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Hurricane risk perceptions among Florida's single family homeowners

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Abstract

Hurricanes and associated storm damage remain a constant threat to the health, safety, and welfare of residents in Florida. Hurricane risk perception has been found to be an important predictor of storm preparation, evacuation, and hazard adjustment undertaken by households, such as shutter usage. Planners and policy makers often employ expert risk analysis to justify hazard mitigation policies, yet expert and lay risk assessments do not always agree. Because the public is increasingly involved in planning and policy decision-making, consistency between "expert" risk assessments and lay perceptions of risk are important for policy legitimization and compliance. This article examines factors contributing to hurricane risk perceptions of single-family homeowners in Florida. Utilizing data from a statewide survey, we first map and spatially analyze risk perceptions throughout Florida. Second, we examine the influence of location on shaping homeowner perceptions along with other factors, such as knowledge of hurricanes, previous hurricane experience, and socio-economic and demographic characteristics. The findings suggest there is a good deal of consistency between residing in locations identified by experts as being high hurricane wind risk areas and homeowner risk perceptions. Finally, we discuss the implications of these findings for land use and hazards planning.

Keywords: Land use planning; Risk perception; Hurricane risk; Building codes

1. Introduction

There is a growing recognition that natural disasters "signal a serious breakdown in sustainability" (Burby, 1998, p. 1). Specifically, researchers and practitioners increasingly acknowledge natural disasters occur, in part, because of a failure to promote community develop that appropriately recognizes the nature of hazard risk in a manner consistent with sustainable development (Mileti, 1999). Land use planning policies and tools can be an important element in sustainable community development; however, the public must support these plans and policies for them to be effectively implemented. Public perception of risk is an important predictor of how citizens will prepare for and respond to hazard threats. Furthermore, because the public is increasingly involved in planning and policy decision-making, perceptions of risk can influence the content of hazard mitigation programs and

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associated strategies. Public perception can also have important consequences for the perceived legitimacy of and compliance with land-use planning policy.

The first step in the development of effective land use hazard mitigation policy is hazard assessment. A critical element in any hazard assessment is risk analysis. Risk analysis seeks to define or specify the probability or likelihood of hazard events of varying magnitudes impacting specific areas (Cutter, 2001; Deyle et al., 1998). Recognized "experts" with respect to the specific hazard or hazards under consideration generally undertake such analysis for policy makers. A critical problem for land use policy development and implementation is the consistency between expert risk analysis and public risk perception. If the two are not consistent, then the public may not support and perhaps even thwart policy development. Furthermore, if policy lacking public support is developed, its legitimacy will be brought into question and compliance may well be low.

This article examines the major factors contributing to hurricane risk perceptions of residents in Florida focusing on the consistency between "expert" risk assessment and public perceptions. Florida represents a unique opportunity for examining the consistency between public risk perception and expert risk assessment adopted in land-use policy[1]. In March of 2002, a Statewide Building Code was fully adopted and implemented in Florida. A critical element of that new building code was the adoption of stricter building standards based upon wind hazard associated with hurricanes. To establish variable building standards for locales throughout Florida, the American Society of Civil Engineer's Standard 7 for the 1998 (ASCE 7-98) was adopted. The ASCE 7-98 provides wind risk assessments for areas throughout Florida along with associated building standards. Utilizing data from a statewide survey, we map and spatially analyze risk perceptions statewide based upon a household's location vis-à-vis wind hazard contours prescribed by ASCE 7-98. We then examine the influence of location on shaping risk perceptions along with other factors, such as knowledge of hurricane threats, previous hurricane experience, socio-economic and demographic characteristics.

[1] Following Burby (1998), we are considering building codes as a form of land-use policy.

The basic research questions guiding this paper are: (1) does location or proximity with respect to wind vulnerability zones influence hurricane risk perceptions? (2) what are the major characteristics explaining hurricane risk perceptions such as previous experience, knowledge regarding hurricanes and hurricane risk, socio-economic variables; and (3) how do the results help guide planning processes and policy formulation for hurricane damage mitigation?

2. Public risk perception, expert risk analysis and public policy

Understanding of the public perception of risk is increasingly being recognized as an important aspect of the decision making process for several reasons. First, public risk perception now plays a key role in shaping natural hazards policy and management response systems (Slovic, 2000). Because the regulation and management of risks, such as hurricanes and floods are subject to public debate and input, the perception of these risks are of considerable interest to planners and policy makers (Fischhoff et al., 1981; Johnson and Tversky, 1984). The growing importance of public participation in hazards planning is well documented (Wood et al., 1985; Brody, 2003; Brody et al., 2003; Burby, 2003; Godschalk et al., 1999) to the point that it is argued the public perception of risk is driving policy as much as technological and scientific risk assessments (Correia et al., 1998; Slaymaker, 1999; Tierney et al., 2001). Second, public risk perception is positively correlated with public response and adjustment to a particular hazard event. In their review of the literature on seismic hazard mitigation and emergency preparedness, Lindell and Perry (2000) found that perceptions of hazard types and different hazard adjustments significantly affects intentions to adopt these adjustments as well as subsequent behavior, such as hazard adjustment[2] (Mileti and Fitzpatrick, 1993; Mileti and O'Brien, 1992; Showalter, 1993). Risk perceptions are also positively related to warning response

[2] As is so often the case in social science research, there are also examples of research where the relationships between risk perception and adjustment was weak or non-existent (Farley, 1998; Lindell and Prater, 2000; Mileti and Darlington, 1997). Some of these inconsistencies, as pointed out by Lindell and Perry (2000, 2004) may well be due to different measures of risk.

in the case of technological hazards such as nuclear power plants and hazard material incidents (Houts et al., 1984; Perry, 1985, 1987; Wiegman et al., 1992) and other natural hazards such as flooding and volcanic eruptions (Perry et al., 1981; Perry and Lindell, 1990a,b). More importantly for this research, hurricane risk perception has also been found to have a positive impact on hurricane warning (Baker, 1991; Dash and Morrow, 2001; Gladwin et al., 2001) and household protective actions. For example, Peacock (2003a,b) found that hurricane risk perception significantly impacted the likelihood and quality of wind protection measures employed by homeowners in Florida.

