



ARTICLE

What Makes Homeowners Consider Protective Actions to Reduce Disaster Risk? An Application of the Precaution Adoption Process Model and Life Course Theory

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Abstract We hypothesize that for disaster risk mitigation, many households, despite being aware of their risk and possible mitigation actions, never seriously consider doing anything about them. In mitigation-focused decisions, since there is no equivalent to warning messages, the decision process is likely to evolve over an extended time. We explore what activates hurricane mitigation protective action decisions through three research questions: (1) to what extent are homeowners unengaged in protective action decision making? (2) What homeowner characteristics are associated with lack of engagement? And (3) to what extent do different life events trigger engagement in the decision-making process? We use the Precaution Adoption Process Model to conceptualize engagement as distinct from decision making; the broader protective action decision-making literature to explore drivers of engagement; and Life Course Theory to examine potential transitions from unengaged to engaged. We use survey data of homeowners in North Carolina to examine these

questions empirically. Findings suggest that one-third of respondents had never engaged in protective action decisions, that life experiences differ in their occurrence frequency and effect on households' mitigation decisions, and that some events, such as renovating, reroofing, or purchasing a home may offer critical moments that could be leveraged to encourage greater engagement in mitigation decision making.

Keywords Homeowners · Hurricane damage · Life course theory · Mitigation decisions · North Carolina · Protective action

1 Introduction

Homeowners play an important role in managing natural hazard-related disaster risk. While government agencies, insurers, and others can provide incentives and restrictions to influence their behavior, ultimately only homeowners have the authority to determine if and how to manage the risk to their homes. They decide whether to strengthen their homes against future hazard events or if they will purchase insurance to ease recovery should damage occur. Thus, understanding the protective action decision-making process of homeowners has been an area of interest for both researchers and practitioners.

This study adopted a simplified version of the stages found in the Precaution Adoption Process Model (PAPM) from the health sciences (Weinstein 1988), and combined it with predictors from prior hazards and disasters literature and from Life Course Theory (LCT) to explore hurricane mitigation attention and engagement. The PAPM is a stage theory that outlines seven stages a person can go through in the precaution adoption process: (1) unaware of the issue;

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(2) unengaged by the issue; (3) undecided about acting; and then either (4) decided not to act; or (5) decided to act; (6) acting; and (7) maintained action. Though common in health research, the PAPM has been applied to a limited number of disaster-focused studies. In those cases, it was considered a tool to explore the effect of educational treatments on transitions through these awareness and decision phases (Glik et al. 2014; Jassemppour et al. 2014). Rather than exploring the effects of education, our approach integrates ideas from LCT to examine the likelihood that a person will shift awareness levels given other life events. This focus brings greater attention to the issue of the connections between life experiences and mitigation attention.

Many other theoretical perspectives have been used to frame and understand household risk decisions, including Protection Motivation Theory (Floyd et al. 2000), Theory of Reasoned Action (Hale et al. 2002), Theory of Planned Behavior (Ajzen 1991), Protective Action Decision Model (Lindell and Perry 2012), Warning Response Model (Mileti and Sorensen 1990), and Subjective Expected Utility Theory (Fishburn 1981). Those frameworks typically consider situations in which there is an explicit risk message or hazard-related cue or trigger, and they tend to focus on understanding how individuals transition from Stage 3 (undecided about acting) to either Stage 4 (decided not to act) or Stage 5 (decided to act). With no equivalent to warnings for a specific event, mitigation decisions differ in that they are likely to evolve over a more extended period of time, influenced by a number of factors and focusing events or experiences. As a result, we hypothesize that for risk mitigation many people may not have engaged with these issues enough to have developed explicit beliefs. Thus, these other theoretical frameworks may not place enough focus on the early stages of the decision process and on what activates attention to nonimminent but high-risk hazards and associated protective actions in the first place.

The PAPM provides a unique emphasis on nuanced dimensions of inaction. Individuals may be generally aware of the risk and possible mitigation actions, but still never have sat down to really consider what, if anything, to do about it. In other words, these individuals may still be at Stage 1, unaware of the issue, or Stage 2, aware of but unengaged by the issue. Weinstein et al. (2008, p. 7) suggests this “condition of awareness without personal engagement is quite common.” In a radon testing survey, for example, half of respondents in a high-risk region said that they had never thought about testing their own homes though they knew quite a bit about radon (Sandman et al. 1987). In a study on the use of disaster survival kits in Iran, 23% of respondents were aware of such kits, but had not personally engaged in the decision to get one or not

(Jassemppour et al. 2014). The most common of the four preparedness profiles identified based on FEMA’s national surveys of household disaster preparedness was called the “Not on Their Radar” profile (FEMA 2014, p. 28), similarly suggesting that many individuals have not actively engaged in the decision-making process. As Weinstein et al. (2008, p. 6) explain: “so many issues compete for their limited time and attention that people can know a moderate amount about a hazard or a precaution without ever having considered whether they need to do anything about it.”

The issue of active engagement is explored using the PAPM and LCT to motivate an analysis of data from a mailed survey of homeowners in the eastern half of North Carolina. The PAPM presents a framework for understanding the movement between stages and LCT frames this process in the temporal context of an individual’s life. Life Course Theory suggests that the likelihood a person engages in a specific action may vary throughout their life depending on past experiences, societal expectations, and public institutions in place (Elder et al. 2003). These choices to engage in an action, sometimes called turning points, build up over a lifetime and continue to inform future decisions, crafting a unique, personal trajectory marked by periodic transitions between different trajectories (Elder et al. 2003). This study examines whether certain experiences trigger engagement in the protective action decision process, focusing on possible turning points that motivate transition to new stages, rather than considering related choices as one long trajectory.

With this motivation, this study specifically examines three research questions:

- *Research Question 1.* To what extent are homeowners unengaged in protective action decision making, that is, in Stage 1 or 2?
- *Research Question 2.* What homeowner characteristics are associated with lack of engagement in protective action decision making, that is, being in Stage 1 or 2?
- *Research Question 3.* To what extent do different life events trigger engagement in the protective action decision-making process, that is, movement to Stage 3?

This study contributes to the literature by offering an examination of protective action behavior focused on how homeowners become engaged in the disaster mitigation decision-making process in the first place (rather than how they make the decision once engaged). It is one of the first applications of the PAPM and LCT to disaster mitigation decision making.

Section 2 provides an overview of the PAPM and LCT theoretical frameworks. The data are presented in Sect. 3, and the analyses addressing the three research questions are detailed in Sect. 4. The article concludes with discussion of

the findings, their implications for research and policy, and study limitations.

