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Real-Time Evidence from the 2012 Atlantic Hurricane Season

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The Dynamics of Hurricane Risk Perception: Real-Time Evidence from the 2012 Atlantic Hurricane Season

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Abstract

Findings are reported from two field studies that measured the evolution of coastal residents’ risk perceptions and preparation plans as two hurricanes—Isaac and Sandy--- were approaching the United States coast during the 2012 hurricane season. The data suggest that residents threatened by such storms had a poor understanding of the threats which the two storms posed; they over-estimated the likelihood that their homes would be subject to hurricane-force wind conditions, but under-estimated the potential damage that such winds could cause, and they misconstrued the greatest threat as coming from wind rather than water. These misperceptions translated into preparation actions that were not well calibrated for the nature and scale of the threat they faced, with residents being well prepared for a modest wind event of short duration but not for a significant wind-and-water catastrophe. Possible causes of the biases and policy implications for improving hurricane warning communication are discussed.
Over the past century, hurricanes have been the single largest source of property damage from natural hazards in the United States. In the last decade alone, losses from hurricanes have been estimated at 290 billion (2012 dollars), with two storms—Katrina in 2005 and Sandy in 2012—collectively inflicting over 120 billion in damage (Blake, et al. 2011; Blake et al. 2012; Pielke et al. 2008; Pielke 2012). What makes the scale of these losses particularly troublesome is that hurricanes are now among the best understood of all natural hazards, and recent years have witnessed dramatic increases in track forecasting abilities and warning times (e.g., Cangialosi and Franklin 2013; Gall, et al. 2013). These scientific advances, however, have seemingly not been matched by commensurate increases in preventive adaptation. To illustrate, 36 hours in advance of Hurricane Sandy residents were warned that the storm would likely bring “life-threatening storm surge flooding” to the Northeast (e.g., NHC Advisory #26, 5PM October 28 2012). Yet, 230,000 cars were still lost in the storm from floods (http://www.theatlantic.com/infocus/2013/01/hurricane-sandy-80-days-later/100440) -- a loss that, at least in hindsight, would seem to have been avoidable.

This article reports the findings of a unique program of research designed to shed light on potential reasons for this adaptation paradox. We report data from field surveys that measured the evolution of coastal residents’ risk perceptions and preparation plans as two hurricanes—Isaac and Sandy---approached the United States during the 2012 hurricane season. In these studies, perceptions and preparation decisions were measured in real time as they were being made by residents threatened by the storms. These data thus provide the first longitudinal look at how hurricane risk perceptions and responses evolve over time during storm threats and how these perceptions compared to the objective risks residents were facing.
The data yield a surprising—and potentially disturbing—view of hurricane threat response. Despite the ubiquity of information available about Isaac and Sandy, residents misperceived the actual risks which they faced in terms of the intensity, nature, and duration of impacts. Surveyed residents, for example, over-estimated the probability that their homes would be affected by hurricane-force winds, but then displayed limited degrees of concern over this prospect. These residents also underestimated the threat posed by flooding—including people living adjacent to water areas. The consequence was a systematic pattern of miscalibrated preparation decisions, with residents taking actions that were suitable for a short-lasting wind event, but not for a significant wind or flood catastrophe with a long-term recovery period, and for which evacuation would be required. In addition, these misperceptions also appeared to be manifested in longer-term investments in protection; only 54% of residents living within a half-mile of water areas threatened by Sandy, for example, reported holding separate flood insurance policies. These issues point to the importance of adjusting hurricane warnings and information campaigns, and of evaluating policy options in the light of these misunderstandings of hurricane hazards.

**Background and Method**

Over the years, a large survey-based literature has developed that describes the kinds of beliefs coastal residents have about the long-term risk posed by hurricanes (e.g., Peacock, et al. 2005; Trumbo, et al. 2011), as well as the basis of shorter-term preparation decisions, particularly those involving evacuation (e.g., Baker 1991; Dow and Cutter 2008; Huang, et, al. 2012; Lindell, et al. 2005; Lindell and Prater 2008; Morss and Hayden 2010; Zhang, et al. 2007). While this work has been useful in providing insights into such issues as the intra-household drivers of decisions to evacuate (e.g., Baker 1991; Lindell and Prater 2008) and media utilization
during storms (e.g., Zhang et al. 2007; Broad, et al. 2007), it has been less informative about how residents perceive hurricane threats when they are arising, and about the accuracy of decisions to take protective action. One primary reason for this gap is that past findings have been based on surveys conducted weeks or even years after storms have past, when memories of what risk perceptions were before the storm and the process by which preparation decisions were made may have faded, and possibly distorted by hindsight bias (e.g., Brown, Williams, and Lees-Haley 1994; Fischhoff and Beyth 1975)\(^1\). As a result, we know little about how risk perceptions evolve over time as storms move toward a coast when the outcome of a storm is still in doubt, and, most critically, about the suitability of preparation actions.