A major issue with incorporating public risk perception into the formulation of hazard mitigation plans and policies is the often sited disparity between public or lay risk perceptions and expert assessments of risk which more often than not are based on scientific assessments (Margolis, 1996; Shrader-Frechette, 1991; Garvin, 2001). Garvin (2001) has suggested considerable epistemological distance between the public and scientists, not to mention policy makers, because of substantial disparity in their general source for evidence, conceptualization of uncertainty, sources of legitimacy and approaches to handling conflicting evidence. While research scientists hold scientific methods must generate evidence, establish legitimacy, resolve competing perspectives, and are comfortable taking probabilistic approaches, such is not always the case of the public (Garvin, 2001). Scientific information is just one form of information about the environment utilized by the public (Cutter, 1993). Furthermore, scientific information most certainly will be provided with unique individual, social, as well as political interpretations that may well dismiss, ignore, or so modify it as to make it unrecognizable (Michael, 1992; Jasanoff and Wynne, 1998).

In general, it is widely held that there can be considerable disparity between expert and public risk judgments (Lichtenstein et al., 1978; Shrader-Frechette, 1991; Margolis, 1996; Powell and Leiss, 1997). Research has shown that difficulties in understanding probabilities, biased media coverage, misleading personal experiences, and irrational fears associated with extreme events or near misses lead to misjudged risks and inappropriate behavioral responses (Slovic, 2000). While some of these findings have come under recent attack (Rowe and Wright, 2001; Wright et al., 2002), the general consensus holds that experts evaluate risk in a probabilistic fashion, while public perception is based much more upon individual personal and historical experiences that are themselves socially constructed within a cultural context (Margolis, 1996; Krimsky and Plough, 1988; Jasanoff and Wynne, 1998; Garvin, 2001). As a result, there can be considerable divergence and disagreement between public risk perceptions and expert risk analysis.

The general concern regarding this disparity between expert and public risk perception and the need to inform the public of potentially acute events such as toxic material releases, nuclear power accidents, and even natural hazard risk has resulted in considerable research focus on risk communication. Indeed, communication of risk information has received increasing attention from researchers studying the mechanisms through which risk information is disseminated to individuals particularly in our diverse communities (Tierney et al., 2001; Lindell and Perry, 2004). The specific channel through which information about a hazard is conveyed to the public (e.g. radio, television, newspapers, etc.) and the format in which the message is received is critical to acquiring information utilized in forming risk perceptions (Johnson, 1993).

3. Explaining hurricane risk perceptions

The general topic of risk perception has been the subject of much research, particularly from a psychological or psychometric approach (Slovic, 2000). Despite the fact that natural hazards was a topic for early research related to risk, on the whole there has been comparatively little empirical research conducted on the factors shaping individual risk perceptions toward specific natural hazards, particularly hurricanes. The following discussion draws from hazards literature, highlighting factors that have been shown to have consequence for natural hazard perception, paying particular focus on those factors that may well shape hurricane hazard risk perception.

One aspect contributing to perceptions of natural hazards most often cited by researchers is previous experience with a hazard event (Lindell and Perry, 1992, 2004). One would expect that when personally experienced, a natural hazard event would be more meaningful and lead to heightened perception of risk (Burton and Kates, 1964; Vitek and Berta, 1982). For example, Anderson (1969) found that individuals who had recently experienced a natural hazard were more sensitive to warnings and more likely to respond. Similarly, Turner (1986) showed that earthquake experience attracts attention and heightens concern, although it is short lived.

The meanings attributed to experience can vary across individuals (Lindell and Perry, 2000) and experience with natural hazards can also work to lower perceived risk associated with future events. Studies of evacuation in response to hurricanes on the Gulf coast report that sizable portions of the people who failed to evacuate were long-time residents of an area that had previously experienced hurricane impact (Windham et al., 1977; Baker, 1991; Gladwin and Peacock, 1997). Similarly, Halpern-Felsher et al. (2001) found that individuals who have experienced a natural hazard perceive that they are less susceptible to harm from future events than their less experienced counterparts. Lindell and Perry (2000) aptly note perception is crafted by the way previous experience with natural hazards is interpreted. The authors point out there is a difference between community experience and "personal" experience where the latter may have more of an affect on heightening individual perception. Also, the perceived relevance of a personal experience is important to predicting how one perceives the threat of a future hazard. Many people think their previous experience has somehow made them invulnerable to future negative outcomes. The degree of risk personalization thus may contribute to a separation between knowledge of natural hazards (e.g. probability of event, potential damage, location of potential damage, etc.) and perceived risk from a natural hazard. On the whole, Lindell and Perry (2004, p. 83) conclude that personal experience appears to shape general beliefs regarding hazards, but does not necessarily impact particular "situational assessments."