2 Theoretical Framework

This study draws on two theoretical frameworks, described in turn. The PAPM presents a way to understand the stages an individual goes through in potentially undertaking a precautionary behavior (Sect. 2.1). The LCT frames these stages in the temporal context of an individual's life and offers possible events that might trigger movement from one stage to another (Sect. 2.2).

2.1 Precaution Adoption Process Model

Although widely used in relation to precautionary behaviors to reduce health risk, such as osteoporosis prevention (Blalock 2007), cancer screening (Costanza et al. 2005), and smoking cessation (Borrelli et al. 2002), the PAPM has rarely been applied to disasters (Glik et al. 2014; Jassempour et al. 2014), and never to explain natural hazard-related disaster mitigation behavior. As a stage theory, the PAPM presumes that there are qualitatively different stages a person can pass through in the decision-making process. Each stage has unique criteria and factors that govern transitions from one stage to the next. Importantly, the factors that determine transition from one stage to another may differ depending on the transition. The PAPM suggests, therefore, that individuals' decisions cannot be described by a single equation, but rather require a series of equations that include one for each stage transition.

The PAPM proposes seven stages (Fig. 1). A person in Stage 1 is unaware of the issue. The person has never heard of the potential precaution and may not even be aware of the hazard. For a person to transition to Stage 2—aware but unengaged—the individual must have heard of the precaution but not have considered if they need to do anything

about it. People are busy with many demands for their time, and, in this stage, the precaution of interest has not sufficiently captured a person's attention to force thoughtful engagement about the decision. Stage 2, which Weinstein et al. (2008) suggest is common, has not been examined much in the disaster mitigation context. Once a person focuses attention on the decision, but before they choose an action, they are in Stage 3. The majority of modern disaster decision theories are focused on articulating what drives movement from this third stage to either Stage 4 if they decide not to act, or Stage 5 if they decide to act. Notably, deciding to act is still substantially different from actually acting and thus implementing the protection to their property. Other theories, such as the Theory of Planned Behavior (Ajzen 1991) and the Protection Motivation Theory (Floyd et al. 2000), have distinguished between deciding to act (Stage 5) and acting (Stage 6). Similarly, the Protective Action Decision Model articulates the importance of facilitators and impediments to this implementation (Lindell and Perry 2012). Finally, some precautionary actions require maintenance or repetition to be effective. Stage 7 captures that state of being. The PAPM is not a theory about risk perception. Each stage is defined in terms of mental states about the precautionary action in question, not about personal vulnerability to risk (Weinstein et al. 2008).

Fully specifying the theory requires identifying the factors that lead one to transition from one stage to another (Weinstein et al. 2008). While Weinstein et al. (2008) do not do that, they offer some examples. They suggest that media messages about the hazard and precaution, for example, may contribute to a transition from Stage 1 to Stage 2 or Stage 2 to Stage 3, but are likely less important for the later transitions. By contrast, beliefs about the hazard likelihood and severity, personal susceptibility, and the effectiveness and ease of implementing precautions may be important in the transition from Stages 3 to 4 or Stage 5.

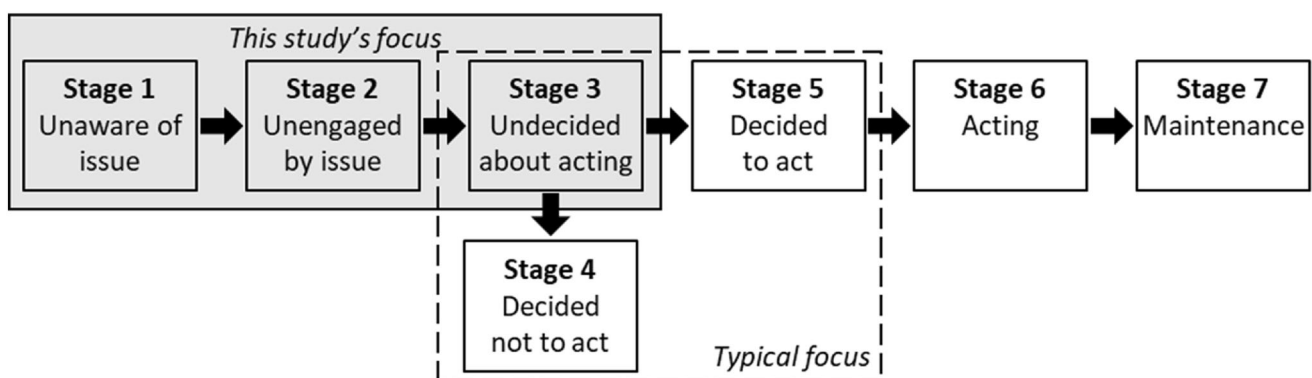


Fig. 1 Precaution Adoption Process Model (PAPM) stages. *Source* Adapted from Weinstein et al. (2008).

There are a couple of potential benefits to adopting the PAPM for homeowner mitigation decision making. First, defining the stages allows for distinctions among different types of homeowners who are not taking the precautionary action. Consider four different types of homeowners—one who is unaware of options to strengthen their home, one who is moderately aware but not focused on the decision about whether to do it, one who is actively deciding whether to do it, and one who has weighed the pros and cons and decided not to strengthen their home. All four of those homeowners appear as those not strengthening their home, but their mental state, and the interventions that might lead them to strengthen their home, may be quite different. Second, to the extent that the decision-making process does indeed include stages, representing that process with an equation for each transition should lead to a greater accuracy and insight than trying to capture it all with one equation.

Previous research has focused largely on the transition from Stage 3 to either Stage 4 or Stage 5 (Fig. 1). In our study, we hypothesize that for natural hazard-related disaster mitigation decisions, many homeowners may be stuck in Stage 1 or 2, before they even get to the actual decision in Stage 3. We focus on trying to understand how common it is for homeowners to be in Stage 1 or 2, and if LCT, described in Sect. 2.2, can help explain the transition to Stage 3.

