.53 in Florida versus 4.14 in Texas; Mann-Whitney U=63362.5; p=0.00) while those in Texas placed significantly greater reliance on the religious leaders or clergy than did those in Florida (mean of 1.48 in Florida versus 1.63 in Texas; Mann-Whitney U=72849.0; p=0.01).

Table 6: Reliance on of Different Sources of Information
Summary Stats, State Comparisons, and Rotated Factor Pattern
(n=804)

Q10. In the event of a hurricane threat, how often would you use the following to get information about the risk of an approaching hurricane?
(Never=1; About half the time=3; Always= 5)

	Sources	Mean (N=804)	Factor 1 *Public Sources*	Factor 2 *Personal Sources*
K	National Weather Service/Weather Forecasting Office	4.36	**0.77**	-0.03
H	National Hurricane Center	4.36	**0.74**	-0.03
D	Public officials/ emergency managers	3.64	**0.50**	0.10
B	Your family, friends, or colleagues	3.24	-0.02	**0.71**
A	Your own experience	3.43	0.14	**0.45**
C	Religious leaders or clergy	1.54	-0.03	0.31

An exploratory factor analysis was performed on responses to these six items, using maximum likelihood extraction. A scree test revealed a large break between Factor 2 and Factor 3 suggesting that two factors should be retained. Following a promax (oblique) rotation, the factor pattern solution displayed a simple structure and proved to be interpretable. The rotated factor pattern appears in the rightmost two columns of Table 6. An item was said to load on a given factor if the relevant loading in the rotated pattern matrix was $\geq \pm$ 0.40 (highlighted in bold).

Using the criterion, items K, H, and D loaded on Factor 1 (labeled *Public Sources*) and items B and A loaded on Factor 2 (labeled *Personal Sources*). The item "Religious leaders or clergy" did not load $\geq \pm$ 0.40 on either factor but in factor space this item mapped very close to items A and B. The

inter-factor correlation was 0.32. Results from this analysis were used to create optimally weighted estimates for each of the two factors and retained for subsequent regression analysis.

5 Regression Analysis

5.1 Methods

To examine how the various factors discussed affect evacuation intentions, we undertook regression analysis on two of the stated evacuation intentions conditions – "saw a forecast that a hurricane would hit where you live" (hereafter the *Forecast* model) and "you received an evacuation order" (the *Evacuation Order* model) and conducted hierarchical regression analyses. We ran six models on each of the dependent variables adding additional explanatory sets of variables to explore how these influence stated intentions and to examine the change in estimated effects of variables from the simpler models. We do this in part to explore how using simpler explanations of evacuation intentions or behavior (based say just on socio-demographic characteristics) may miss important behavioral influences that accounting for less commonly measured variables helps better explain.[4]

The simplest model assesses the relationship of socio-demographics to intentions, as prior research has primarily focused on socio-demographics in explaining evacuation behavior (see Section 2.1). Successive models add variables that may explain evacuation behaviors in the following order (1) measures of individualism and egalitarianism derived from cultural theory (see Section 2.2), (2) perceived hurricane vulnerabilities and risk (see Section 2.3), (3) prior hurricane experience and response (see Section 2.4), (4) motivations and barriers to evacuation (see Section 2.5), and (5) frequency and types of information sources respondents would use in a situation where they were threatened by a hurricane (see Section 2.6). The full hierarchical results for all twelve models appear in Appendix B1 and Appendix B1 (*Forecast* and *Evacuation Order* models respectively)

As part of our analysis we consider potential "structural" differences between the Florida and Texas respondents under these two information regimes—Forecast and Evacuation Order, respectively—in which both policy and social contexts differ. Tables 7a and 7b presents the regression results from the two full models (*Forecast* and *Evacuation Order* models respectively) with the full data

4. At this time we are using ordinary least square regression (OLS) treating the dependent variables as interval scale. We've undertaken limited analysis using ordered logit modeling and the results and subsequent interpretation were largely similar.

set as well as for the Texas and Florida subsamples.