The nature of the experience may also be an important factor shaping risk perceptions. As implied above, those with more personal experiences or more salient experiences with regard to personal danger may well have different interpretations and thus risk perceptions. In the case of hurricanes, Florida residents are much more likely to "experience" a miss than a direct hit from a storm. Hence, the nature of the experience can be dramatically different, as was the case of residents of northern sections of Miami-Dade County, versus those in the direct path of Hurricane Andrew. Yet all residents may well claim hurricane experience. Research has found that experiencing hurricane damage is positively related to risk perception (Windham et al., 1977; Norris et al., 1999; Raid et al., 1999). Perry and Lindell (1990) found that residents who reported damage from earlier eruptions were much more likely to perceive elevated risk than those who had not. Furthermore, research on students found that those whose families had experience damage events—such as earthquakes—were more likely to have higher risk perceptions (Burger and Plamer, 1992; Helweg-Larsen, 1999). Thus, all experience may not be equal with respect to risk perception.

Of course, the principal reason that experience and communication are often the focus of hazard research is that both are mechanisms through which individuals acquire knowledge, either directly or indirectly, about a hazard and as suggested by Johnson (1993, p. 183) "[K]nowledge is and should be important in risk perception; if not humans would have died out long ago." And yet the consequences of knowledge are not always clear. Lindell and Perry (2004, p. 153) note that hazard knowledge generally refers to information about its "genesis, its mechanisms of exposure, and types of hazard adjustments that can avoid its impacts." But, just as with experience, its consequences for risk perception can be variable. On the whole, to the extent that it does indeed consistently inform individuals about "certainty, severity, immediacy, and duration of personal consequences" it should be correlated with risk perception (Lindell and Perry, 2004, p. 153). Research has generally found that individuals with higher levels of knowledge are more likely to undertake protective actions or adjustments (Drabek, 1986; Faupel et al., 1992; Perry et al., 1981, 1982; Peacock, 2003a). However, inconsistency in knowledge may well diminish the impact of knowledge, and, as with experience, individuals with higher levels of knowledge may well become overconfident and consider themselves and their households invulnerable (Svensen, 1981; Weinstein, 1989; Johnson, 1993; Perry and Lindell, 1990a,b).

Individual socio-economic and demographic characteristics can also play an important role in shaping risk perception about natural hazards. For example, gender has been found to be important in that women perceive risks differently from men and appear to be more risk averse (Brody, 1984; Cutter et al., 1992; Stern et al., 1993). Women are more likely to view disaster events and hazards, such as volcanoes and earthquakes as risky (Turner et al., 1986; Fothergill, 1996). Lindell and Perry (1992, 2004) also note that race and ethnicity influence a wide range of perceptions, such as threat perception and trust of authorities. Specifically, racial and ethnic minorities in general are much more likely to perceived risk from technological risks, such as nuclear power (Vaughn and Nordenstam, 1991) and various potential pollutants (Vaughn and Seifert, 1992), as well as natural hazards such as volcanoes and earthquakes (Hodge et al., 1979; Turner et al., 1986; Major, 1999). The convergence of these race/ethnicity and gender differences in risk perception findings has also been noted in the literature. In a study on environmental health risks, Flynn et al. (1994) found that white males were significantly less likely to consider a range of hazards as risky compared to white females and both black males and females. Slovic (1997) found similar findings and interestingly extended these findings to include income and education. For example, Slovic (2000, p. 398) notes that not only is risk perception inversely related to income and education, but even after controlling for these socio-economic factors, white males still have significantly lower perceptions of risk than the other three groups.

Tierney et al. (2001) along with others suggest that more research is needed to understand which ethnic groups are most likely to perceive themselves as vulnerable to risk, particularly when it comes to disentangling income and race (Slovic, 2000). Indeed, one might extend this to all elements of social status: income, education, gender, and race/ethnicity. In general women, racial and ethnic minorities, and individuals of low income and little education all tend to have higher perceptions of risk from technological and natural hazards. A host of explanations have been proffered. A recurring theme is that, due to a lack of power and resources, these groups find themselves in much more vulnerable positions within society and hence are much more inclined to perceive potential hazards as more risky (Merchant, 1980; Gilligan, 1982; Cutter et al., 1992; Flynn et al., 1994; Gustafson, 1998; Slovic, 2000; Finucane et al., 2000). For example, it is often noted that white males in general seem to have more trust in institutions and the ability for individuals to make their own choices about the risks they encounter. They also tend to find themselves in positions of relative power and control. Women and minorities, on the other hand find themselves to be much more vulnerable to potential hazards and their impacts. The literature on the differential impacts of natural disasters on women, minorities, and lower socio-economic populations has substantiated these fears (Bolin and Bolton, 1986; Blakie et al., 1994; Morrow and Enarson, 1996; Peacock et al., 1997; Bolin and Stanford, 1998).

Age and household composition are other factors identified in the literature as being associated with hazards risk perceptions, although the findings have been somewhat inconsistent. Age has been found to be positively associated with tornado risk perception (Hanson et al., 1979) and Houts et al. (1984) concluded that the presence of children in the household is a primary indicator of a household's perceived susceptibility to a threat. Similarly, Perry and Lindell (1990) concluded that having school-aged children in the home was positively correlated with volcano risk perception near Mt. St. Helens and Turner et al. (1986) also found similar results with respect to earthquakes. On the other hand, Lindell and Prater (2000) did not find that the presence of children had a significant impact on earthquake risk perception and Baker (1991) did not find the presence of children to be reliably correlated with increased perception of threat and subsequent evacuation to avoid an impending hurricane. And yet, Gladwin and Peacock (1997) in one of the few studies of household evacuation both inside and outside officially designated evacuation zones, found that households with children were much more likely to have evacuated in both areas, while households with elderly were much less likely to evacuate. On the whole, the question of the consequences of children and the effects of age composition in general, has clearly found salience in the literature, although the findings have been inconsistent.