2.2 Life Course Theory

Life Course Theory (LCT) is a theoretical paradigm developed to study individuals' lives. It centers on the idea of a life course, "a sequence of socially defined events and roles that the individual enacts over time" (Giele and Elder 1998, p. 22). The concept incorporates diverse types of events, including historical events, social interactions, and age-related biological states of the person. As such it connects the trajectory of a person's life to the larger social and cultural context. Life course integrates the importance of time, context, and meaning on human development and family life (Bengtson and Allen 1993). Life Course Theory suggests that the likelihood a person will experience a specified life transition or engage in a specific action depends on: (1) past experiences and the knowledge gained from those experiences; (2) societal pressures and expectations, such as the belief a person should be married by a certain age (George 1993); and (3) public institutions, such as the legality of marriage for people of different sexual orientations. These three factors inform a person's life course, moving them down different "trajectories" with specific durations between "transitions," which are changes in their mental state, role, status, or identity (for example, becoming a parent or retiring). A person also

experiences "turning points," or substantial changes in the direction of their life, triggered by further experiences or expectations (Elder et al. 2003). Without a change stimulated by these three factors, a person is expected to continue their behavior as normal.

Most commonly used in sociology, LCT has also been applied to natural hazards and protective action engagement to a limited extent. DeWaard (2016) uses a life course perspective to study differences in vulnerability to hazards and disasters as processes. In Cohan and Cole (2002), a disaster event, Hurricane Hugo, is the impetus for transitions within individuals' life courses. In addition, there are studies that do not explicitly reference LCT, but similarly reflect the idea that prior experiences, social expectations, and institutions can influence protective action engagement (Paton et al. 2010, Lo 2013). Weinstein (1989, p. 46) noted the "effects of individual experience were greater in the communities that had more hazard experience" and later paired this idea with the development of the PAPM model (Weinstein et al. 2008).

Life Course Theory research can be conducted over a longitudinal time frame or at specific cross-sections of life courses. Longitudinal studies compare the life courses of individuals exposed to different turning points after an initial assessment of similar control variables. Warr (1998), for example, studied continued criminal behavior of previously incarcerated individuals based on the way peer interaction changed after marriage. Here, multiple turning points or events are tracked (initial incarceration, marriage, opportunities to participate in crime) and the influence of these events is studied in their sum on an individual's life course. Other LCT research has addressed the cross-section of life courses after facing the same transitional trigger, such as the way birth, marriage, and divorce rates changed as a result of individuals experiencing Hurricane Hugo (Cohan and Cole 2002). In that example, individuals share a common singular triggering event (experiencing Hurricane Hugo) and the study uses changes in behavior (birth, marriage, and divorce rates) to understand the effect of the triggering event as a turning point in an individual's life course.

In this study, we apply LCT in a cross-sectional manner, examining how 10 possible life experiences—some related to natural hazards and disaster risks, others related to common life events—affect engagement in protective action decisions for hurricanes, specifically strengthening the home and purchasing insurance. These 10 measures represent an initial exploratory set of items that includes common transition moments often used in related LCT studies and experiences found to influence hurricane risk perceptions in past studies. Due to the limited size of the data set, we examine only the effect of each individual experience on a homeowner's protective action behavior

rather than to consider how multiple experiences might act in combination.

3 Data Collection

In this section, we present the data used for the empirical analysis. Section 3.1 describes the survey deployed to collect the data, and Sects. 3.2, 3.3., and 3.4 define, respectively, the variables that assess an individual's engagement in the protective action decision, explanatory variables potentially associated with that engagement, and life experiences that may trigger that engagement.

3.1 Survey Overview

In January 2017, a mail survey was deployed to a random sample of 2,500 single-family households in the eastern half of North Carolina, from the Raleigh-Durham area eastward to the coast. The study region was selected because it regularly experiences damaging hurricanes, including Hurricanes Isabel (2003), Irene (2011), Matthew (2016), and Florence (2018). On average 2.3 tropical cyclones affect North Carolina every year, and one makes direct landfall in the state every other year (NCSCO 2019). In fact, Hurricane Matthew caused extensive flooding and damage in the study area in October 2016, just a few months before the survey was deployed. The sample was purchased from *Genesys*, a branch of the Marketing Systems Group, which uses the U.S. Postal Service address database to select random addresses for research purposes. To be eligible, respondents had to confirm that they were at least 18 years old, owned and lived at the delivery address, and participated in home improvement decisions related to the property. The survey instrument included sections on risk perception, hurricane experience, past and hypothetical future retrofit, and property acquisition decisions, as well as sociodemographic information. It also included questions on life experiences and their possible relation to protective action decision making, which were a focus of this study.

Our study used Dillman's (2007) recommendations to maximize survey response rates. Postcards were mailed first, indicating that respondents' participation in a scientific research study was being requested. One week later, the surveys were mailed with a personal note from the researchers, an addressed, stamped return envelope and a USD 1 bill. Surveys were mailed again two and four weeks later. A total of 234 surveys were returned and used in the analysis. Based on the American Association for Public Opinion Research's (AAPOR) Response Rate 1 metric (AAPOR 2019), the response rate for our survey was 10%. The Cooperation Rate 1 is 90%, suggesting that a large

driver of our response rate was noncontact, a well-known problem.¹ All elements of the study design and instrumentation were reviewed by our university Institutional Review Board and approved as conforming to standards for informed consent.

Compared to the demographics for the population from which it was drawn—homeowners in the eastern half of North Carolina—the sample was slightly older and included slightly higher percentages of people identifying as White and as married than the population. Since the average age of first-time homebuyers in 2017 was 32 years (Ramirez 2017), we assume homeowners include only persons 30+ years. The average age in our sample was then 59 years, compared to 54 years in the population. Based on 2019 homeownership rates by race (U.S. Census Bureau 2019), the population of homeowners was approximately 79% White versus 81% for the sample. The sample was 48% male and 52% female, compared to 47% male and 53% female, for the comparison population.

3.2 Engagement Variables

To capture the extent to which a homeowner is engaged in the protective action decision-making process, the first survey question read: "Before you received this survey, how often would you say you thought about each of the following: (a) the risk of a hurricane damaging your home?, (b) Options to strengthen your home against a hurricane?, (c) Insurance options to reduce the cost if a hurricane affected your home?" This was the first question asked so as to minimize the extent to which taking the survey itself might engage the respondent in the protective action decision process. Table 1 summarizes the responses to parts (b) and (c), which are used to address Research Question 1 (Sect. 4.1). These responses were also collapsed into binary variables *Engaged in strengthening decision*, y_{engstr} , and *Engaged in insurance purchase decision*, y_{engins} , respectively, with levels "Never" (0) and "More than never" (1), and used as the dependent variables in the logistic regression conducted to address Research Question 2 (Sect. 4.2). While we recognize recall may not be precise enough to distinguish between one and 10 years ago, the difference between never and the other options is likely to be more reliable, and the analysis is based only on those binary responses.

¹ Response rate measures the number of people who completed the survey compared to the total requests made. Cooperation rate measures the number of people who completed the survey compared to the total responses of any kind from a respondent.

