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Should We Leave? Attitudes towards Relocation in Response to Sea Level Rise

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Abstract: The participation of individuals contributes significantly to the success of sea level rise adaptation. This study therefore addresses what influences people's likelihood of relocating away from low-lying areas in response to rising sea levels. The analysis was based on a survey conducted in the City of Panama Beach in Florida (USA). Survey items relate to people's risk perception, hazard experience, threat appraisal, and coping appraisal, whose theoretical background is Protection Motivation Theory. Descriptive and correlation analysis was first performed to highlight critical factors which were then examined by a multinomial Logit model. Results show that sea level rise awareness is the major explanatory variable. Coping appraisal is qualitatively viewed as a strong predictor for action, while threat appraisal is statistically significant in driving relocation intention. These factors should be integrated in current risk communication regarding sea level rise.

Keywords: coastal hazards; climate change; regression; questionnaire; flooding

1. Introduction

Recent incidences of huge fatalities due to cyclones and hurricanes have raised strong concern about coastal vulnerability to climate change related hazards. These stimulated a major debate on quantifying climate change impacts in coastal regions, and sea level rise has been identified as a primary impact [1]. Various sources have confirmed the historical trends of sea level variations and have projected as high as 2-m sea level rise by the end of this century [2–4]. Unfortunately, the overwhelming majority of coasts over the globe would be exposed to sea level rise in several decades, according to the fifth report published by [4]. However, coasts have become major poles attracting population migration and economic growth; as a result, millions of people will have to cope with the adverse consequences of sea level rise, such as erosion [5], flooding [6,7], and salt water intrusion [8,9].

In response to sea level rise, governments and communities have developed different adaptation programs. The European Union is now advocating projects related to integrated coastal zone management that is a concept to deal with sea level rise issues under an overarching framework [10]. The Netherlands is a pioneer in testing different adaptation strategies, and developing countries in Asia have attempted to seek alternative ways to minimize sea level rise consequences [11]. Distinct views, though, exist with regard to which strategy should be employed. "Optimists" have confidence in the effectiveness of coastal defense systems and promote the use of protective structures such as sea walls and dikes, thereby encouraging a phenomenal increase in economic activities [12]. However, "pessimists" doubt that coastal lowlands may survive sea level rise inundation and advocate such strategies as the realignment of shorelines and complete abandonment of vulnerable areas. While these two sides have held strong debates about the prioritization of adaptation strategies, the understanding

of individual-level adaptation has been inadequate. The strategies can hardly be successful in isolation from the context in which households perceive climate change risks and self-efficacy regarding hazard mitigation [13]. Hence, there exists a shift from top-down analysis of adaptation measures to the cognitive and behavioral aspects of individuals in the face of risks. Nevertheless, there are only a few studies regarding people's perception on sea level rise. Current research gaps are twofold. First, it remains unclear which factors drive residents' voluntary relocation decisions in anticipation of disastrous flooding [14]. Second, little research has applied Protection Motivation Theory (PMT) into the analysis of sea level rise adaptation.

This article aims at bridging these gaps by (1) examining the relocation decisions of vulnerable households in the face of hypothetical inundation due to sea level rise and (2) identifying the linkages between risk perception, hazard experience, and intended mitigation behaviors. Its innovations are twofold. First, it illuminated whether the PMT social-psychological model, incorporated with the components of Social Amplification/attenuation of Risk Framework, is applicable to such invisible threats as sea level rise. Second, the authors explored those factors that encourage or deter residents' intention to relocate, if their residences would be inundated. The findings can help to justify whether aggressive strategies are feasible in industrialized countries—from the perspective of local residents. Local authorities can use the information to facilitate conservations with the general public and deploy efficient strategies in susceptible coasts, not necessarily the relocation option.

The rest of this article is organized as follows. We commence the paper with a literature review on people's cognitive and social variables associated with risks. Following the review, Section 3 presents several hypotheses regarding how residents view voluntary relocation because of sea level rise. Section 4 introduces the study area and a roadmap whereby we designed, administered, and analyzed structured surveys. Section 5 highlights crucial findings, and scholarly discussions are provided in Section 6. Concluding remarks are summarized in the last section.

2. The Linkages between Risk Experience, Perception, and Mitigation Behavior

Our literature review was guided by two questions. What are the classical theories and models that explain general risk perception and mitigation behaviors? What are the crucial factors that determine residents' response to sea level rise?

A growing body of the literature focuses on individuals' response towards flooding, storm surge, and other sea level rise related hazards, and the majority is centered on understanding the causal relationship between risk perception and mitigation actions. The UK, a country extremely vulnerable to flooding [15], has witnessed a proliferation of relevant studies. For instance, Harris [16] suggested that the impact of flooding experience on mitigating behaviors was mediated by the beliefs in defensive structures and insurance. In other words, people having been flooded would show greater anxiety about the adequacy of protective measures and less reliance on insurance. Similarly, Soetanto et al. [17] examined people's perception on flooding resilience in four communities in Birmingham and London and asserted that the experience with flooding, age, and additional demographic attributes were significant variables affecting people's social responsibility regarding hazard mitigation. Lo and Chan [18] further substantiated the role of risk perception in motivating individuals' actions. Investigating a community in the UK, the authors stated that perceived severity of flooding drove actions for flooding management more effectively than risk information alone. Moreover, the experience with wet-weather-related events may be associated with raised concerns about climate change, according to a recent national survey conducted in the UK [19]. People residing in flooding-prone areas were more likely to form the belief of climate change than those having heat-wave discomfort experience only. The relationship was further justified by Demski et al. [20], who found additional significance of direct experience of extreme weather events and claimed that citizens who were affected by severe storms in the winters of 2013/2014 showed a higher level of vulnerability assessment and climate change awareness than the other individuals.