4. The role of proximity in shaping risk perceptions

Traditionally, natural hazards risk perception has been explained by factors such as prior experience, knowledge, socio-economic and demographic, and household composition. Comparatively little research has been conducted on the influence of respondents' location and proximity perception of risk. While little or no empirical research has been conducted on location-based risk perceptions related to hurricanes, some informative work has been done on earthquakes and more general human hazards. For example, Farley et al. (1993) reported that adoption of household adjustments was correlated with proximity to the New Madrid fault. In contrast, Palm et al. (1990) and Mileti and Darlington (1997) found no association between risk perception and proximity to an earthquake fault line. Lindell (1994), on the other hand, found proximity an important feature in hazard risk assessment when examining volcanic or toxic gas or radioactive materials releases.

Examinations of the importance of proximity also include research into attitudes toward and decisions about environmental risk. For example, Gawande and Jenkins-Smith (2001) found that distance from transportation routes for nuclear waste drove perception of risk and influenced property values. Elliot et al. (1999) found that proximity to adverse air quality locations affected community cohesiveness over air pollution issues. The role of proximity and geographic location is indeed an under-examined variable in explaining the perception of risk, particularly with regards to hurricanes where spatial risk models are well documented and, as noted above, are being incorporated into land-use planning. Additional study may provide important insights on the relationship between where individuals reside and the degree to which they perceive risk from natural hazards.

The focus of this research is on an individual's location or proximity, relative to high wind hazard zones derived from expert risk analysis, for homeowner risk perception in Florida. Specifically, our interest is on whether individual risk perceptions are consistent with their location relative to expert risk appraisals of their home's location. The logic associated with the development of effective land use policy suggests that consistency is a necessity. Without consistency the legitimacy of land use policy will be undermined and brought into question. In order to assess consistency, we first spatially examine risk perceptions across wind hazard zones. We then model hurricane risk perception using many of the factors discussed above in order to determine if location still has consistent consequences for risk perception net of the other effects.

5. Methods and data analysis

5.1. Sample selection

The data utilized in this research were collected as part of a survey of households residing in owner-occupied single-family detached residences throughout the entire state of Florida. These households represent the major contributors to the State's catastrophic insurance (CAT) fund, are a primary target for many statewide hurricane mitigation initiatives, and are households, that as homeowners, can undertake to modify their homes to enhance mitigation[3]. According 2000 US Census just over 70% of households are located in owner occupied housing, which is up slightly from the 1990 census figure of 67.2%. However, again according to the 2000 census, the homeownership rate for single-family detached housing is only 49% percent for the State of Florida, a figure that is also up from 1990 when it was approximately 46%. Thus, when considering the development of our sampling methodology, our target population represented only 49% of all households in the State.

The survey was conducted at the Institute for Public Opinion Research at Florida International University between February and March of 2003, employing an equal probability randomly digit dialed sample. At the beginning of each call a series of screening questions was asked to determine if the contacted person was an adult decision maker in a household residing in an owner-occupied single-family detached residence and was a Florida resident. If these criteria were met, an interview was conducted. The final sample[4] size was 1260 households residing in single-family owner occupied detached homes.

5.2. Measurement

Hazard risk perception has been measured in a number of different ways by researchers, which as Lindell and Perry (2000) suggest accounts, in part, for the variability in findings. Following Lindell and Perry (2004,

[3] Renters generally cannot make structural modifications to their homes and the homeowners of attached housing, such as condominiums and townhouses, are subject to many more constraints in terms of modifying their structures to make them more hurricane safe.

[4] For a complete discussion of the sample and its characteristics, see Peacock (2003).

p. 127), risk perception is conceptualized in terms of "certainty, severity, and immediacy of disaster impacts to the individual, such as death, property destruction and disruption of work and normal routines." In other words, risk perception is assessed, not simply in terms of a hurricane's perceived potentiality or probability of occurring for an individual, but rather in terms of personalized risk from such an event. For our purposes, a three-item hurricane risk measure was created by factor analyzing and scoring three questions: how likely do you think it is that a hurricane will prevent you or members of your household from being able to work or go to your jobs this up-coming hurricane season; how likely do you think it is that a hurricane will disrupt your daily activities this up-coming season; and how likely do you think it is that a major hurricane will potentially damage your home this up-coming hurricane season? In each case, the response categories were: (1) very; (2) somewhat; and (3) not very likely.[5] The empirical results suggest that these three items hang together quite well. The inter-item correlations range from a low of .42 to a high of .56, yielding an average correlation of .47 and an alpha of .731. The resulting rescaled measure ranges from low of 0, low perception of hurricane risk to 3.72, indicating the highest level of hurricane risk perception, with a mean of 1.09 and a standard deviation of 1.

Three sets of independent variable will be utilized in models predicting perceived hurricane risk to assess the impact of factors suggested by the literature and discussed above as being important determinants of risk perception. These variables cluster into three categories, those that assess individual knowledge or experience, socio-demographic variables, and lastly a locational or proximity measure. Experience or knowledge variables assess, directly or indirectly, information and knowledge individuals possess regarding hurricanes and hurricane risk. The first measure, years a resident of Florida, is often employed in the literature to proxy measure indirectly assessing hurricane experience. Respondents were also asked directly if they or households members had either "hurricane experience" or resided in a home that was damaged by a hurricane. In both cases, individuals responding in the affirmative were coded one, while others were coded zero.

The final variable is a three-item factor score generated by factor analyzing three questions regarding knowledge about hurricanes. Respondents were asked to consider themselves and other adult members in their household in terms of how knowledgeable they were about the chances of a hurricane directly impacting their home, the types of damage a hurricane might inflict upon their home and what types of things they might do to reduce potential damage. The responses were highly, somewhat, slightly, or not very knowledgeable. The inter-item correlation ranged from .47 to .53, yielding an alpha of .755. In general, give the literature, the expectation is that each experiential or knowledge measures should have a positive effect on hurricane risk perception.