We report standardized regression coefficients (beta coefficients) where the independent variables have been standardized with variances equal to one. The parameter estimates thus indicate how many standard deviations evacuation likelihood will change per one standard deviation increase in each respective predictor variable. For the hierarchical models in the Appendices we also report sequential model fit and change statistics (F-tests) to evaluate whether adding the blocks of factors significant improves the explanation of evacuation intentions.

5.2 Results

In this section we summarize initial observations regarding the results of the regression analysis. We focus on how the various factors (meaning any of the explanatory variables and not just factor scores per se) help explain evacuation intentions, how the explanatory power of factors changes as additional factors are included in the models, and how these differ between the *Forecast* model and *Evacuation Order* model as well as between Florida and Texas respondents.

5.2.1. Message recipient characteristics

Estimated relationships between socio-demographics and evacuation intentions are fairly consistent across steps of the hierarchical regression analyses (models 0-5, Appendix B1 and B2), within each model (Forecast and Evacuation Order).

Evacuation likelihood decreases with age on receipt of an evacuation order in both states, and decreases with age in Florida in the Forecast case, but increases with age in Texas in the Forecast model, controlling for other variables in the model.

Total years residing in hurricane vulnerable areas was insignificant, with opposite signs across models, although fairly consistently negative across steps in the hierarchical modeling (i.e., whether controlling for some or all of the other variables).

Increases in education predict modest increases in evacuation on receipt of an evacuation order in Texas, but Floridians are less likely to evacuate on receipt of an order. Education appears to have no significant effect on evacuation likelihood in the Forecast case, controlling for all else, although the coefficient signs are largely consistent across both sets of models.

Taking the survey in Spanish is here assessed as an indicator of potential ethnic differences that might correlate with increased vulnerability and so intentions to evacuate. Estimate coefficients are

small and have opposite signs in the two states, with a net overall mostly positive but insignificant association with evacuation intentions in both models.

Those in Texas who own their residence are less likely to evacuate than those who don't own their residence whether they see a forecast or receive an evacuation order. Those in Florida who own their residence are more likely to evacuate than those who don't own their residence if they get an evacuation order – but probably no different if they just see a forecast.

Initially it appears that those with children in house are a little more likely to evacuate but this is not significant when "Evacuation Motivations and Barriers" are accounted for (in the Forecast model). Whereas on receipt of an evacuation order, in the initially steps of our hierarchical modeling it appears that those with children in house are no more or less likely to evacuate, but they are significantly less likely to evacuate when "Evacuation Motivations and Barriers" are accounted for in the full model.

As expected, males are less likely to evacuate than females across the board, but estimated coefficients are not significantly different from zero in the Forecast model.

5.2.2. Cultural theory

Contrary to expectations, neither individualism nor egalitarianism was predictive of evacuation intentions in either model, whether controlling only for the socio-demographics discussed above, or controlling also for the rest of the variables in the full model. In only one model was either cultural theory factor score significant – egalitarian was positive and significant in Forecast Model 3 (increased factor score on egalitarian related to increased likelihood of evacuation).

5.2.3. Perceived risk from and vulnerability to earthquakes

In the full model, the only risk perception variable in this category that contributed to explained variance in evacuation intentions in the Forecast case was the perception that the risk from hurricanes is controllable. In response to the question "How much personal control do people exposed to each hazard have over it? That is, to what extent can they prevent mishaps or illnesses to themselves from occurring, or reduce their severity if they do occur? " on a scale from 1="No personal control" to 5="Total personal control" those who perceived they had more control over the risk were more likely to say that they would evacuate if they saw a forecast that said it would hit where they lived. This relationship held true in the overall model for both states in the case of

evacuation as well, but the association was too weak to reach statistical significance in the analysis by state.

In the case of having received an evacuation order, two characteristics of hurricane behavior were associated with evacuation intentions. The higher the estimated likelihood of "blowing objects or debris" the greater the intent to evacuate, in response to the question "How likely would each of the following conditions [blowing objects or debris] be in the general area where you live if a major hurricane (Category 3 or higher) hit your area?" However, this association did not reach statistical significance for Floridians. Contrary to expectations, intentions to evacuate on receipt of an evacuation order decreased the greater perceived likelihood of storm surge, and this association was statistically significant for the overall model and in Florida.