The above-mentioned studies largely imply a pattern between the risk perception and hazard mitigation, and such a pattern can be explained by the PMT. The PMT was first introduced as a psychological model [21] and was applied in the domain of health behaviors. For example, the model can interpret how a diabetes patient perceives long-term risks associated with unhealthy eating behaviors and whether such cognitive assessment may influence his/her diet habits accordingly. It was later justified by the scholars in behavioral studies concerning earthquake [22], wildfire [23], flooding [24], and other natural hazards [25], but the applications on slow-onset disasters are rare.

A thorough survey of the literature on all types of disasters goes beyond the scope of this paper, so we primarily focused on flooding, hurricane, and other sea level rise related hazards. One major contribution of the PMT is its illustration of the linkage between hazard perception and risk reduction behaviors. For example, Frondel et al. [26] and Ling et al. [27] both confirmed that flood experience was positively correlated with adaptation efforts, while Lawrence et al. [28] maintained that the witnessing of major floods among German residents failed to encourage people to take more active mitigation actions. Therefore, attitude or perception may not be a good behavior predictor [29]. Between risk perception and behaviors, specifically, the PMT adds two crucial components of the perceptual process: threat appraisal and coping appraisal [30]. The former includes the assessments of how severe a risk is, what the associated possibility is, and the degree to which people fear the occurrence of the risk. The latter, often termed as adaptation appraisal in the climate change literature, deals with people's confidence and capacities of protective measures—and with the costs of such protection.

Adaptation appraisal normally occurs following threat appraisal, but their relationships may be bidirectional and dynamic [31]. Applying the PMT, Zheng and Dallimer [32] found that adaptation appraisal in response to climate change was a better predictor than risk perception. In line with this finding, Werg et al. [33] suggested that crucial cognition-related factors were confidence in official information channels, role model effects, perceived risk, and costs. Furthermore, Koerth et al. [34] stated that when faced with flooding risk, coastal residents relied more on coping appraisal to judge their adaptation capacities than threat appraisal. In addition to these variables, Werg et al. [33] found that traditional household characteristics—such as age, income, residence type—may be more important in predicting mitigating behaviors than psychological counterparts.

PMT is associated with perceptual process regarding natural hazards at the individual level, but it inadequately captures the impacts of social norm. Social Amplification/attenuation of Risk Framework (SARF) addresses such deficiency. The SARF assumes that people analyze information sources through "social and individual stations" [35]. Social stations mean that what homeowners learn from social circles influences their climate change adaptation decisions substantially [36]. This effect shows that the risk perception is socially formed and could affect how people position themselves in their social networks about the concerned climatic issues [14]. In other words, individual perception of natural risks is subject to social influence [37].

Lastly, the studies about the motivation of households' adaptation to sea level rise are scarce. When we intend to take into account the full spectrum of factors from natural to psychological dimensions, understanding residents' response to sea level rise becomes particularly difficult. People may simply use denial as a coping skill to respond to sea level rise [38]. This distant and invisible threat has gone largely unnoticed because "people are uncertain of the effectiveness of recommended actions" and "they are motivated to control their fear through denial, defensive avoidance, or reactance ([24], p. 1478). Additionally, some residents might be unable to understand the risk of what sea level rise means [38]. In some cases, sea level rise is merely one consideration among a variety of climatic and non-climatic risks [39]. For instance, Barnett et al. [40] investigated Lakes Entrance, Port Albert, and several other coastal communities in Australia and concluded that residents' lived values were more related to natural beauty, relaxed lifestyle, and the proximity to water, while people generally lacked the awareness of sea level rise issues. However, to the knowledge of the author, little research has investigated people's attitudes towards a specific sea level rise adaptation strategy at the individual level, which is a focal point of this study.

3. Hypotheses

The goals of this study are to investigate (1) whether hazard experiences and perception are directly associated with people's intention to relocate away from vulnerable areas and (2) whether the threat and coping appraisal is feasible in examining people's adaptation responses to sea level rise. Regarding disaster experience, the following hypothesis was formulated.

Hypothesis 1. *Hazard experience and perception can affect residents' relocation decision in anticipation to sea level rise.*

While we hypothesized such a linkage, the direction of effects still deserves investigation. Flood experience could increase people's likelihood to take mitigation measures [26,41,42], there is also evidence that past experience does not contribute to a higher level of intention to take self-protective actions [28,43].

Concerning the appraisal process, the hypothesis was structured as follows:

Hypothesis 2. *Adaptation appraisal is statistically significant in determining households' relocation decision.*

Finally, we also wanted to identify which demographic factors contribute to people's potential relocation preferences. The hypothesis was developed as:

Hypothesis 3. *Income, age, education background, the length of residence, and other household-level variables play a vital role in affecting residents' intention to relocate.*

4. Methods

4.1. Survey Development and Administration

To validate proposed hypotheses, face-to-face interviews guided by a structured questionnaire (in Supplementary Materials) were conducted in the City of Panama and Panama Beach in Bay County, Florida (USA) (Figure 1). Bay County lies in the northeastern part of Florida and is consistently threated by storm surge, hurricane, and other coastal hazards. Since 1877 it has been stricken by more than fifteen major hurricanes that resulted in huge economic loss and fatalities [44]. Increasing exposure to flooding, combined with recent land development, makes this region extremely vulnerable to sea level rise.