The second set of measures employed in this analysis includes various socio-demographic measures: gender, race/ethnicity (Hispanic, Black, Anglo), age, household income, education and households with young children. Gender is coded 1 for females and 0 for male and is expected to have a positive effect. Race/ethnicity is coded using a series of dummy variables for non-Hispanic Blacks (1 Black; 0 otherwise) and Hispanics (1 Hispanic; 0 otherwise), Anglos are the excluded category. In light of the literature, both should have positive effects, indicating higher perceptions of hurricane risk for minority populations. Both education (highest year of schooling completed) and total household income are expected, in light of the literature, to have negative effects. Age of respondent should, in light of the literature have a positive effect, indicating increasing perceptions of risk with older respondents. Households with younger children (coded 1 if children under 12 are present; 0 otherwise) are expected to have higher perceptions of risk.

The final measure employed in this analysis is the location of each respondent's home relative to the ASCE 7-98 wind contours. A household is located within a wind contour based upon its US Postal zip code. For most observations the placement, based on zip code, was not problematic. If, however, the wind contour line cut through a zip code, than the location could be problematic. In those cases, households within the zip code were all classified based upon the locations of the zip's centroid. In other words, if the wind contour line cut through a zip code, respondents were place in the zone containing the zip-code areas centroid.

[5] The fourth category, do not know, was considered missing. The resulting factor score accounted for 65% of the observed variance in these three items.

6. Results

Fig. 1 presents the zip code-based location of each respondent and the ASCE 7-98 wind contours. These wind contours are based on the American Society of Civil Engineers Standards (ASCE 7-89) 50–100 year peak gusts. The highest wind contour line of 150 mph is found in the extreme southern tip of the Florida peninsula and indicates the boarder between zones where wind gusts of less than 150 might be expected and areas, principally the Florida Keys, where gust of 150 mph or higher are probable. Because very few respondents

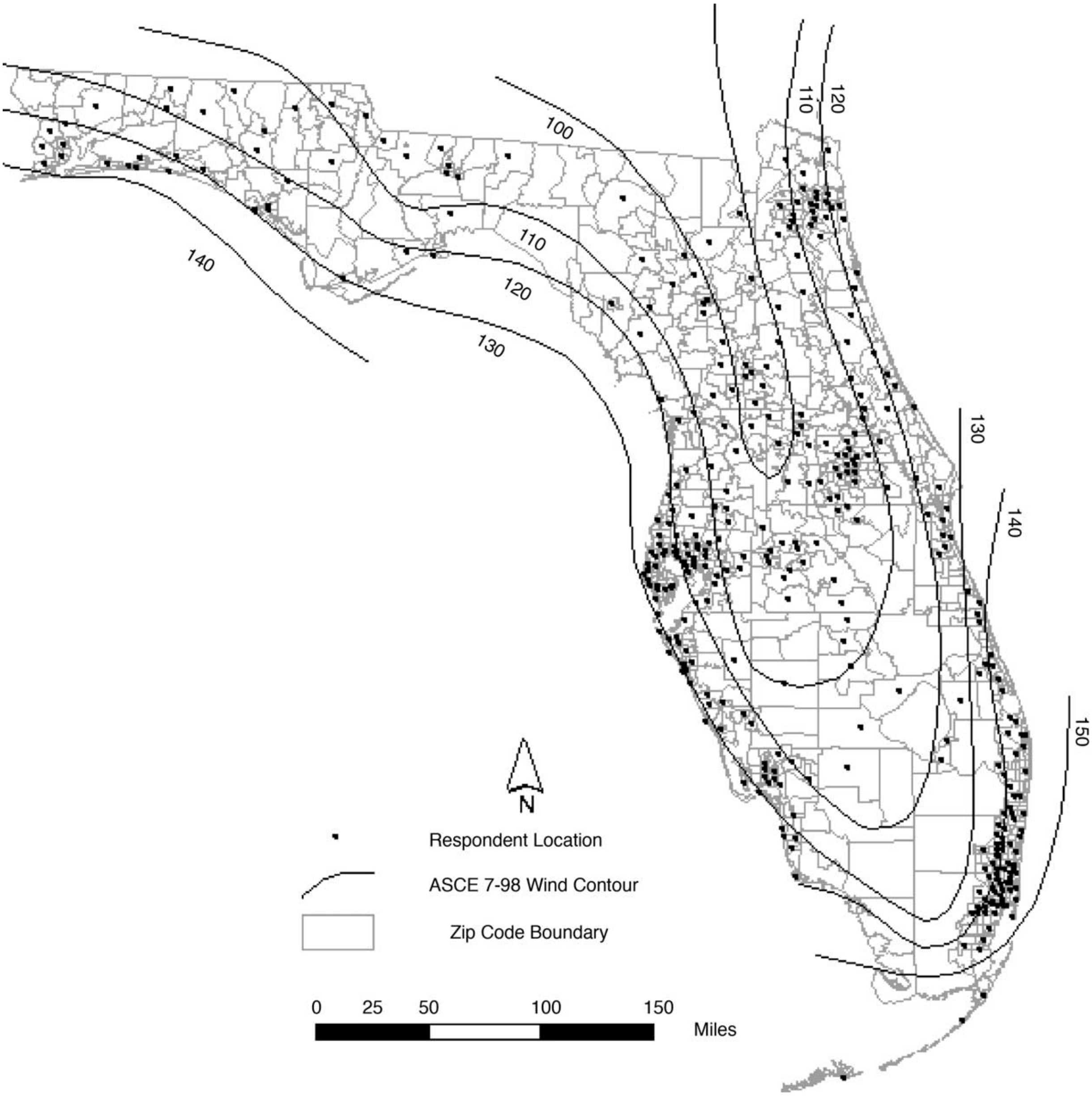

Fig. 1. ASCE 7-98 wind contours with respondent locations.