In an attempt to obtain this knowledge, we conducted a program of survey research during the 2012 hurricane season that measured risk perceptions and preparation decisions as they were being made by threatened residents. The storm season offered two opportunities for study: Hurricane Isaac, which made landfall on the coast of the Louisiana just west of the Mississippi River in late August (Berg 2012), and Hurricane Sandy, which made landfall on the coast of New Jersey near Atlantic City in late October (Blake, et al. 2012). The surveys were conducted by phone, and were initiated 72 hours (for Sandy) or 48 hours (for Isaac) before each storm’s predicted landfall, and then repeated with different random samples three shifts a day until 6 hours before predicted landfall (see Figure 1). The surveys were timed to allow measures of subjective storm beliefs to be paired with objective storm information carried in the 5AM, 11AM and 5PM EDT National Hurricane Center advisories.

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\(^1\) Studies that have directly measured recall accuracy for natural hazards have shown reasonably high test-retest reliability in stated reports, something that would seem to assuage this concern (e.g., Neisser et al. 1996; Norris and Kaniasty, K. 1992). The limitation of this work, however, is that because there were no measures taken before events, little is known about whether post-event reports are influenced by hindsight bias, and the degree to which test-retest reliability was inflated by temporal non-independence of the measures.
Each survey instrument contained between 60 and 80 questions (depending on screens) that focused on five domains: 1) current beliefs about the objective characteristics of the storm and warnings; 2) perceptions of the threat posed by the storm; 3) sources of information about the storm; 4) preparation actions, and 5) personal background characteristics. The nature and wording of the specific items evolved from the experience gained designing two prior real-time survey instruments that were developed for use in 2010 (Hurricane Earl) and 2011 (Hurricane Irene). The 2012 surveys contained several new items not contained in previous versions (e.g., probability assessments for different kinds of threats), and were tested for comprehension by the field survey firm (Kerr and Downs) prior to administration.

For the Isaac study, respondents were drawn from a random sample of households in coastal zip codes with land telephone lines along the middle Gulf coast from southeast Louisiana to Alabama, as well as the two westernmost counties in the Florida Panhandle (see Figure 1). For the Sandy study, respondents were drawn from coastal zip codes along the middle-Atlantic from Virginia to northeastern New Jersey. Within each survey shift, approximately 50-60 surveys could be completed, producing a total of 893 completed surveys across both storms. In Table 1 we provide the basic demographic profile of each sample for each storm, along with, for comparison, the corresponding 2010 population demographics of the associated counties the sample was pooled from. While there was some storm-to-storm variation in samples, most participants were homeowners between the ages of 30 and 80 with at least some college education, and approximately three quarters reporting total household incomes over $40,000. As such, the sample tended to be somewhat older, more educated, and more likely to own homes than the mean of the general population in the surveyed areas.
The absolute response rate for the Isaac and Sandy Surveys (percent of phones dialed that yielded a completed survey) was 7.1% for Isaac and 10% for Sandy, a number consistent with recently-published norms for telephone surveys in public opinion polls (Pew Center 2012; Table p. 5). The realized cooperation rates (the percent contacted who participated), however, was much higher than the Pew norms, being 39% for Isaac and 49.3% for Sandy. As a point of reference, these cooperation rates are on a par with response rates reported in recent mail-based post-hurricane surveys (e.g., Huang, et al. 2012).