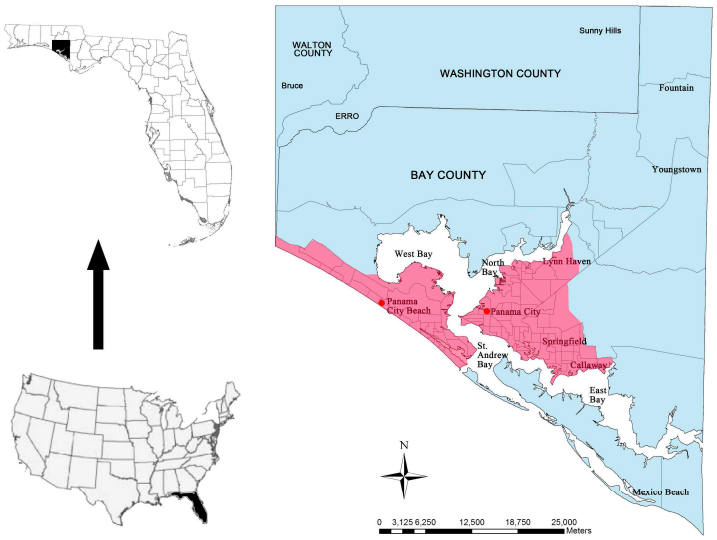

Figure 1. The cities where the survey study was conducted.

The questionnaire was designed to include the major components specified in the PMT and guided by the literature about sea level rise perception. It includes four major sections with the majority of closed questions being 5-point Likert Scale: sea level rise perception [45] and hazard experience [34], people's intention to relocate in the face of permanent inundation due to sea level rise, threat appraisal and coping appraisal [34,46], adaptation preferences [47], and respondents' demographic and housing information. An initial draft was produced and pre-tested by planning students and professors, and the text was revised according to the feedbacks from those participants. Five hundred questionnaires were administered in public beaches, city malls, and parks from March 28 to 30, 2014, in Panama City, and the respondents were randomly selected. Interviewees who were confirmed as local residents were asked to fill out a survey with the assistance of a trained investigator. We collected 226 effective questionnaires, and the return rate was 45%. The responses on the paper copies of the questionnaires were recorded in Qualtrics, an online survey instrument platform, and then exported to Statistical Package for Social Science for data cleaning and NLogit 5 for analysis.

4.2. Variables and Analytical Procedure

Table 1 presents all cognitive variables that were included in the questionnaire. At a first step, all variables underwent a Spearman correlation analysis with the dependent variable—the intention whereby a household would relocate following sea level rise inundation. The Spearman method was applied because some variables were not normally distributed, and the data were ranked before the analysis was conducted. The dependent variable was measured as an ordinal scale—i.e., not relocate, not sure, and will relocate. The correlation analysis offered an overview regarding the potential associations between factors and the relocation decisions of households. It also helped to exclude those factors with possible multi-collinearity issues. A multinomial Logit model (MNL) was then employed to identify significant variables that influence people's decisions of relocation. Stepwise regression methods were used to exclude insignificant variables.

Table 1. An overview of perception and appraisal variables used in the analysis.

Category	Description	Coding Scheme
Risk perception	To what degree do you agree with the fact that sea level rise is occurring?	Likert Scale: 1–5
	To what degree do you consider sea level rise as a threat to our future natural environment?	5-point scale: 1 (not serious at all) to 5 (very serious)
	To what degree do you consider sea level rise as a threat to our built environment?	
	Do you believe that sea level rise intensifies extreme weather events, e.g., floods, hurricanes and storm surges, etc.?	Binary scale: 1 (yes), 0 (no)
Hazard experience	Have you experienced any damage due to the following extreme weather events? Flooding Extreme precipitation Hurricane Other disasters	Binary scale: 1 (yes), 0 (no)
Coping/adaptation appraisal	To what extent can each of the following factors affect your decision to move or not? Job opportunities of new communities The distance of new communities to current work places The distance of new communities to current primary home residence Infrastructure quality of new communities School quality of new communities Health care services of new communities Social and family ties of new communities Social activities within new communities Safety issues like crime rates in new communities Relocation costs	5-point scale: 1 (not important at all) to 5 (very important)

Table 1. *Cont.*

Category	Description	Coding Scheme
Threat appraisal	To what extent can each of the following factors affect your decision to move or not? Current adaptation strategies including seawalls, sand dunes, and marshes Cost of damage to existing homes Flooding insurance policies of existing communities The value of your existing properties	5-point scale: 1 (not important at all) to 5 (very important)
Threat appraisal	Under what conditions would you consider moving? Inundation would happen	Binary scale: 1 (yes), 0 (no)
Social Influence	Under what conditions would you consider moving? Your family, relatives, or neighbors decide to move	Binary scale: 1 (yes), 0 (no)
The following variables were not included in the correlation and Logit modeling analysis.		
Relocation destinations	Please rate the preference of the following places where you would move? Move inland but in the same city Move out of the city but in the same county Move out of the county but within the same state Move into an adjacent state Move into a non-contiguous state Elevate existing house Do nothing	5-point scale: 1 (least preferred) to 5 (most preferred)
Motivation of inaction and relocation, and the shift of responsibility	- If you decide not to move, what are the major reasons? - Under what conditions would you consider moving? (except the social influence and inundation variable) - What should local communities and governments do to cope with inundation due to sea level rise from your perspective?	Measurements with binary scale: 1 (yes) or 0 (no)

Two remarks should be noted here regarding variable selection. First, in representing coping/adaptation appraisal, we wanted to include two additional variables to enrich the existing model framework. The first stated that "inundation is inevitable", and the second represents role model effects of neighbors and relatives. However, both correlation analysis and the Logit model indicated the insignificance of these variables. Second, as responsibility is a much debated topic in the climate change literature, the respondents were asked for opinions about how they think local governments should cope with the inundation due to sea level rise. This aspect may illustrate how households want to shift adaptation responsibilities to local authorities since people might consider climate change as a societal issue—rather than individual obligation.