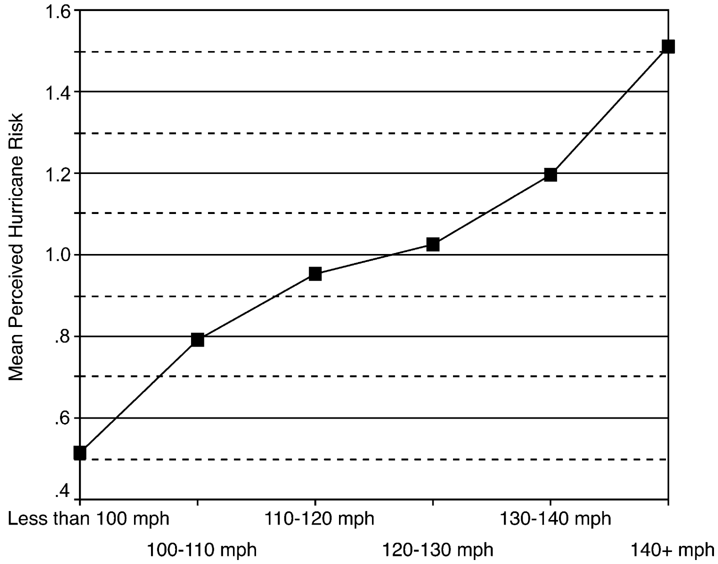

Fig. 2. Mean perceived hurricane risk by wind zone.

were located in the Florida Keys, respondents in 150 and 140 wind zones were combined. As a result, the wind zone variable consists of 6 categories ranging from 1, indicating potential wind gusts of less than 100 mph to 6, indicating potential gusts of 140 mph or more. If indeed hurricane risk perceptions are consistent with expert wind hazard analysis, than it can be expected that hurricane risk perceptions will increase with higher wind zone classification.

Fig. 2 graphically displays the mean hurricane risk perception of respondents across wind zones. The means range from a low hurricane risk perception of .515 for residents in the lowest wind hazard zone with probable peak gusts less than 100 mph to a high of 1.51 for residents in the highest wind hazard zones where experts predict 50–100 year wind gusts of 140 mph or more. There is some leveling or relative convergence of mean risk perceptions toward the middle wind speed zones, however on the whole, hurricane risk perceptions do indeed climb as one moved from lower to ever higher wind hazard zones.

Furthermore, statistical testing suggests that there are statistically significant[6] differences among the means. Post-hoc testing using the least significant difference method suggests that residents in the highest wind hazard zone have significantly higher levels of perceived hurricane risk than residents in each of the other zones. While the residents of remaining zones are not always significantly different than their adjacent neighboring zones in a consistent manner, all zones have perceived risks that are significantly different than those in at least three if not four other zones. On the whole, the pattern suggests that public risk perceptions are indeed consistent with wind hazard zones determined by ASCE 7-98 risk analysis, as utilized in Florida's statewide building code policy, and there are significant differences across wind hazard zones with residents in higher wind hazard zones perceiving higher hurricane risk than those in lower zones. The question remains however if this consistency holds after other factors relevant for hazard risk perception are controlled.

Table 1 presents four models predicting hurricane risk perception. The first utilizes experiential/knowledge variables, the second socio-demographic variables, the third only the location variable, and the last is the full model. Each model is statistically significant. The experiential/knowledge model accounts for only 1.2% of the variance and having experienced damage is the only significant effect, suggesting that individuals that have experienced hurricane damage have

[6] F-test = 19.562 with 5 and 1132 d.f., which is significant at the .001 level.

Table 1
Hurricane risk perception models

	Experiential/knowledge model	Socio-demographic model	Wind model	Full model
Constant	.939[a]	1.557[a]	.461[a]	1.189[a]
Experiential				
Years FL resident	.001 [.028]			.004[a] [.052]
Experienced hurricane	.085 [.039]			.003 [.001]
Experienced damage	.176[a] [.083]			.086[b] [.041]
Hurricane knowledge	−.009 [−.009]			.022 [.024]
Socio-demographic				
Female		.130[c] [.067]		.128[a] [.066]
Black		.482[a] [.140]		.366[a] [.106]
Hispanic		.485[a] [.187]		.317[a] [.123]
Age		−.004[c] [−.066]		−.006[a] [−.100]
Income		−.001[d] [−.036]		−.003[c,d] [−.073]
Education		−.026[c] [−.065]		−.028[c] [−.068]
Children under 12 in home		.039 [.018]		.023 [.011]
Spatial				
Wind zones			.158[a] [.262]	.130[a] [.215]
R^2	.012[a]	.078[a]	.068[a]	.133[a]
Adj-R^2	.009	.073	.068	.124

n: 1259; [B]: standardized coefficient.
[a] Two-tailed $P(t) \leq .01$.
[b] One-tailed $P(t) \leq .1$.
[c] Two-tailed $P(t) \leq .05$.
[d] $b(10^{-3})$.

significantly higher levels of perceived risk. The socio-demographic model accounts for 7.8% of the variance. As expected, females and minorities have higher levels of perceived risk and higher educated have lower levels of perceived risk. Surprisingly, given the literature, age has a negative effect, suggesting that older individuals have lower perceptions of risk. The wind zone model accounts for slightly less of the variance in perceived risk than did the socio-demographic model, although it only has the single variable included. As expected, wind zones have a significant positive effect indicating that as one moves to successfully higher wind risk zones, the perception of hurricane risk also increases. Not surprisingly, the full model, that including all three sets of variables accounts for the greatest proportion of variance (13.3%), which is adequate for a model predicting individual level risk (cf. Lindell and Prater, 2000). The major difference between the results of this model and the others is that, in addition to the other factors mentioned, years a Florida resident is now significant and positive and income now produces a significant negative effect. On the whole then, having younger children, reported hurricane experience, and reported hurricane knowledge seem to have no impact on hurricane perceptions.