Effects that dropped out when we controlled for motivations and barriers to evacuation included perceptions of being in an evacuation zone,

Individuals who perceive themselves to be in an evacuation zone are more likely to evacuate as per models 2 and 3 in both the Forecast and the Evacuation Order model (Appendix B1), but this influence drops out when "Evacuation Motivations and Barriers" are included (see Table 7).

Before "Evacuation Motivations and Barriers" are accounted for in Models 4 and 5, the greater the perceived catastrophic potential of hurricanes the higher stated likelihood of evacuating – when the individual sees a hurricane forecast – but no impact when there is an evacuation order.

5.2.4. Prior Experience

Those with prior evacuation experience are more likely to evacuate when seeing a forecast or receiving an order, though this association is not statistically significant for Texans. Prior experience severity does not appear to have a significant influence on evacuation intent once prior experience and barriers and motivations are accounted for. The number of prior preparations one has undertaken previously appears to be negatively associated with evacuation intentions on receipt of an order, but this only reaches weak statistical significance at $p<0.10$ in full model without allowing the coefficients to vary by state.

5.2.5. Evacuation Motivations and Barriers – Factor Scores

The evacuation motivations and barriers assessed in this study (see Table 5 for details) explained by far the most variance in evacuation intentions, for both models (Forecast, and Evacuation Order).

Those with higher motivation to evacuate are more likely to evacuate – no difference on this between FL and TX, and this holds for both models (Forecast and Evacuation Order). This has the largest standardized coefficients. The greater the perceived barriers, the lower the likelihood of evacuating on receipt of an evacuation order, although this does not quite reach significance for those in Texas. However, barriers as measured do not influence evacuation intent in the case of having seen a forecast. The perceived safety or vulnerability of one's house (Factor 3) matters in the case of a forecast, with greater vulnerability associated with increased likelihood of evacuating, all else equal. ,

5.2.6. Reliance on Information Sources – Factor Scores

Those accessing more information from public sources in the event of an evacuation order are more likely to evacuate. Given that evacuation orders come from public sources, this may be capturing trust in government information.

Table 7a: OLS Regression Analysis on Evacuation Intentions if you saw a forecast that a hurricane would hit where you live						
Dependent Variable: Saw Forecast	**Combined (N=804)**		**Texas (N=347)**		**Florida (N=457)**	
	Beta	Sig.	Beta	Sig.	Beta	Sig.
(Constant)		0		0		0
Sociodemographics						
Age_in_Years	0.06	0.138	**0.13**	**0.04**	0.001	0.977
Reside_Yrs_Tot_Hurr_Vuln_Age_Ltd	-0.03	0.449	-0.005	0.927	-0.04	0.329
Education_Years_Continuous	-0.006	0.854	-0.03	0.645	0.005	0.906
Survey_In_Spanish	0.05	0.116	0.05	0.370	**0.09**	0.054
House_Type_Dummy	-0.03	0.362	0.04	0.547	-0.08	0.108
Income_Continuous_Thousands	0.02	0.513	0.007	0.909	0.05	0.362
Male_Dummy	-0.05	0.128	-0.04	0.469	-0.05	0.250
Own_Residence_Dummy	0.006	0.864	**-0.15**	**0.037**	**0.10**	**0.042**
Children_In_House_Dummy	0.008	0.798	0.05	0.383	-0.02	0.727
Cultural Theory						
H10_Factor1_Individualistic	0.02	0.474	-0.009	0.845	0.02	0.564
H10_Factor2_Egalitarian	-0.003	0.915	-0.013	0.801	0.01	0.797
Perceived risk and vulnerabilities						
Evac_Zone_Perceived_Yes_Dummy	0.03	0.305	0.03	0.619	0.02	0.697
Likely_Conditions_Winds_Obj_Blow	-0.04	0.285	-0.07	0.268	-0.005	0.919
Likely_Conditions_Storm_Surge	0.02	0.551	0.02	0.739	0.02	0.759
Likely_Conditions_Inland_Flood	0.002	0.968	-0.02	0.796	-0.001	0.982
Likely_Impacts_Mort_Morb	0.03	0.472	0.01	0.829	0.06	0.239
Likely_Impacts_Looting	-0.006	0.861	-0.01	0.802	-0.02	0.618
Risk_Catastrophic _Hurricanes	0.03	0.335	0.03	0.508	-0.002	0.958
Risk_Control_Hurricanes	**0.09**	**0.003**	**0.11**	**0.027**	**0.08**	**0.061**
Hurricane_Likelihood_Next_Yr	0.01	0.745	0.004	0.933	0.008	0.846
Prior experience						
Prior_Response_Evac_Dummy	**0.17**	**0.000**	**0.11**	**0.027**	**0.17**	**0.000**
Q3_NoExp0	-0.04	0.228	-0.08	0.114	-0.012	0.781
Prior_Prep_Q9_Total	-0.01	0.787	0.04	0.466	0.013	0.770
Perceived motivations and barriers						
REGR factor score 1_Motivations	**0.42**	**0.000**	**0.45**	**0.000**	**0.42**	**0.000**
REGR factor score 2_Barriers	-0.01	0.869	-0.08	0.112	0.05	0.242
REGR factor score 3_House_Safe	**-0.24**	**0.000**	**-0.22**	**0.000**	**-0.26**	**0.000**
Sources of information						
Sources_Factor_1_Official	-0.02	0.590	-0.05	0.401	-0.01	0.785
Sources_Factor_2_Personal	0.06	0.109	0.08	0.169	0.04	0.352
Model Statistics						
Adj R-Sq	0.34		0.314		0.322	
F value	15.625		6.668		8.744	
Model DF, Error DF	28,775		28,318		28,428	
Pr > F	0.00		0.000		0.000	