5. Survey Results

5.1. Descriptive Statistics

The survey responses are representative of the demographic profile of the City of Panama. Specifically, out of all the respondents 50.9% with a confident interval of 44% and 58% at 0.05 significant level are male, while the male population of the city in 2012 was 49.1% [48]. The majority of the respondents are White with a percentage of 78% (72%, 83%, α = 0.05), which corresponds to the percentage of White population in the city in 2012 (70%). Other ethnical groups have some deviations from the real data, but the magnitude of fluctuation is acceptable (for example, approximately three percent of the respondents are Asian (1%, 5%, α = 0.05), which is comparable to the read share of 2.5% in 2012). There is an underrepresentation of people over 65 (5%). Such bias may be partly attributed to our sampling technique. Since the research was majorly conducted in public places, the elderly may be physically inconvenienced to go to these places.

5.2. Threat Appraisal and Coping Appraisal

It has been suggested that coping appraisal is a better predictor for mitigating behaviors than threat appraisal [32,34]. Figure 2 appears to show such a pattern since four out of the five items with the highest scores represent coping appraisal. In anticipation of invisible threats such as sea level

rise, people have many other economic and livelihood priorities—apart from the relocation option. Surprisingly, the survey shows that the respondents rank safety issues in new communities as the most crucial factor (4.30) when they consider relocation choices. This is in line with Graham et al. [49] who concluded that people when faced with sea level rise adaptation options, attached a high value to the feeling of safety. Another important aspect is the value of current properties (4.08). The abandonment or resale of a high-value property is always a difficult decision. Additional critical factors relate to the medical (4.06) and educational (4.03) aspects of new communities, followed by job opportunities (4.03). However, adaptation strategies in existing communities are the least considered items. This may be due to a lack of public awareness of local adaptation efforts.

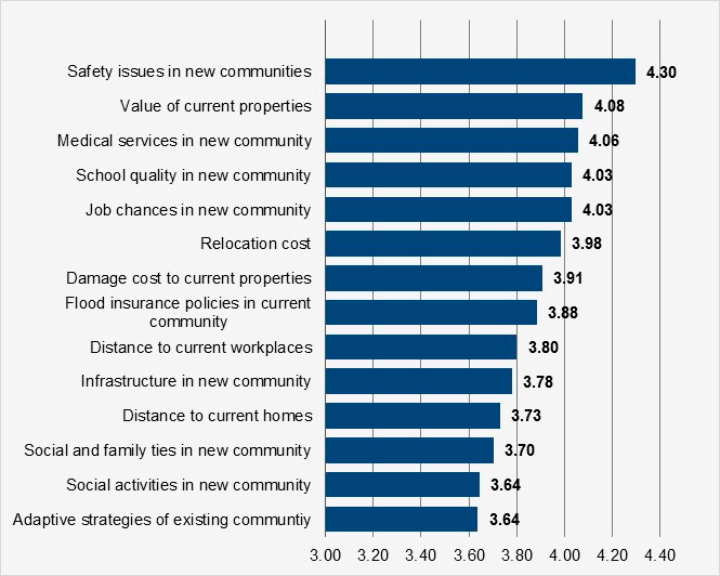

Figure 2. Mean values of key factors associated with threat and coping appraisal that affect households' decision to relocate. (5—very important; 1—not important at all).

5.3. Additional Aspects Regarding Relocation, Action, and Responsibility

Not surprisingly, the respondents consider inland areas in the same city as the most ideal relocation destinations (Figure 3) and the more distant the destination is to current residences, the lower its preference score is.

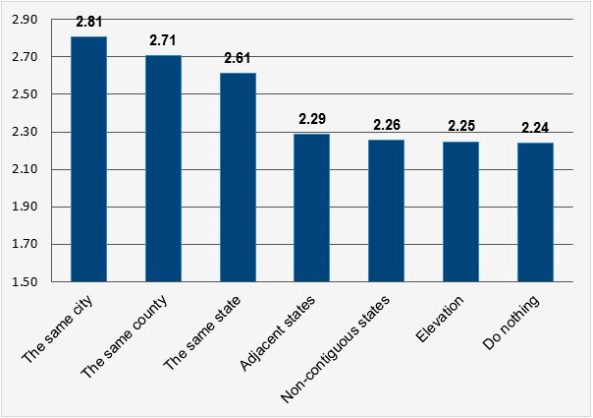

Figure 3. Mean values of residents' responses toward the question: please rate the preference of the following places where you would move. (5—the most preferred; 1—the least preferred).