Table 1 Responses to first survey question (frequency of thoughts about strengthening home and purchasing insurance)

	Once a week	Once a month	Once a year	Once every 5 years	Once every 10 years	Never
b. Strengthen	3	11	108	22	7	81
c. Insurance	3	10	105	33	10	70

3.3 Sociodemographic and Other Explanatory Variables

This section describes explanatory variables used in the logistic regression to address Research Question 2 (Sect. 4.2). There has long been interest in understanding protective action decisions in the hazards and disasters research community. The resulting literature has identified many social, economic, and other factors associated with household decisions to take actions to manage their risk (Langer 1975; McClelland et al. 1993; Kunreuther et al. 1998; Lindell and Perry 2000; Lindell and Whitney 2000; Peacock 2003; Grothmann and Reusswig 2006; Botzen et al. 2009; CSSC 2009; Lindell et al. 2009; Botzen and van den Bergh 2012). Given the novel conceptualization of our dependent variable (engagement in protective action decisions) and the body of knowledge related to protective action decisions, it is valuable to consider demographic and other variables beyond those specified by our focal theoretical frameworks. As a result, Research Question 2 is focused on exploring factors from across the social science and engineering literature that have been associated with protective actions in order to explore their associations with engagement as conceptualized in the current study. This exploration included: (1) psychological factors such as worry, dread, and fear (Slovic et al. 2004; Ge et al. 2011; Terpstra 2011; Mulligan and Scherer 2012); (2) demographic factors such as age (Kunreuther et al. 1978; Atreya et al. 2015), race (Peacock 2003; Lindell and Hwang 2008; Ge et al. 2011), education (Jackson 1977; Garcia 1989), and income (Peacock 2003; Grothmann and Reusswig 2006; Ge et al. 2011; Osberghaus 2015); (3) location factors such as hazard proximity (Kriesel and Landry 2004; Zahran et al. 2009; Kousky 2011; Petrolia et al. 2013; Atreya et al. 2015), and tenure and tenure expectation (Lindell and Hwang 2008; Ge et al. 2011); (4) home characteristics such as home type (Petrolia et al. 2013); (5) perceptions of individual versus government responsibility for risk management (Botzen and van den Bergh 2009); (6) emotion-focused coping strategies such as locus of control and self-efficacy (Whitney et al. 2004; Grothmann and Reusswig 2006; Zaalberg et al. 2009; Becker et al. 2013); and (7) risk perception (Asgary and Willis 1997; Lindell and Whitney 2000; Lindell et al. 2009; Becker et al. 2013).

Each of these factors was captured in the survey instrument. We then selected a reduced set of variables to consider in the model so as to avoid overfitting, given the limited sample size. In selecting the reduced set, the authors aimed to capture the range of factors most often used in the extant literature while ensuring that the variables were not strongly correlated with each other and that each includes sufficient variability. Descriptive statistics for the final set of variables are presented in Tables 2 and 3.

The *thought about home damage risk* variable ($x_{thinkdam}$) was elicited in part (a) of the first survey question (Sect. 3.2): “Before you received this survey, how often would you say you thought about the risk of a hurricane damaging your home?” The six options—once a week, once a month, once a year, once every 5 years, once every 10 years or longer, and never—were collapsed into a binary coding of “Less often than once/year” (0) and “Once/year or more often” (1). To assess each respondent’s *perception of hurricane frequency* (x_{freq}) they were asked “On average, how often would you say hurricanes affect North Carolina?” Respondents selected one of six answer options—once every (a) year or more, (b) 2–4 years, (c) 5–9 years, (d) 10–14 years, (e) 15–19 years, or (f) 20 years or longer (Table 2). Of the 215 responses to the open-ended question “About how many more years do you expect to own your current home?”, 54 (25%) wrote in forever, so we coded the variable *Expected future tenure in home* (x_{fren}) as binary with values “Forever” (1) and “Less than forever” (0). *Owner responsibility* ($x_{ownresp}$) was derived from the question “To what extent do you think individual homeowners are responsible for reducing the potential effects of hurricanes in your community?”, with the four-level Likert scale responses collapsed into a binary variable (Table 2). The *education level* (x_{educ}) of respondents was evaluated by asking “What is the highest level of education you have completed?” with six answer options—(a) Less than high school graduate, (b) High school graduate, (c) 2 year college degree, (d) 4 year college degree, (e) Graduate degree, or (f) Professional degree—which were coded as two levels (Table 2).

The following four survey questions used five-level Likert scale responses, which were then coded as continuous data as supported by Norman (2010): (a) $x_{likelydam}$. “If a hurricane affects North Carolina, how likely is it to cause

Table 2 Descriptive statistics for categorical explanatory variables

Variable		Levels	Number of respondents ^a
$x_{thinkdam}$	Thought about home damage risk	0 Less often than once/yr 1 Once/year or more often	33 199
x_{freq}	NC hurricane frequency	0 Once every >4 years 1 Once every 1–4 years	45 186
x_{fien}	Expected future tenure in home	0 Not forever 1 Forever	160 53
$x_{ownresp}$	Owner responsibility	0 Not at all or a little 1 To a moderate or great extent	62 168
x_{educ}	Highest level of education completed	0 < 4 years of college 1 4 years of college or more	90 134

^aThe sum of respondents for each variable are not equal if there are missing values in the original data

Table 3 Descriptive statistics for continuous explanatory variables

Variable		Number of respondents	Mean	Standard deviation
$x_{likelydam}$	Likely damage to home ^a	231	1.68	0.92
x_{dread}	Dread ^a	220	1.65	1.26
x_{res}	Year moved to residence	225	2000	15.74
$x_{control}$	Locus of control ^a	232	2.27	0.96
$x_{selfeff}$	Self-efficacy ^a	231	2.53	1.02
x_{inc}	Annual household income, \$1000s ^b	197	99.76	75.72

^aThese variables were collected using a 5-level Likert scale, but were modeled as continuous values from 0 to 4.