Table 7b: OLS Regression Analysis on Evacuation Intentions on receiving an evacuation order.						
Dependent variable: Evacuation Order	**Combined (N=804)**		**Texas (N=347)**		**Florida (N=457)**	
	Beta	**Sig.**	**Beta**	**Sig.**	**Beta**	**Sig.**
(Constant)		0.000		0.000		0.000
Sociodemographics						
Age_in_Years	**-0.09**	**0.033**	-0.06	0.410	**-0.11**	**0.036**
Reside_Yrs_Tot_Hurr_Vuln_Age_Ltd	-0.03	0.360	-0.10	0.117	-0.01	0.777
Education_Years_Continuous	0.06	0.126	0.15	0.009	-0.02	0.706
Survey_In_Spanish	-0.02	0.624	0.06	0.313	-0.03	0.560
House_Type_Dummy	-0.04	0.300	0.04	0.593	-0.06	0.279
Income_Continuous_Thousands	0.04	0.321	0.03	0.654	0.06	0.280
Male_Dummy	**-0.09**	**0.005**	**-0.11**	**0.041**	**-0.09**	**0.038**
Own_Residence_Dummy	**0.07**	**0.081**	-0.07	0.392	**0.13**	**0.014**
Children_In_House_Dummy	-0.02	0.561	-0.09	0.141	0.005	0.909
Cultural Theory						
H10_Factor1_Individualistic	-0.003	0.918	0.06	0.258	-0.05	0.233
H10_Factor2_Egalitarian	-0.003	0.924	-0.03	0.636	0.03	0.545
Perceived risk and vulnerabilities						
Evac_Zone_Perceived_Yes_Dummy	0.03	0.383	0.03	0.554	0.04	0.422
Likely_Conditions_Winds_Obj_Blow	**0.09**	**0.028**	**0.14**	**0.036**	0.06	0.243
Likely_Conditions_Storm_Surge	**-0.10**	**0.012**	**-0.11**	**0.067**	**-0.11**	**0.033**
Likely_Conditions_Inland_Flood	-0.002	0.968	0.02	0.750	-0.001	0.991
Likely_Impacts_Mort_Morb	0.01	0.721	-0.05	0.421	0.07	0.208
Likely_Impacts_Looting	-0.02	0.637	-0.02	0.768	-0.03	0.515
Risk_Catastrophic _Hurricanes	0.03	0.299	0.01	0.845	0.04	0.412
Risk_Control_Hurricanes	**0.08**	**0.020**	**0.10**	**0.063**	0.064	0.140
Hurricane_Likelihood_Next_Yr	0.02	0.607	-0.01	0.932	0.04	0.382
Prior experience						
Prior_Response_Evac_Dummy	**0.10**	**0.006**	0.07	0.228	**0.11**	**0.014**
Q3_NoExp0	**-0.06**	**0.099**	-0.06	0.292	-0.07	0.146
Prior_Prep_Q9_Total	-0.05	0.131	0.01	0.866	-0.06	0.200
Perceived motivations and barriers						
REGR factor score 1_Motivations	**0.32**	**0.000**	**0.29**	**0.000**	**0.35**	**0.000**
REGR factor score 2_Barriers	**-0.11**	**0.001**	**-0.07**	**0.219**	**-0.14**	**0.003**
REGR factor score 3_House_Safe	**-0.08**	**0.016**	**-0.12**	**0.031**	-0.07	0.114
Sources of information						
Sources_Factor_1_Official	**0.14**	**0.000**	**0.17**	**0.007**	**0.13**	**0.008**
Sources_Factor_2_Personal	0.01	0.880	0.02	0.749	-0.009	0.852
Model Statistics						
Adj R-Sq	0.217		0.197		0.213	
F value, p	8.97, p<0.001		4.04, p<0.001		5.407, p<0.001	
Model DF, Error DF	28, 775		28, 318		28, 428	