One hundred and four respondents claim that family and social ties make them unwilling to relocate (Figure 4). A lack of economic stability is another deterrent for households to take actions, as reflected by 82 respondents agreeing with the statement "The relocation costs are too high" and 81 agreeing with the statement "It is difficult to find a job at another place". It should be further noted that current adaptation strategies are minor reasons why people do not want to relocate. It may be due to the fact that the respondents do not "feel" the existence of protective structures when they are in fact protected in the case of hurricanes and floods.

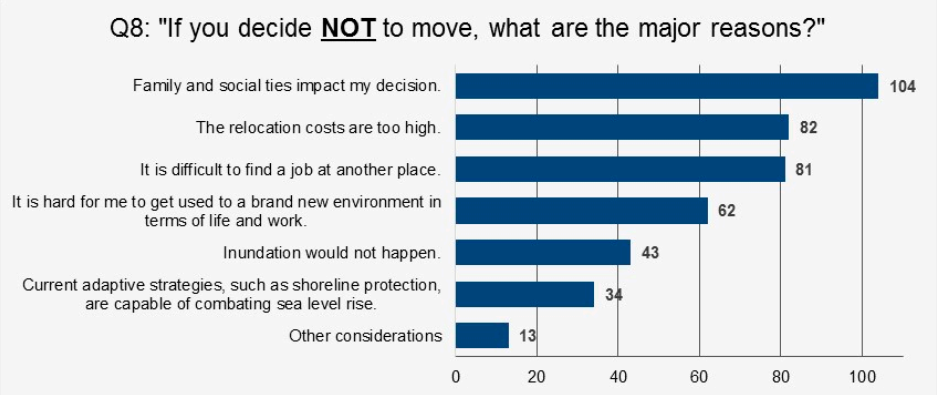

Figure 4. A description of the denial of risk (response frequencies).

Figure 5 shows which situations can motivate households' relocation willingness. The statement "Find a job at another place" produces a majority of agreement (120). This is followed by the statement "You feel unsafe in the area" (109). Social influence is another important determinant, generating 63 responses of agreement. However, only seven respondents think that the absence of insurance plans would urge them to consider moving. These results further confirm that people place employment as a top priority.

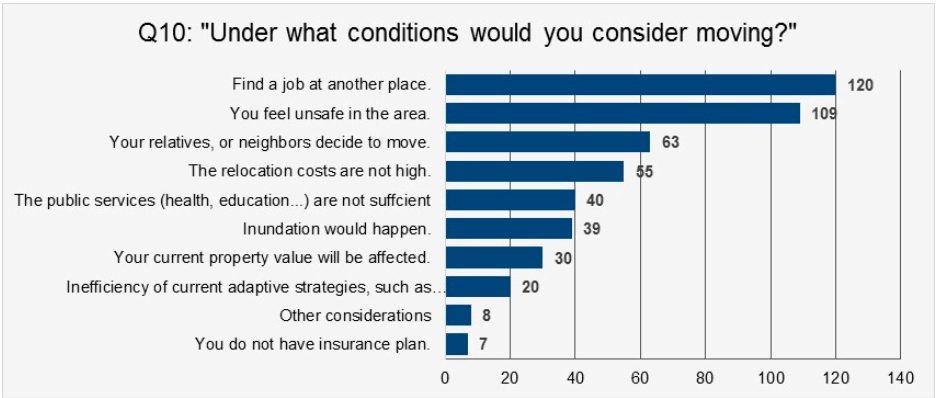

Figure 5. Motivation of relocation action (response frequencies).

In order to understand citizens' expectation on governments and communities, we created the following statements to investigate respondents' opinions on adaptation options (Figure 6). The mean values of the statements suggest that residents prefer hard protection structures (3.12) and beach nourishment (3.12) to the other alternatives. The respondents also highly agree that governments should raise funds to address sea level rise issues (3.12). These are three top rated governmental responsibilities and reflect that people still want to rely on coastal defense systems and public funds in the face of sea level rise.

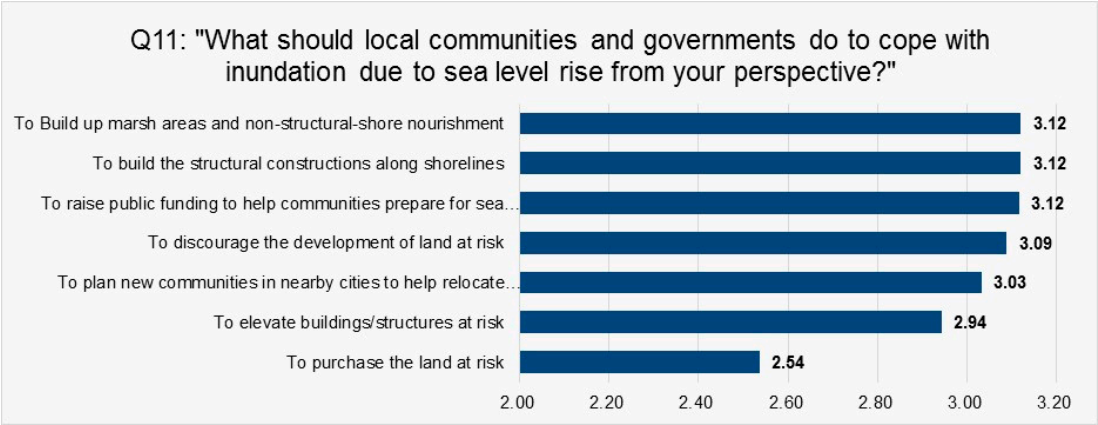

Figure 6. Responses to the governmental responsibilities concerning sea level rise adaptation (mean values).