^bIncome was asked an interval variable but was coded as a continuous variable with the values in parentheses for each interval: less than USD 15k (USD 7.5k), USD 15k–35k (USD 25k), USD 35k–50k (USD 42.5k), USD 50k–75k (USD 62.5k), USD 75k–100k (USD 87.5k), USD 100k–150k (USD 125k), USD 150k–250k (USD 200k), more than USD 250k (USD 300k)

significant damage to your home?”, “Very unlikely” (0) to “Very likely” (4); (b) x_{dread} . “To what degree do you experience dread when it comes to hurricanes?”, “Not at all” (0) to “An extreme amount” (4); (c) $x_{control}$. “Do you believe that hurricane damage is unavoidable?”, “Strongly disagree” (0) to “Strongly agree” (4); and (d) $x_{selfeff}$. “Do you believe that your actions matter in determining how much a hurricane will damage your home?”, “Strongly disagree” (0) to “Strongly agree” (4). Homeowner’s time in their residence (x_{res}) was evaluated based on the open-ended question “About what year did you start living in your current home?” Homeowner income level (x_{inc}) was evaluated by asking respondents “Please mark the income range that best describes your annual household income from all sources” as noted in the footnote of Table 3.

3.4 Life Experience Variables

To address Research Question 3 (Sect. 4.3), survey respondents were asked about life experiences and their

potential effects on engagement in the protective action decision-making process in two two-part questions. The first question asked for revealed preference data (RP), also known as behavioral data. Specifically, it read, “Below is a list of experiences that you may have had in the past. For each experience, please answer the two questions about its effect on you: (A) Have you ever had this experience? (“Yes” or “No”), and (B) Did having this experience make you consider buying more insurance or strengthening your home to protect it from hurricanes? (“Yes,” “No,” “N/A”).” The second question asked for stated preference data (SP), that is, perceptions of what might happen in the future. With a similar structure, it read, “Below is the same list of experiences. For each experience, please answer the two questions about its effect on you: (A) Is it possible you will have this experience in the next 5 years? (“Yes” or “No”), and (B) If you do have this experience, do you think it will make you consider buying more insurance or strengthening your home to protect it from hurricanes? (“Yes,” “No,” “N/A”).” The 10 experiences listed in each

of these two two-part questions are shown in Table 4. They represent a variety drawn from past hazards research and ordinary life events commonly used in LCT including: (1) hazard events (*experienced a hurricane, heard about a hurricane*), (2) general life events (*marital status changed, dependent joined household*), (3) life events directly related to homes (*purchased a home, renovated a home*), and (4) events in which homeowners observe or interact with social systems connected with risk reduction (*family or friends strengthened their homes, insurance premium changed, options to protect home explained, learned about program to pay to strengthen home*).

Table 4 summarizes the data on life experiences and their potential influence on protective action decision engagement. Let $A_{RP,j}$ and $A_{SP,j}$ be binary variables with a value of one if the respondent had or will have, respectively, experience j , and zero otherwise. Let $B_{RP,j}$ and $B_{SP,j}$ be binary variables with a value of one if, given the respondent had (will have) experience j , the experience led (will lead) to consideration of buying more insurance or strengthening the home, and zero otherwise. If a response to Question A was Yes for an experience j , an N/A response for B for the same experience j was interpreted as a No. (If those responses are omitted instead, the effect is to increase probability $P(B|A)$ values by an average of 0.03, and the conclusions do not change.) The number of missing responses varied across the 10 experiences (Table 4). Overall, 213 (4.6%) responses were missing for $A_{RP,j}$ and $A_{SP,j}$, and 133 (5.7%) for $B_{RP,j}$ and $B_{SP,j}$.

4 Data Analysis and Results

Data analyses conducted to address each of the three Research Questions are presented in Sects. 4.1, 4.2, and 4.3, respectively. The implications of those results are discussed at length in Sect. 5.

4.1 Prevalence of Being Unengaged

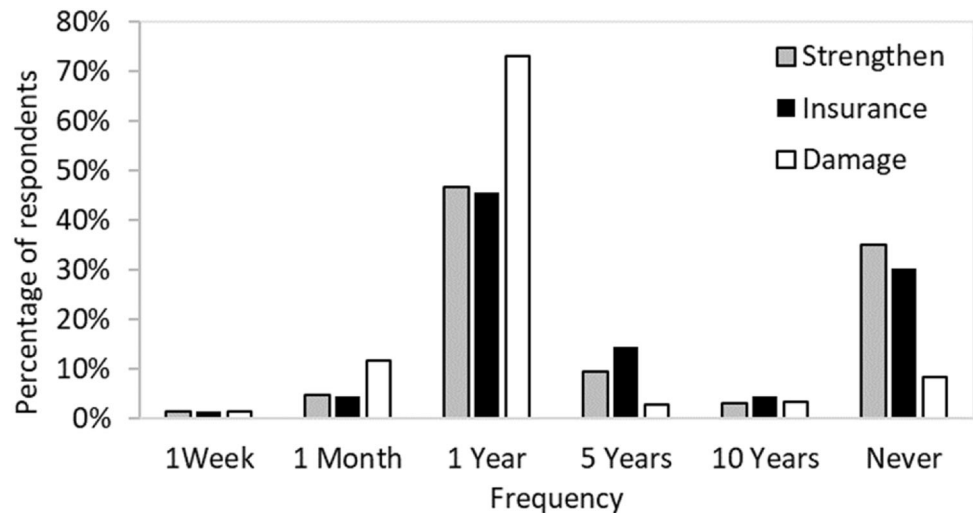
The first Research Question asks: *To what extent are homeowners unengaged in protective action decision making, that is, in Stage 1 or 2?* The results (Fig. 2), based on data from Sect. 3.2, indicate that one in three respondents never thought about options to strengthen the home (35%) or insurance options (30%), and 44% of respondents said never to at least one of the actions. This suggests that approximately one-third of homeowners have never actively engaged in protective action decision making for hurricanes. They may be aware of the possibilities of purchasing insurance or strengthening their home to protect against hurricanes to some extent, but they have not actively engaged in the decision, that is, moved to Stage 3. The responses from part (a) of this question ($x_{thinkdam}$ from Sect. 3.3) indicate the difference between thinking about the risk (potential hurricane damage) and the protective action (insurance or strengthening). While few people have never thought about the risk of hurricane damage to their home (8%), many have never thought about protective actions to reduce that risk. As noted in Sect. 2.1, the PAPM

Table 4 Data on life experiences and their potential influence on engagement in protective action decision making