The full model allows us to assess the consequences of location after controlling for other factors. The findings clearly suggest that location or proximity relative to wind hazard zones is indeed significant determinant of hurricane risk perception. Specifically, the findings suggest that even after controlling for knowledge, experience, and socio-demographic factors, location relative to wind zones have a significant effect. Indeed, examining the standardized effects, wind zone appears to have the strongest effect on hurricane risk perception. Just as important, the effect is positive indicating that, net of the other effects, residents located in zones likely to be subjected to ever stronger and more damaging wind gusts, also have higher perceived hurricane risk. These results indicate there is a good deal of consistency between wind hazard zones derived from expert risk assessment and the perceptions of hurricane risk of single family homeowners in Florida. This bodes well for likelihood that single-family homeowners at least, would consider the utilization of ASCE 7-89 wind standards as part of the statewide building code as legitimate. This does not of course insure legitimacy nor compliance. However, in this case, public perceptions of risk and expert risk analysis do appear to be consistent.

6.1. Consistency in wind zone application considered

There is at least one other element of consistency that can be important for public assessments of legitimacy and compliance. For effective mitigation, policies should be implemented in a clear and unambiguous manner based upon sound scientific expert analysis (Burby, 1998; Olshansky and Kartez, 1998; Godschalk et al., 1999). If a policy is applied in an even handed manner, whereby all members of a potential target population must adhere to a policy, then it would seem probable that it is more likely to be seen as legitimate or at least fair. On the other hand, if for seemingly arbitrary reasons a policy is applied to only a select few, when others are exempt for some unknown reason, then legitimacy and fairness can be brought into question. This is potentially the case with the Florida's statewide building code. While the ASCE 7-98 wind contours in excess of 120 mph define areas requiring additional construction requirements along the coastal areas of the Florida peninsula, such is not the case in the Panhandle region. In the Panhandle, a 1 mile "Panhandle protection provision" was adopted, which requires additional building requirement only for structures build within a mile of the coast. For the remaining areas that fall within contours defining potential gusts in excess of 120 mph, there are no special building requirements. The omission of much of the Panhandle region is conspicuously evident in the State's wind-borne debris region maps[7] where areas between 120 and 130 mph are yellow and those between 130 and 140 mph are marked in light orange. And yet, as one moves into the Panhandle, the colors no longer appear and one finds only a dashed line along the immediate coastline indicating the "Panhandle protection zone." Could it be that some in the legislature were simply sensitive to very different hurricane risk perceptions of Panhandle residents and therefore promulgated a policy that was consistent with local public populations and exempted much of the Panhandle from new wind-borne debris requirements?

In order to assess this question, an additional series of models was run that allows for a determination of whether residents in the Panhandle have significantly different hurricane risk perceptions, when compared to other Florida residents, or whether the processes impacting hurricane risk are operating differently for Panhandle residents producing different risk perception outcomes. Presented in Table 2 are three models. The first is simply the full model from Table 1, termed a base model here. The second model includes a dummy coded variable indicating residency in the Panhandle (1 for Panhandle residents; 0 otherwise). If overall levels of hurricane risk are lower for Panhandle residents, having controlled for other factors, then the coefficient for this variable should be negative and significant. A third model takes this a step further by allowing for the effects of wind hazard location to vary, by including an interaction term between the wind zone and Panhandle variables. Again, if wind hazard zone is a less salient factor influencing hurricane risk perception, this coefficient should also be negative and significant. However, as can be seen in Table 2, the addition of these variables does not significantly increase the variance accounted for by the models[8] (note the models' R^2 values) and none of the additional variables are statistically significant. In addition, but not presented here, a fully interactive model was also run, allowing the effects of all factors to vary between Panhandle and other Florida residents. Here again, the results were not statistically significant.[9]

The implication of these findings is clear; there are no significant differences in hurricane risk perception between Panhandle residents and those residing elsewhere in Florida, all other things being equal. Specifically, residents residing in similar wind hazard zones have similar hurricane risk perceptions and the effects of hazard zone location are also consistent. Hence, the inconsistency in building code requirements vis-

[7] This map can be found at: http://www.dca.state.fl.us/fhcd/fbc/maps/1_maps.htm.

[8] The *F*-test for adding the Panhandle dummy was 1.271 (1.1246 d.f.) and the *F*-test for adding the interaction term was .345 (1.1245 d.f.), both were not significant at the .05 level.

[9] *F*-test was 1.190, with 12 and 1234 d.f., which is not statistically significant at the .05 level.

Table 2
Models testing for Panhandle effects

	Basic model	Basic plus Panhandle	Panhandle and wind interaction
Constant	1.189[a]	1.185[a]	1.193[a]
Experiential			
Years FL resident	.004[a] [.052]	.004[a] [.074]	.004[a] [.075]
Experienced hurricane	.003 [.001]	−.002 [−.001]	−.004 [−.002]
Experienced damage	.086[b] [.041]	.083[b] [.039]	.081[b] [.038]
Hurricane knowledge	.022 [.024]	.022 [.023]	.023 [.023]
Socio-demographic			
Female	.128[a] [.066]	.129[a] [.066]	.127[a] [.065]
Black	.366[a] [.106]	.362[a] [.105]	.367[a] [.106]
Hispanic	.317[a] [.123]	.324[a] [.125]	.327[a] [.126]
Age	−.006[a] [−.100]	−.006[a] [−.100]	−.006[a] [−.101]
Income	−.003[c,d] [−.073]	−.003[c,d] [−.070]	−.003[c] [−.070]
Education	−.028[c] [−.068]	−.028[c] [−.070]	−.028[c] [−.069]
Children under 12 in home	.023 [.011]	.024 [.011]	.023 [.011]
Spatial			
Wind zones	.130[a] [.215]	.132[a] [.218]	.130[a] [.214]
Panhandle		.111 [.030]	−.053 [−.015]
Panhandle wind interaction			.048 [.047]
R^2	.133[a]	.134[a]	.134[a]
Adj-R^2	.124	.125	.124