5.4. Correlation Analysis

Tables 2 and 3 give the correlation matrixes between risk perception, hazard experience, cognitive appraisal, and the intention to relocate. First, the results indicate that risk perception has uncertain relationships with relocation intention. While the respondents' agreement with the fact of sea level rise ($r = 0.235$, $p < 0.01$) and its impacts on natural hazards ($r = 0.297$, $p < 0.01$) is positively associated with relocation willingness, the statement "sea level rise is a threat to our natural/built environments" has a negative effect. However, hazard experience largely has insignificant association with relocation intention. This is intuitively reasonable since previous studies have already drawn similar conclusions [28], and since people who have first-hand experience but survive disasters may have a lower level of willingness to take actions in the future [50]. Regarding coping and threat appraisal, the results are quite surprising. The majority of appraisal items turn out to be no association with relocation intention. Only the damage cost variable shows a moderately positive relationship ($r = 0.189$, $p < 0.01$) with relocation propensity. The insignificance of most variables may be partially due to a mixture of categorical and ordinal variables. Continuous data are absent in the model, which makes the correlation less obvious.

Table 2. Spearman correlation between relocation decision, risk perception, and hazard experience.

	1	2	3	4	5	6	7	8	9	10
1 Relocation response	-									
2 Sea level rise fact	0.235 ***	-								
3 Sea level rise and disaster	0.297 ***	0.149 **	-							
4 Sea level rise and natural environment	−0.440 ***	−0.208 ***	−0.382 ***	-						
5 Sea level rise and built environment	−0.368 ***	−0.196 ***	−0.320 ***	0.745 ***	-					
6 Flood experience	0.055	0.100	0.105	−0.031	−0.095	-				
7 Extreme precipitation experience	0.014	0.056	0.060	0.024	−0.033	0.072	-			
8 Hurricane experience	−0.010	0.045	−0.100	0.095	0.096	0.021	0.049	-		
9 Storm Surge experience	0.077	0.139	0.032	−0.133	−0.079	0.150 **	0.016	0.183 **	-	
10 Other hazard experience	−0.148 **	−0.063	−0.119	0.041	0.088	−0.101	−0.118	−0.138	−0.110	-

Notes: *** significant at 99% level; ** significant at 95% level.

Table 3. Spearman correlation between relocation decision, threat appraisal, and coping appraisal.

	1	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1 Relocation response	-																
11 Job chances in new community	0.036	-															
12 Distance to current workplace	0.061	0.503 ***	-														
13 Distance to home	0.111	0.344 ***	0.794 ***	-													
14 Facility	0.131	0.400 ***	0.348 ***	0.391 ***	-												
15 School	0.026	0.370 ***	0.416 ***	0.435 ***	0.481 ***	-											
16 Medical service	0.075	0.307 ***	0.343 ***	0.343 ***	0.489 ***	0.544 ***	-										
17 Social ties	0.088	0.206 ***	0.277 ***	0.367 ***	0.422 ***	0.444 ***	0.404 ***	-									
18 Social activities	0.123	0.282 ***	0.263 ***	0.285 ***	0.382 ***	0.354 ***	0.393 ***	0.512 ***	-								
19 Relocation cost	0.124	0.373 ***	0.401 ***	0.399 ***	0.363 ***	0.344 ***	0.322 ***	0.321 ***	0.250 ***	-							
20 Safety of new community	0.035	0.310 ***	0.350 ***	0.337 ***	0.438 ***	0.461 ***	0.529 ***	0.322 ***	0.236 ***	0.471 ***	-						
21 Adaptation strategies of current community	0.075	0.137	0.299 ***	0.376 ***	0.457 ***	0.338 ***	0.485 ***	0.485 ***	0.419 ***	0.360 ***	0.371 ***	-					
22 Damage cost	0.189 ***	0.305 ***	0.315 ***	0.337 ***	0.537 ***	0.359 ***	0.510 ***	0.504 ***	0.319 ***	0.557 ***	0.456 ***	0.583 ***	-				
23 Existing flood insurance	0.051	0.260 ***	0.310 ***	0.398 ***	0.539 ***	0.358 ***	0.453 ***	0.436 ***	0.344 ***	0.452 ***	0.396 ***	0.571 ***	0.728 ***	-			
24 Current property value	0.119	0.295 ***	0.307 ***	0.328 ***	0.456 ***	0.345 ***	0.452 ***	0.358 ***	0.243 ***	0.448 ***	0.424 ***	0.358 ***	0.544 ***	0.562 ***	-		
25 Inundation is inevitable	0.010	−0.102	−0.152 **	−0.166 **	−0.086	−0.191 ***	−0.010	−0.070	0.004	−0.128	−0.079	−0.080	−0.041	−0.079	−0.049	-	
26 Neighbor's action	0.024	0.014	0.071	0.076	0.107	0.092	0.129	0.227 ***	0.126	0.106	0.208 ***	0.148 **	0.069	0.029	0.030	−0.024	-

Notes: *** significant at 99% level; ** significant at 95% level.

5.5. Multinomial Logit Model

Table 4 shows the regression results of a MNL between household's relocation choices, cognitive variables, and social-demographical factors. The model's log likelihood at convergence is −140.118. The log likelihood ratio test for the model is far beyond the corresponding critical Chi-squared value, suggesting that the included variables offer a good model fit. The table presents significant parameters for the choices of "Not sure" and "Will relocate", with "Not move" being the base category.

Table 4. Household's relocation choice model.