Experience j		Revealed preference ($i = RP$)						Stated preference ($i = SP$)					
		A: had experience			B: considered protective action given experience			A: possible will have experience in next 5 years			B: will make you consider protective action if have experience		
		Yes	No	Mis ^a	Yes	No	Mis ^a	Yes	No	Mis ^a	Yes	No	Mis ^a
Pur	Purchase a home	210	20	4	78	128	4	57	168	9	30	26	1
Reno	Renovate your home or reroof	146	78	10	43	97	6	113	111	10	57	51	5
Ins	Your insurance premium changes	159	66	9	48	103	8	164	58	12	67	83	14
Ret	Learn about a program to help pay to strengthen your home	21	204	9	8	12	1	78	136	20	56	16	6
Ehurr	Experience a hurricane	217	11	6	86	118	13	204	18	12	91	102	11
Hhurr	Hear about a major hurricane somewhere else	225	4	5	46	166	13	213	10	11	59	138	16
Dep	A child or elderly dependent joins your household	97	129	8	14	76	7	33	182	19	11	21	1
Mar	Your marital status changes	102	127	5	9	85	8	28	193	13	9	18	1
Fam	Family or friends strengthen their homes	42	183	9	19	19	4	80	136	18	35	39	6
Opt	Someone explains options to protect your home	47	179	8	20	24	3	91	127	16	55	31	5

^aMis Missing

Fig. 2 Responses to questions about regularity of engagement in hurricane home insurance and strengthening decisions and thinking about risk to damage to the home



is focused on psychological states with regard to protective action, not risk perception.

4.2 Homeowner Characteristics Associated with Lack of Engagement

With the substantial percentage of homeowners not engaged in the protective action decision, it makes sense to ask what differentiates those in that stage of the process. Thus, we examine Research Question 2: *What homeowner characteristics are associated with lack of engagement in protective action decision making, that is, being in Stage 1 or 2?* We do so by investigating possible relationships between being unengaged (in Stage 1 or 2) and various attributes of the homeowner drawn from prior hazards literature (Sect. 3.3). Specifically, we fitted logistic regression models with the response variables *Engaged in strengthening decision*, y_{engstr} , and *Engaged in insurance purchase decision*, y_{engins} , respectively (defined in Sect. 3.2).

Logistic regression is a specific case of a generalized linear model (GLM) in which the response variable, Y , is assumed to follow a binomial distribution and a logit link function is used (Agresti 2007):

$$\ln\left(\frac{p_i}{1-p_i}\right) = \vec{x}_i^T \vec{\beta} = \beta_0 + \sum_{k=1}^m \beta_k x_{ki} \quad (1)$$

where p_i is the probability $Y_i = 1$ (in this case, the probability respondent i is engaged in the protective action decision), $\vec{x}_i$ is a vector of explanatory variables for respondent i , and $\vec{\beta}$ is a vector of regression coefficients to be estimated. Logistic regression models were fitted using the *glm* function in the *{stats}* package in R (R Core Team 2016). All explanatory variables in Tables 2 and 3 were included. They were selected as described in Sect. 3.3.

Incomplete observations were removed. The McFadden's R^2 values of $R_{MF}^2 = 0.47$ and 0.38 for the strengthening and insurance models, respectively, suggest good model fits. Table 5 summarizes the remaining results.

The logistic regression results suggest that homeowners are more likely to be unengaged in the strengthening decision (that is, in Stage 1 or 2) if, before taking the survey, they: (1) thought about the risk of a hurricane damaging their homes less frequently than once/year ($x_{thinkdam}$); (2) think hurricanes affect North Carolina on average no more than once every 4 years (x_{freq}); (3) think significant hurricane damage to their homes is less likely ($x_{likelydam}$); (4) do not experience dread when it comes to hurricanes (x_{dread}); and (5) disagree that their actions matter in determining how much a hurricane might damage their homes ($x_{selfeff}$). Similarly, homeowners are more likely to be unengaged in the insurance purchase decision if they: (1) thought about the risk of a hurricane damaging their homes less frequently than once/year ($x_{thinkdam}$); (2) think significant hurricane damage to the home is less likely ($x_{likelydam}$); and (3) disagree that hurricane damage is unavoidable ($x_{control}$). Those with higher perceived risk of damage are more likely to be engaged in both strengthening and insurance purchase decisions. Interestingly, self-efficacy predicts engagement in only strengthening and belief that damage is unavoidable (locus of control) in only insurance purchase where it is modestly significant.

4.3 Influence of Life Experiences on Engagement in Protective Action Decision

The third Research Question asks: *To what extent do different life experiences trigger engagement in the protective action decision-making process, that is, movement to Stage 3?* To address this, we use the data in Table 4 to compute two probabilities for each life experience j —the probability

Table 5 Logistic regression models for engagement in strengthening and insurance purchase decisions

Variable	Engaged in strengthening, y_{engstr}			Engaged in insurance purchase, y_{engins}		
	Estimate, β	SE	p -Value ^a	Estimate, β	SE	p -Value ^a
<i>Intercept</i>	19.806	34.15	0.562	51.261	33.30	0.124
$x_{thinkdam}$	1.107	0.60	0.066*	1.543	0.61	0.011**
x_{freq}	1.527	0.55	0.006***	−0.118	0.56	0.833
$x_{likelydam}$	0.723	0.27	0.006***	0.807	0.26	0.002***
x_{dread}	0.452	0.19	0.020**	0.001	0.18	0.994
x_{res}	−0.011	0.02	0.514	−0.026	0.02	0.117
x_{fen}	−0.482	0.55	0.382	−0.497	0.50	0.325
$x_{control}$	0.097	0.22	0.665	0.353	0.21	0.097*
$x_{selfeff}$	0.599	0.21	0.004***	0.104	0.19	0.582
$x_{ownresp}$	−0.128	0.49	0.795	0.187	0.46	0.681
x_{educ}	−0.815	0.50	0.102	0.426	0.47	0.367
x_{inc}	−1.72(10 ^{−4})	0.003	0.953	−3.08(10 ^{−3})	0.003	0.285

^aSignificance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

of having experience j , $P(A_j) = (A_j = Yes) / [(A_j = Yes) + (A_j = No)]$, and probability of considering protective action (that is, buying insurance or strengthening the home) given the experience j , $P(B|A)_j = (B_j = Yes) / [(B_j = Yes) + (B_j = No)]$. Observations with missing responses for Question A for experience j were omitted from the analysis of $P(A_j)$, and observations with a Yes for Question A but a missing response for Question B were omitted from the analysis of $P(B|A)_j$ (Table 4).

Figure 3 shows the $[P(B|A)]_{SP}$ vs. $[P(B|A)]_{RP}$, with a point for each experience j . It suggests that there are life experiences that influence—to varying degrees—

engagement in hurricane home protective action decisions. The conditional probabilities are 0.10 to 0.50 based on the revealed preference questions and 0.30 to 0.78 based on the stated preference questions. Further, the RP and SP results are similar (correlation is 0.68).