6 Discussion/Conclusion

This paper examines the influence of multiple factors – including type of warning message, sociodemographic characteristics, worldviews, perceived risk and vulnerabilities, experience and prior protective actions, motivations and barriers, and information sources – on intended protective evacuation behavior for approaching hurricane threats, using analysis of results from a survey of residents of the Miami and Houston-Galveston areas. We found that when our measures of evacuation motivations and barriers were included in the analysis, some factors that have been correlated with evacuation decisions in prior work (such as sociodemographic characteristics and perceived location in an evacuation zone) were less robust predictors. Contrary to expectations based on work in other risk contexts, we found that worldview (individualist or egalitarian) was not a strong predictor of evacuation intent in the information conditions presented. We also found people's expectations of likely conditions and impacts associated with a hurricane, which we expected to be important influences based on our individual mental model interviews, were not strong predictors of evacuation intent. Evacuation intent was found to be higher among those with higher perceptions of hurricane risk controllability and prior hurricane evacuation experience, across the two information conditions examined. In addition, as hypothesized based on our theoretical model, another influence on evacuation intention was anticipated frequency of use of official sources of information in hurricane threats; this suggests the potential value of understanding the interactions among information behaviors and protective behaviors. Further analysis will examine these initial findings in greater depth, and seek to interpret how the results can be used to help identify key risk misperceptions that contribute to ineffective protective decisions when a hurricane threatens.