The location of respondents vis-a-vis-evacuations zones was reasonably well known for Isaac but less so for Sandy, where evacuation orders varied by municipality. As we detail in Appendix 2, most respondents to the Isaac surveys lived in mandatory evacuation areas (Zone A or Category 1) with the exception of some in Harrison County, Mississippi, who lived inland from evacuation zones. In most areas in Isaac’s track, evacuation was advised both for those in beach-front areas as well as those in low-lying areas and adjacent to stream prone to flooding from rain. Because respondents likely varied in their awareness of such orders, our subsequent analysis will focus on stated awareness rather than actual orders (for which we have incomplete measures).

A natural source of concern when contacting respondents via landlines was the possibility of non-response bias due to an increasing tendency for those who were most at risk from the storm (or were most concerned about risk) to leave the study area as the storms approached. Our data offered two means for testing this possibility: by measuring temporal changes in home-
contact and survey completion rates over time, and by seeing if there were temporal changes in sample demographics that might be associated with decisions to evacuate in past studies (e.g., Lindell, et al. 2005; Huang 2012). Because homes were contacted on a randomized basis, non-response bias due to evacuation would be manifested in a decreasing rate of successful telephone contacts over time, as fewer residents would be home to answer calls. As shown in Figure 2, however, response rates showed no such declining pattern; if anything, successful contact rates actually increased over time in the case of Sandy (presumably due to work cancellations in advance of the storm). In the case of Sandy a logistic trend analysis of the number of homes successfully contacted supported a significant positive trend as the time to landfall wore on ($\chi^2$ (1,N=9)= 13.77; p=<.01), whereas there was no significant trend in the case of Isaac ($\chi^2$ (1,N=6)= 2.28; p=.13).

Further reassurance that nonresponse bias was likely not a major factor in our surveys was that the demographic profile of the respondent pool remained largely stable over time. For both storms we regressed five different profile variables that have been found in the past to be correlated with propensities to evacuate--age (Q72; Appendix 1), education (Q75), past storm damage experience (Q63), gender (Q86), and distance from water (Q80; available only in the Sandy study; e.g., Baker 1991; Lindell and Prater 2008)—with time until landfall. For the Sandy study none of these univariate analyses could not reject a null hypothesis of temporal stationarity. In the Isaac study there was a significant tendency for the sample to be slightly younger later in the survey period (t=-2.44; p=.015). Age, however, was separately found not to
be a significant predictor of two risk-perception variables that might associated with decisions to evacuate in the absence of an order: ratings of perceived safety in home, probability of wind damage.²

**Findings**

The survey data provided a rich array of cross-sectional and spatial-temporal data about storm knowledge, perceptions, and preparation actions. Below we report the most salient features of these data, focusing on three categories: awareness of the storms and warnings, the accuracy of the mental models that residents held about storm threats, and the suitability of short- and long-term preparations. In Appendix 3 the sample sizes underlying each figure are reported.

**Storm and warning awareness**

Both Isaac and Sandy were major local, regional and national media events. Local news stations provided continuous coverage of the storm from the time warnings were first issued until after landfall, and the Weather Channel set an all-time viewership record during Sandy, when 39 million U.S. households tuned in to watch their television coverage on October 29th (Bibel 2012). This impact was matched by high levels of web viewing, with the Weather-Channel web-based platforms (*weather.com*, mobile apps) receiving over 450 million page views that same day (Bibel, 2012).

Reflecting this ubiquity of media attention, survey respondents displayed universal (100%) awareness of each storm (Q1), with respondents indicating that they were keeping regularly abreast of storm information. Across all time periods, 88% of Isaac respondents indicated having received their latest information (from any source) within the previous 2 hours (Q23), as did 79% in Sandy, with this percentage increasing to 83% within the last 36 hours prior to landfall. The primary source of this information (Q24) was television for 90% of respondents

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² Details of these analysis are available upon request
in Isaac and 87% in Sandy. In contrast, perhaps surprisingly, internet web sites and social media were less commonly indicated as the source of most recent information; 21% in Isaac and 15% in Sandy reported that their last information came from an internet source (either alone or in conjunction with TV), and of the 43% of respondents across both storms who indicated that they owned a social media account (e.g., Facebook, Twitter), only 4.5% indicated that it was used as a source of storm information.