To determine if the differences in the $P(B|A)$ values across experiences are statistically significant, we conducted 45 pairwise comparisons of the proportions using z-tests, with the Benjamini-Hochberg procedure with a 0.1 false discovery rate to account for multiple comparisons (Benjamini and Hochberg 1995). The results suggest that for both RP and SP data, there is evidence that a change in marital status (*mar*), addition of dependents to the household (*dep*), and hearing about a hurricane elsewhere (*hhurr*) are statistically less likely than the other experiences to trigger engagement in the protective action decisions. For the SP data, there is also evidence that learning about a program to help pay for strengthening your home (*ret*) is statistically more likely than the other experiences to trigger engagement.

In comparing the 10 particular life experiences and considering their potential roles in the protective action decision-making process, it is important to recognize that they are not equally common. Figures 4a, b present the probability of engaging in a protective action decision given one has experience j , $P(B_j|A_j)$ vs. the probability of having experience j , $P(A_j)$, with an observation for each experience j , based on the revealed and stated preference data, respectively. The probability of having had or in the future having each experience j , $P(A_j)$, varies from 0.1 to almost one (Fig. 4). The results for the RP and SP data are similar except that the probabilities of purchasing a home

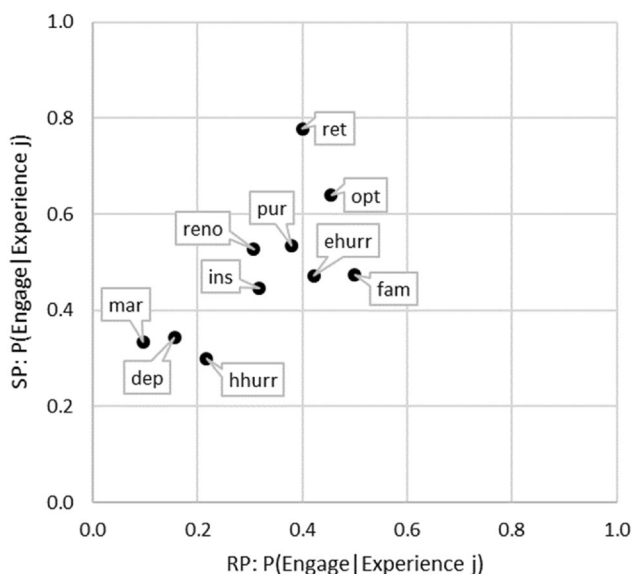


Fig. 3 $[P(B|A)]_{SP}$ vs. $[P(B|A)]_{RP}$. Experience variables are defined as in Table 4.

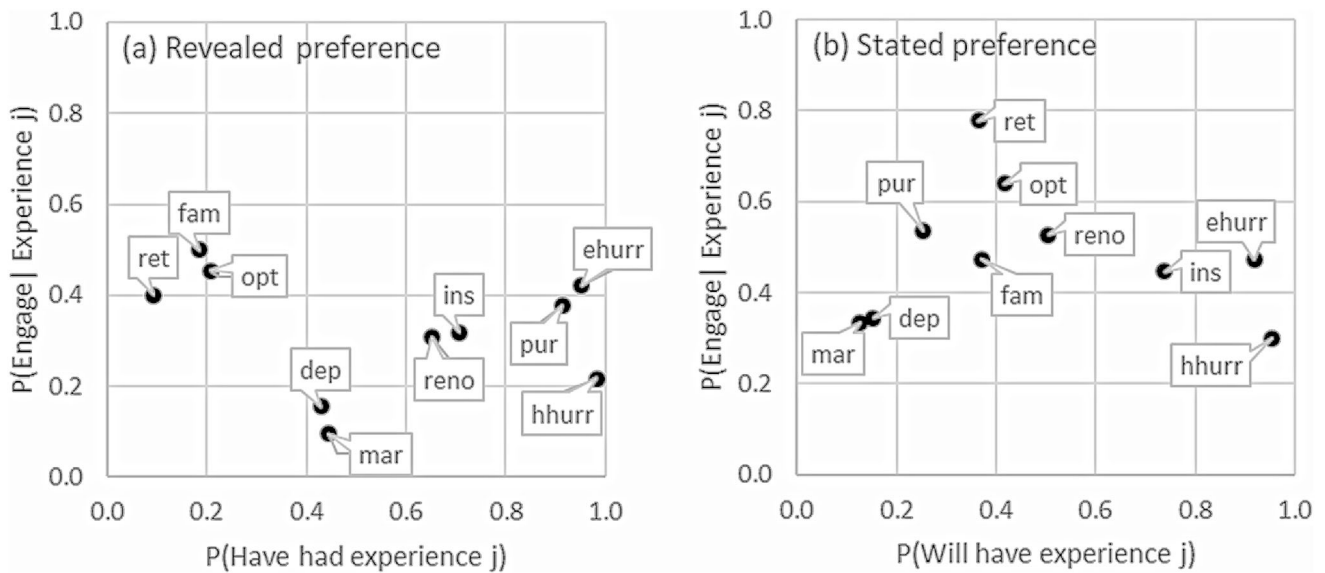


Fig. 4 $P(B|A)$ vs. $P(A)$ for (a) revealed preference data and (b) stated preference data. Experience variables are defined as in Table 4.

(*pur*), changing marital status (*mar*), and adding a dependent (*dep*) are lower in the future (SP) than the past (RP), which makes sense since those are events that often happen only once or twice. If those three are omitted, the order of experiences from most to least likely is the same for RP and SP (Fig. 4). In particular, learning about a program to pay to strengthen the home (*ret*), family or friends strengthening their home (*fam*), and someone explaining options to protect the home (*opt*) are all relatively likely to trigger engagement, but uncommon (that is, towards the upper left corner of Fig. 4a). Experiencing a hurricane (*ehurr*) and purchasing a home (*pur*), however, have similar likelihood of triggering engagement, but are already quite common (that is, towards the upper right corner of Fig. 4a).

To check if certain respondents were more or less likely to be influenced by life experiences in general, we examined the distribution of the number of Yes responses across

the 10 experiences for $A_{RP,j}$, $A_{SP,j}$, $B_{RP,j}$, and $B_{SP,j}$ (Fig. 5). In Fig. 5, for each of the four histograms, the leftmost column indicates the number of respondents who provided zero Yes responses for that question; the rightmost column indicates the number who provided ten Yes responses (that is, “Yes” for every life experience). The histograms for $A_{RP,j}$ and $A_{SP,j}$ are both approximately normal, with most respondents indicating they had 4 or 5 of the 10 life experiences listed, and only one person having or likely to have all ten. The histograms for $B_{RP,j}$ and $B_{SP,j}$, on the other hand, indicate that the great majority of respondents thought none of the experiences they had or expected to have had led or would lead them to consider protective action. These results suggest homeowners evaluated each experience differently rather than some simply indicating “Yes” for all and some indicating “No” for all.