n: 1259; [B]: standardized coefficient.
[a] Two-tailed $P(t) \leq .01$.
[b] One-tailed $P(t) \leq .1$.
[c] Two-tailed $P(t) \leq .05$.
[d] $b(10^{-3})$.

à-vis wind hazard contours for Panhandle versus other Florida residents does not reflect the consistency in hurricane risks perceptions among Florida's single-family homeowners.

7. Discussion

This paper began by addressing a fundamental question of relevance for policy makers and planners interested in using various forms of land-use policy to address natural hazard mitigation in their efforts to make our nation's community landscapes safer and more sustainable. An important element required by such efforts is the utilization of natural hazard risk analysis undertaken by experts to form the "factual basis" upon which the land-use mitigation efforts are developed (Deyle et al., 1998). Unfortunately, as the literature on risk perception points out, there is often considerable divergence between expert risk assessments and public risk perceptions. This research examined the potential gap between expert wind hazard analysis developed and presented in the ASCE 7-98 high wind risk zones, which were incorporated into the State of Florida's new statewide building code, and hurricane risk perceptions of Florida's single family homeowners. Specifically, we assessed whether the hurricane risk perceptions of Florida's single-family homeowners were consistent with high wind hazard zones as identified by ASCE 7-98.

Our findings suggest that there is a good deal of consistency between the hurricane risk perceptions of Florida's single-family homeowners and high-risk wind zones. Not only were mean levels of risk perception consistent with wind hazard zones, but location relative to wind zone was an important influence on individual risk perception net of other factors that might influence risk perception. Indeed, location was the most important factor determining risk perception relative to other factors.

The findings respect to wind zone and the findings with respect to the other variables also may well have consequences for future programs and policy. First, the fact that these models only account for a relatively small percentage of the variance, suggest not only that there is much more room for further research, but also, potentially, that there is a good deal of noise or variation when examining hurricane risk perceptions. For example, examine the considerable differences between the mean hurricane risk for those in the highest wind hazard zone and those of the next two lower zones (see Fig. 2). While they are statistically lower than the highest zone, they are not significantly different from each other nor from the mean risk in the 110–120 wind zone. Since many of these respondents reside in homes without proper wind protection (Peacock, 2003a,b) and new building code requirements will not impact existing housing stock, there may well be a need to increase public education about the potential consequences of hurricane winds for existing homes. In other words, there is perhaps a need to further educate the public about their actual risks. This is further tempered by the fact that knowledge of hurricanes has no impact on risk perception in the models.

Of course, it may well be that we have not sufficiently measured existing knowledge or that experience will always outweigh general hazard knowledge, hence the knowledge factor simply has no effect. However, it is also possible, that the nature of the knowledge held by these Florida residents does not really help them make good risk assessments. Our point is that as planners and public officials, these findings are not written in stone, public policy can have an impact on the relative influences of these factors on risk perception and thereby change future research results. Hence, what may well be needed is education programs targeting those living in high hazard areas (e.g. in wind zones with potentials for greater that 120 mph gust) as well as the aged, helping them personalize that nature of the hurricane hazard risks such that they better recognize their risks and take protective actions such as installing shutters.

While these findings did find consistency between wind hazard zones and perceived risk, inconsistency was also found between the implementation of the statewide building code and risk perceptions. That inconsistency was a function of a modification in the statewide building code that exempted high hazard wind areas located in the Panhandle from stronger building standards, instead opting for stronger standards for only a single mile wide area along the coastline termed the “Panhandle protection provision.” This research has found that Panhandle residents have similar risk perceptions as other throughout Florida. As a result, the Panhandle protection provision is inconsistent with public risk perceptions. The concern is of course that the exemption of the stronger building standards will provide Panhandle residents with a false sense of security and this exemption may possibly undermine the codes legitimacy and compliance, in part because of its perceived lack of fairness for other parts of the State. Furthermore, for those unsuspecting new residents who move into newer housing in the Panhandle and perhaps have heard of Florida’s new stronger building code, they may find a very different picture should a storm strike the Panhandle in the future.

While this study provides key insights into explaining hurricane risk perceptions, it should only be considered a starting point for examining the topic. Further research is needed to better understand the relationship between expert knowledge and public perceptions. Specifically, how residents formulate their ideas of risk vulnerability and which factors play the largest role in explaining risk perceptions. Most notably, the channel through which citizens obtain and process information pertaining to hazards needs further examination. There appear to be significant differences between the informational channels community residents use most as well as variations among different ethnic groups within the same community. Lindell and Perry (2000) concluded in their study of environmental hazards across three sites that radio and newspapers are the communication channels most commonly used by community residents to obtain information about hazards. Other researchers found that there is a tendency for people to seek information primarily from radio and television to assess their personal risk, rather than automatically follow the requests of public officials and technical experts (Dow and Cutter, 2002; Dash and Morrow, 2001). In general, the mass media seems to be an influential source for non-experiential information that potentially shapes the public perception of hazards risk. A question of focus for future research should be on the role of information on shaping hurricane risk perception, particularly in conjunction with location in high wind hazard zones for hurricane risk perceptions.

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