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Appendix B1: Dependent Variable: Evac_Likelihood_Saw_Forecast												
	Model0		Model1		Model2		Model3		Model4		Model5	
COMBINED(N=804)	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.
(Constant)		0.00		0.00		0.00		0.00		0.00		0.00
Age_in_Years	0.00	0.98	0.00	0.95	0.04	0.35	**0.07**	**0.09**	0.05	0.18	0.06	0.14
Reside_Yrs_Tot_Hurr_Vuln_Age_Ltd	-0.04	0.31	-0.04	0.33	-0.05	0.19	-0.05	0.23	-0.02	0.49	-0.03	0.45
Education_Years_Continuous	0.03	0.52	0.03	0.46	0.02	0.66	0.02	0.61	0.00	0.91	-0.01	0.85
Survey_In_Spanish	**0.09**	**0.02**	0.08	0.04	0.10	0.01	0.11	0.00	0.05	0.11	0.05	0.12
House_Type_Dummy	**-0.07**	**0.07**	-0.08	0.06	-0.06	0.12	-0.06	0.10	-0.03	0.37	-0.03	0.36
Income_Continuous_Thousands	-0.04	0.36	-0.04	0.42	-0.05	0.25	-0.06	0.16	0.02	0.60	0.02	0.51
Male_Dummy	**-0.11**	**0.00**	**-0.11**	**0.00**	**-0.10**	**0.01**	**-0.08**	**0.02**	**-0.05**	**0.10**	-0.05	0.13
Own_Residence_Dummy	-0.03	0.44	-0.03	0.51	-0.03	0.55	-0.02	0.70	0.01	0.88	0.01	0.86
Children_In_House_Dummy	**0.08**	**0.05**	**0.08**	**0.04**	**0.08**	**0.04**	**0.07**	**0.06**	0.01	0.85	0.01	0.80
H10_Factor1_Individualistic			0.05	0.18	**0.03**	0.40	0.03	0.38	0.02	0.50	0.02	0.47
H10_Factor2_Egalitarian			0.05	0.14	0.05	0.19	**0.06**	**0.07**	0.00	1.00	0.00	0.92
Evac_Zone_Perceived_Yes_Dummy					**0.17**	**0.00**	**0.11**	**0.00**	0.03	0.30	0.03	0.31
Likely_Conditions_Winds_Obj_Blow					**-0.08**	**0.07**	**-0.07**	**0.09**	-0.04	0.25	-0.04	0.29
Likely_Conditions_Storm_Surge					**0.06**	0.16	0.05	0.25	0.02	0.50	0.02	0.55
Likely_Conditions_Inland_Flood					0.03	0.50	0.02	0.67	0.00	0.98	0.00	0.97
Likely_Impacts_Mort_Morb					0.04	0.31	0.04	0.29	0.02	0.53	0.03	0.47
Likely_Impacts_Looting					0.04	0.39	0.03	0.38	0.00	0.99	-0.01	0.86
Risk_Catastrophic_Hurricanes					**0.09**	**0.01**	0.08	0.02	0.03	0.32	0.03	0.34
Risk_Control_Hurricanes					**0.08**	**0.03**	**0.08**	**0.02**	**0.09**	**0.00**	**0.09**	**0.00**
Hurricane_Likelihood_Next_Yr					0.03	0.38	0.05	0.19	0.01	0.70	0.01	0.75
Prior_Response_Evac_Dummy							**0.24**	**0.00**	**0.17**	**0.00**	**0.17**	**0.00**
Prior_ExperienceSev_NoExp=0							**-0.08**	**0.03**	-0.03	0.29	-0.04	0.23
Prior_Prep_Q9_Total							-0.02	0.62	0.00	0.90	-0.01	0.79
REGRfactorscore1_Motivations									**0.43**	**0.00**	**0.42**	**0.00**
REGRfactorscore2_Barriers									0.00	0.98	-0.01	0.87
REGRfactorscore3_House_Safe									**-0.24**	**0.00**	**-0.24**	**0.00**
Sources_Factor_1_Official											-0.02	0.59

Sources_Factor_2_Personal											0.06	0.11

	Model Summary						Change Statistics			
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**F Change**	**Df 1**	**Df 2**	**Sig. F Change**	
0	.248a	0.062	0.051	1.375	0.062	5.783	9	794	0	
1	.258b	0.066	0.053	1.373	0.005	2.036	2	792	0.131	
2	.361c	0.13	0.108	1.333	0.064	6.385	9	783	0	
3	.424d	0.18	0.156	1.296	0.05	15.802	3	780	0	
4	.599e	0.359	0.337	1.149	0.179	72.171	3	777	0	
5	.601f	0.361	0.338	1.148	0.002	1.29	2	775	0.276	