5 Discussion and Conclusions

This study applied the PAPM and LCT as a way to conceptualize the transition from unaware/unengaged to active mitigation decision making. The results have implications for future research and practice. The study’s adoption of the PAPM provides a novel emphasis on stages of engagement prior to decision making when compared to other common protective action decision models in the hazards and disasters literature, such as the Warning Response Model or the Protective Action Decision Model. When explored empirically, our results show that almost one-third of homeowners fall into these “unengaged” stages when it comes to hurricane mitigation (Sect. 4.1). This suggests that rather than having actively chosen

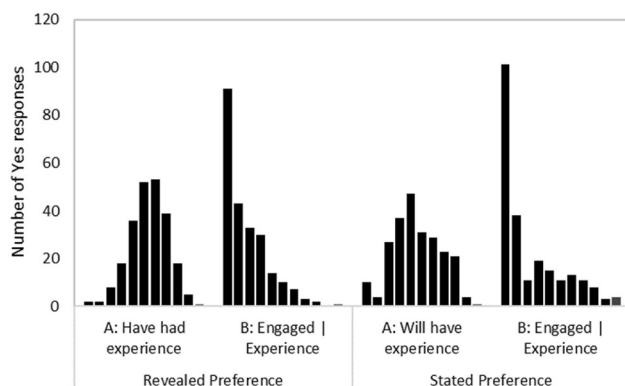


Fig. 5 Distribution of responses to 10 life experience questions

inaction, these homeowners may never have seriously considered the decision. While this warrants further investigation, the initial findings open new options for program design and for research.

Second, the results of the logistic regression (Sect. 4.2) indicate that respondents are more likely to be unengaged in protective action decisions if they think about the risk of a hurricane damaging their homes less frequently than once/year and think significant hurricane damage to their homes is less likely. These results suggest that more efforts need to be made to educate homeowners about their property's hurricane risk and likely damage. More generally, the findings reinforce the importance of risk perceptions as a driver of protective action decisions as has been commonly found in the extant literature.

In comparing the types of life experiences that appear most influential in Research Question 3 (Sect. 4.3), the data suggest that, given the measures we adopted, life status changes such as changing marital status (*mar*) or adding dependents (*dep*) have relatively little influence. Of importance for research and practice, risk reduction interventions (for example, learning about a program to help pay for strengthening your home, *ret*) were associated with increased engagement. Further, other contextual, but not risk-specific experiences, such as renovating or reroofing (*reno*) and purchasing a home (*pur*), were important and could be seen as opportunities for interventions to increase engagement in protective action decision making. The data also provide evidence that experiencing a hurricane (*ehurr*) is more influential than hearing about a major hurricane elsewhere (*hhurr*) (p-values < 0.0005 for both RP and SP data), so the type of prior hurricane experience matters, a finding that is consistent with the literature (Demuth 2015).

More generally, application of LCT provides a broader perspective for considering what stimulates risk decisions. The analysis results show an opportunity to increase engagement in protective action decision making by increasing the occurrence of life experiences that are more likely to trigger engagement. Teaching homeowners about a program to help pay for strengthening the home (*ret*) or explaining options to protect the home (*opt*), for example, were found to have relatively high probabilities of triggering engagement, but relatively low probabilities of occurring. Increasing their frequency, therefore, could increase engagement and ultimately protective actions. In a related manner, experiencing a hurricane (*ehurr*), renovating or reroofing (*reno*), and purchasing a home (*pur*) are common life experiences, but could be better leveraged by stakeholders as opportunities to increase engagement with protective action decision making. Thinking of the intersection of occurrence and effect is an important and novel notion not only for those attempting to understand human behavioral patterns, but also for those designing programs

and policies to increase mitigation behavior. Evaluating experiences in terms of their likelihood of occurrence and effect on increasing engagement could help target when and where to intervene for the greatest risk reduction.

6 Limitations and Future Work

While the conceptualization of our study provides a novel approach to consideration of mitigation and insurance, this initial exploratory study includes several important limitations and associated opportunities for future work. First, given the relatively small sample size of our dataset ($n = 234$), it would be valuable to replicate the analysis with larger samples to better ascertain the strength and complexity of these effects. In addition, it is unclear what, if any, effect the survey response rate of 10%, while increasingly common in the modern data collection, may have on the reliability of the results. Future work should compare these results with additional samples and assess this potential issue.

Second, future work should examine alternate and refined methods of measurement for the concepts included in the study. For example, some of the more general categories of life experiences, such as change in marital status, could be defined more specifically to capture potentially different effects depending on the type of change (for example, married vs. divorced vs. widowed). Likewise, the dependent variable could be partitioned to consider insurance and mitigation separately. Individual life events could also be measured in a more nuanced way, or a scale developed to capture levels of exposure.

Third, our initial results suggest that some life experiences that have not previously been the focus of attention, such as renovating, reroofing, or purchasing a home, may offer critical moments that could be leveraged by stakeholders to encourage greater engagement in mitigation decisions. Future work should explore a wide range of hazard and nonhazard life experiences and/or utilize qualitative methods to discover when and under what circumstances homeowners become engaged in mitigation decisions. Knowing this would help guide homeowner choices about the most effective times to invest in promoting mitigation decisions and help develop a variety of interventions that target the different stage transitions. In addition, broader multi-measure operationalization of these factors should be explored and empirically examined for validity and reliability.

Fourth, future work should more explicitly operationalize all the phases of the PAPM in this context. For example, it may be that media messages encourage transitions from Stage 2 to Stage 3 (unengaged to engaged in decision making), but beliefs about the hazard likelihood

and severity, personal susceptibility, and the effectiveness and ease of implementing precaution are more important in the transition from Stage 3 to 5 (engaged in decision making to action). This and many additional questions about these stages as distinct experiences may reveal further new insights as well and should be explored in more nuanced ways. With this combination of larger samples, more predictors, and greater nuance on the stages of the decision process, it may also be possible to develop improved models of the relationships among these items. Finally, in our application of LCT, we only considered the independent effects of single life experiences using a cross-sectional model. It would also be possible and useful to develop a longitudinal approach to capturing combinations of experiences in order to better understand such effects.

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