Variables	Not Sure		Will Relocate	
	Parameter	***t*-Statistic**	**Parameter**	***t*-Statistic**
Constant	1.704	2.786	1.050	3.225
Risk perception and hazard experience				
Sea level rise is occurring	0.521 *	0.273	0.737 **	0.295
Sea level rise and hazards	0.608	0.625	1.516 **	0.673
Sea lever rise and natural environment	−0.756 *	0.450	−1.279 **	0.491
Hazard experience (other types)	−1.081	1.009	−3.681 **	1.536
Threat and coping appraisal				
Adaptation strategies of existing communities (sea walls and beach nourishment)	−0.679	0.424	−0.789 *	0.476
Flood insurance police of existing community	0.028	0.499	−1.118 **	0.555
Cost damage to existing homes	0.598	0.587	1.684 **	0.667
Household-level characteristics				
Age between 18 and 45	−1.511 **	0.715	−1.318 *	0.783
High school graduate or less	−1.846 *	1.092	−2.409 **	1.141
College degree	−1.244	1.010	−1.963 *	1.074
Male	0.099	0.616	1.166 *	0.653
American African	1.731	1.817	4.300 **	1.973
Log likelihood				
Convergence	−140.118			
Constant only	−213.150			
Number of observations	196			

Notes: ** significant at 95% level; * significant at 90% level.

Among the variables regarding risk perception and hazard experience, individuals believing that sea level rise is happening are more likely to relocate if their primary residences would be inundated due to change sea levels. Similarly, individuals with good knowledge of the effects of sea level rise on environmental hazards have a higher willingness to move. This may be related to the positive linkage between climate change awareness and mitigation behavior. People who admit that sea level rise threatens the natural environment are more inclined to stay if inundation would happen in the proximity of their homes. This is hard to interpret. A possible explanation is that they may think sea level rise is by large a natural process and therefore has no impacts on urban systems. People experiencing other types of hazards (wildfire, landslide, and so on) show a lower preference of relocation in anticipation of sea level rise flooding. However, the majority of hazard experience variables are statistically insignificant, which is in line with the correlation analysis.

While more than ten appraisal related variables were tested, only three are significant in the final specification. The insignificance of coping appraisal variables may be related to the fact that those variables are more relevant to such behaviors as migration and job needs, rather than the relocation

response to sea level rise inundation. Moreover, two variables that are considered low priority in Section 5.2 appear to have substantial effects on people's relocation choices, after we controlled the other variables. Specifically, people attaching a high value on existing adaptation strategies tend to reject the relocation decision. This may be because these individuals are confident that current seawalls, beach nourishment projects, and other countermeasures are sufficient to address sea level rise threat. Additionally, the negative coefficient of insurance suggests that individuals who consider flooding insurance as a very important factor prefer staying within hazard-prone regions. Lastly, as expected, individuals who fear the high damage cost due to sea level rise inundation would be more inclined to relocate.

In terms of social-demographic variables, adults aged between 18 and 45 are likely to stay in the events of sea level rise inundation, presumably because the population of this age group has stable income sources and maintains good social ties. It is therefore difficult for them to discard these life aspects and move to a new city. The influence of education variables suggests that people with college degrees or less are reluctant to move before the catastrophic inundation due to sea level rise. Additionally, the coefficients of the gender variable indicate that male individuals prefer leaving current residences only if inundation would happen. The only significant race variable is African American, and the magnitude of the coefficient is the largest among all the factors (4.300). It has been claimed that African American is a socially vulnerable group to natural hazards [51]. Therefore, that African Americans are more likely to relocate due to sea level rise is intuitively understandable because people with fewer resources and adaptive capacities are more willing to respond to natural threats [52].

6. Discussion

This paper contributes to a small body of the literature available regarding the effect of risk perception and cognitive appraisal of preparedness on the relocation intention of vulnerable households before sea level rise inundation. The authors identified some emerging patterns of how people respond to distant threats such as sea level rise and climate change.

Theoretically, well-educated adults would be likely to take individual-level adaptation strategies. As indicated by our results, however, people with college degrees do not want to relocate voluntarily. The root cause of such phenomenon may be a lack of the understanding of the risks. College graduates, often belonging to the high-income group, trust their own judgment and believe that sea walls and levees can protect them from floods, storm surges, and hurricanes [53]. Another worrying aspect of the false trust is that people think governments would provide total security for their properties, because urban developments are tolerated or even encouraged in hazard-prone regions [54]. Residents would expect that governments' obligation is to undertake high-cost adaptation strategies, while they can thereby take precautionary measures of low costs and efforts [34].

Moreover, individuals have difficulties to visualize sea level rise and are therefore unaware of the risk. People hardly have direct experience of being flooded by sea level rise. Scientists always stress that sea level will increase dramatically, but such projections depend on a long time period up to several decades. Additionally, local residents envisage sea level rise by their time stories where past and present lived experience of places is connected with the future, while researchers are spatially isolated from these places [55]. The ways by which residents and scientists construct the images of climatic change are therefore incongruent. Furthermore, the invisibility of changing sea levels fails to convince people of its adverse consequences [56], and thus some people just deny the risk before thinking about any further countermeasures. How to raise the public's awareness about sea level rise has been long discussed. Recent incidences of "King Tide" provide one possible solution. As a result of sea level rise, every year for several times the water overtopping of seawalls in Miami and the California coasts inundates major roads and forces local authorities to use pumps to drain the water. "King Tide" exposes people to higher water levels temporarily, and people with "King Tide"

experience would have a stronger feeling toward sea level rise. Similar conclusions have been drawn by Zaalberg et al. [57].