Appendix B2: Dependent Variable: Evac_Likelihood_Order												
	Model0		Model1		Model2		Model3		Model4		Model5	
COMBINED(N=804)	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.
(Constant)		0.00		0.00		0.00		0.00		0.00		0.00
Age_in_Years	**-0.08**	**0.08**	**-0.08**	**0.08**	**-0.07**	**0.10**	-0.05	0.25	-0.06	0.12	**-0.09**	**0.03**
Reside_Yrs_Tot_Hurr_Vuln_Age_Ltd	-0.04	0.34	-0.04	0.35	-0.05	0.18	-0.04	0.28	-0.02	0.52	-0.03	0.36
Education_Years_Continuous	**0.10**	**0.01**	**0.10**	**0.01**	**0.08**	**0.04**	**0.08**	**0.05**	0.05	0.16	0.06	0.13
Survey_In_Spanish	0.03	0.41	0.03	0.53	0.02	0.63	0.03	0.53	-0.01	0.81	-0.02	0.62
House_Type_Dummy	**-0.09**	**0.03**	**-0.09**	**0.03**	**-0.09**	**0.03**	**-0.09**	**0.03**	-0.05	0.25	-0.04	0.30
Income_Continuous_Thousands	0.04	0.35	0.05	0.28	0.02	0.66	0.01	0.75	0.04	0.28	0.04	0.32
Male_Dummy	**-0.13**	**0.00**	**-0.13**	**0.00**	**-0.13**	**0.00**	**-0.12**	**0.00**	**-0.10**	**0.00**	**-0.09**	**0.01**
Own_Residence_Dummy	0.04	0.32	0.05	0.29	0.05	0.29	0.05	0.23	0.06	0.14	0.07	0.08
Children_In_House_Dummy	0.04	0.37	0.03	0.38	0.03	0.37	0.03	0.40	-0.03	0.46	-0.02	0.56
H10_Factor1_Individualistic			0.00	0.92	-0.01	0.87	-0.01	0.88	0.00	0.92	0.00	0.92
H10_Factor2_Egalitarian			0.04	0.31	0.04	0.31	0.05	0.19	0.01	0.80	0.00	0.92
Evac_Zone_Perceived_Yes_Dummy					**0.11**	**0.00**	**0.08**	**0.04**	0.04	0.29	0.03	0.38
Likely_Conditions_Winds_Obj_Blow					**0.08**	**0.07**	**0.09**	**0.05**	**0.10**	**0.01**	**0.09**	**0.03**
Likely_Conditions_Storm_Surge					**-0.10**	**0.01**	**-0.11**	**0.01**	**-0.09**	**0.02**	**-0.10**	**0.01**
Likely_Conditions_Inland_Flood					0.04	0.44	0.02	0.61	-0.01	0.81	0.00	0.97
Likely_Impacts_Mort_Morb					0.05	0.28	0.05	0.26	0.03	0.50	0.01	0.72
Likely_Impacts_Looting					-0.02	0.67	-0.02	0.71	-0.02	0.62	-0.02	0.64
Risk_Catastrophic _Hurricanes					**0.09**	**0.02**	**0.08**	**0.02**	0.04	0.28	0.03	0.30
Risk_Control_Hurricanes					**0.07**	**0.06**	**0.07**	**0.05**	**0.07**	**0.03**	**0.08**	**0.02**
Hurricane_Likelihood_Next_Yr					0.04	0.31	0.06	0.13	0.02	0.53	0.02	0.61
Prior_Response_Evac_Dummy							**0.15**	**0.00**	**0.10**	**0.01**	**0.10**	**0.01**
Prior_Experience Sev_NoExp=0							**-0.08**	**0.03**	-0.05	0.19	**-0.06**	**0.10**
Prior_Prep_Q9_Total							-0.02	0.53	-0.03	0.44	-0.05	0.13
REGR factor score1_Motivations									**0.35**	**0.00**	**0.32**	**0.00**
REGR factor score2 _Barriers									**-0.12**	**0.00**	**-0.11**	**0.00**
REGR factor score3_House_Safe									**-0.08**	**0.02**	**-0.08**	**0.02**

Sources_Factor_1_Official											**0.14**	**0.00**
Sources_Factor_2_Personal											0.01	0.88

	Model Summary						Change Statistics		
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
0	.221a	0.049	0.038	1.226	0.049	4.532	9	794	0
1	.224b	0.05	0.037	1.226	0.001	0.522	2	792	0.594
2	.303c	0.092	0.069	1.206	0.042	4.013	9	783	0
3	.336d	0.113	0.087	1.194	0.021	6.078	3	780	0
4	.477e	0.228	0.202	1.116	0.115	38.605	3	777	0
5	.495f	0.245	0.217	1.105	0.017	8.683	2	775	0