People are emotionally attached to their familiar places [58] and reluctant to move to new environments. Ideally, future land use planning should leave room for inland development and develop economic strategies to attract migrants to less developed hinterlands. However, the implementation of such policies is difficult since people have additional economic considerations with high priorities [49] such as the high values of coastal properties. It appears that people are more concerned about livelihood stability than the mere exposure to natural hazards. Finally, the respondents did not want governments to purchase the land at risk. The implementation of this policy is financially difficult, and governments' taking up coastward lands would be unfavored by residents—because governments may abandon scenic residential and commercial units in low-lying areas.

It should be emphasized that the consequences of sea level rise are diversified. Sea level rise affects coasts not only by inundating urban lands. It depletes sand volume along shorelines and drives wetlands to migrate inland [59]. However, human activities may lead to wetland loss and coastal squeeze, because seawalls cut off the migrating routes for wetlands and thereby result in widespread wetland drowning [6]. In addition, seawalls cannot entirely prevent sea water that may slip underneath the structures and invade fresh water systems [60]. Wetland loss, coastal squeeze, and salt water intrusion further expose urban areas to coastal hazards. However, many respondents we interviewed are unaware of these consequences. Thus, we cannot expect people having a low threat appraisal would take mitigation actions.

The communication of risk and adaptation should focus on increasing individuals' confidence of their ability to relocate. Our results have shown that the most important factors related to relocation are job opportunities and the cost of actions. To secure enough job openings requires a coordinated work between the governments of hazard prone areas and potential relocation places. However, it is also challenging to let coastal governments abandon their labor forces. Thus, the empirical pillars of future research on this topic are needed to justify the feasibility of relocation. Regarding relocation costs, there has been ample evidence that governments can "use disasters as opportunities" to facilitate relocation [61]. For example, following Hurricane Katrina, affected households were offered a buyout program which allowed people to sell their properties at pre-storm market values if they opted to relocate—rather than rebuilding homes [62]. Such financial incentives have contributed to considerable resettlement of the displacees.

Social ties are another hindrance of relocation. Also, social circles are important in the decision making of individuals' mitigating behavior, indicating that the campaign of adaptation strategies could focus on the community level. Educating the community as a whole is an essential ingredient in the recipe of raising public acceptance of the planned retreat option. Behavioral studies indicate that attitudes and behaviors are strongly influenced by subjective norms that are subjective to the belief of social groups [29,63]. A person may become more active to consider relocating in response to sea level rise, if his/her neighbors or community members expect he/her to do so. This requires a dialogue between governments and communities in a coordinated and communication-rich system.

However, several limitations of the current study must be acknowledged. First, empirical components are still lacking. Our results primarily rely on a stated preference survey. All situations are hypothetical, and therefore the findings deserve further investigation. It is recommended that an experimental survey is conducted in a concrete context—for example, "King Tide"—to explore people's attitudes towards sea level rise. Second, an examination of the other adaptation strategies is needed in future research. This paper only investigated how people view planned retreat—the most aggressive adaptation option. Nonetheless, individuals' opinions on seawalls, beach nourishment, and other forms of sea level rise adaptation are equally important. A comparison of the perceptions of different strategies is captivating and can contribute significantly to climate change resilience literature. Third, although this study applied the PMT, the measurements for coping and threat appraisal can be refined. Currently, none of the coping appraisal items is significant in explaining the relocation

propensity of the respondents. One potential problem is the representation of coping appraisal in our model, and it may be corrected by a refinement and the re-specification of model structures. In addition, the variable representing social influence is insignificant in the model, and we fail to incorporate the SARF into the PMT. We stress the importance of social norms in shaping people's beliefs in vulnerability and driving their propensity of protective measures, but this study merely considered the effects of neighbors' action in the correlation analysis. Better representations of social norms should be constructed, and how the norms play a mediating role between risk perception and behavior could be further answered in the following-up research—either by multivariate regression or path dependency theories. Finally, the model specification may have bias since insignificant variables were included, and the application of some other specifications such as ordered Logit model could address such bias—given that adequate choice sets are available.

7. Conclusions

This paper addresses the overall question of what affects coastal residents' intention to relocate in anticipation of sea level rise inundation. It relies on a household survey that was conducted in the City of Panama and Panama Beach, Florida (USA). The framework of the survey is based on the factors associated with the PMT in order to understand what motivates people's adaptation to distant threats such as sea level rise. Three hypotheses are examined. First, sea level rise awareness is positively associated with people's willingness to relocate their vulnerable houses. However, hazard experience appears to have an insignificant relationship with relocation decisions. Second, in the case of sea level rise, threat appraisal seems a better predictor than coping appraisal. In other words, there exist additionally unobserved factors related to coping appraisal that were not covered in this study, since relocation itself is a complex decision and involves the process of prioritizing a variety of non-climatic and climatic risks. Third, the characteristics of residents—education, gender, age, and race—influence the likelihood of implementing the planned retreat strategies in response to sea level rise. Unlike other acute and visible risks such as flooding and hurricane, sea level rise is a slow ongoing and invisible phenomenon. This means that our current communication campaigns should be refined in several aspects. The campaigns should illuminate the severe impacts of sea level rise on coastal hazards, focus on raising households' confidence in adaptation measures, and inform people at the community level about the benefits of planned retreat.

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