Despite the high awareness of the storm threats and frequent monitoring of information, respondents’ knowledge about the warnings that had been issued for their locations was surprisingly imperfect. For example, during our Isaac surveys, hurricane warnings were continuously in effect in Louisiana and Mississippi, with watches in Alabama and Florida. Nevertheless, when asked, 11% of respondents were unaware or unsure whether watches or warnings of any kind had been issued (Q13) and, among those who were aware, only 66% who were under a hurricane warning correctly reported this (Q14). Likewise, in the 36 hours just before Sandy made landfall, 20% of respondents in coastal New Jersey, Delaware, and Maryland (the main threat areas that were sampled) were still unaware or uncertain whether warnings had been issued for their areas, and, of those aware, 40% thought it was something other than a hurricane warning.

What makes this result somewhat surprising is that residents in both study had recent experience with tropical cyclones, and, as noted, media coverage of both storms was extensive. The surveyed area of the Gulf Coast, for example, had been under some kind of tropical cyclone warning five times since 2008, and the middle Atlantic had been affected by hurricane Irene just

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3 It is possible, of course, that respondents were using social media for functions other than as a source of factual storm information.
4 The most common error was to believe that they were still under a hurricane watch (22% in Isaac and 27% in Sandy)
the year before (Avilia and Cangialosi 2011). One possible explanation for particularly high
rates of confusion in Sandy, however, is that as the storm approached the coast the National
Hurricane Center decided to switch from issuing traditional hurricane watches and
warnings to “hurricane wind warnings” in anticipation of extra-tropical transition prior to
landfall (Blake, et al. 2012).

The accuracy of mental models: misperceiving intensity and impact

In addition to misconstruing warnings, residents also displayed relatively poor mental
models of the meteorological threats each storm posed. (Mental models are the cognitive
representations of real-world objects, events and processes which people form in their minds
Jones et al. 2011.) The data suggest that perceptions were marked by two prominent biases: an
overestimation of wind intensity—believing hurricane wind conditions winds were far more
likely to occur than was actually the case—and an underestimation of impact—being relatively
unconcerned about the prospect of such winds and a tendency to underestimate the threat posed
by storm surge and flooding.

To illustrate these biases, in Figure 3 we plot the time course of respondents’ subjective
beliefs about the probability that their homes would experience hurricane-force winds of 75mph
or greater (Q16; red line) along with the corresponding objective probabilities derived from the
National Hurricane Center wind forecasts, pooled across states. The objective benchmarks were
constructed using the published cumulative hurricane-force wind probability in a given

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Insert Figure 3 about here

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advisory for the city closest to a resident’s location. For example, in Sandy the benchmark forecast were Norfolk for southeastern Virginia, Ocean City for Maryland and Delaware, and either Atlantic City or Newark for New Jersey.

The data show that residents systematically over-estimated their likelihood of experiencing hurricane-force winds, with estimates, at times, averaging five times those of the scientific estimates for both storms. For example, as Sandy was approaching coastal New Jersey, the national hurricane center cumulative hurricane wind probability at Atlantic City remained below 30%, yet the New Jersey sample consistently reported subjective estimates between 70 and 80%.

But while residents fully expected the arrival of a hurricane, paradoxically few of them expressed high degrees of worry over this prospect. Respondents were asked a number of questions designed to elicit expected personal storm impacts, including rating (on a 100-point scale) how safe they felt riding out the storm in their homes (Q30), the probability that the winds would be such to risk property damage (Q17), the probability that property damage might be such as to threaten personal safety (Q18), and whether or not they believed that the storm would hit and be a danger to them (Q31). In Figure 4 we plot the time course of these multiple measures, which shows that residents’ high expectations of experiencing hurricane-force winds shown earlier (Figure 3) were not manifested in high levels of concern about these winds.

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Insert Figure 4 about here
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For example, across all time periods only 13% of respondents threatened by Isaac and only 17% in the case of Sandy thought that the storm posed personal danger. Likewise, the judged
probability that the winds would be strong enough to inflict some kind of property damage was consistently lower than the probability that the winds would be of hurricane-force. For example, in the survey period before expected landfall in Isaac, the average judged probability of hurricane force winds was 40% (Figure 3), but the average judged probability of property damage was 22% for any personal danger (with the likelihood of severe damage being predictably lower). Likewise, in the last survey period before landfall in Sandy, the average judged probability of hurricane force winds was 58%, but the average judged probability of any property damage was 30%.

A potentially more worrisome aspect of the findings, however, is that the data also show evidence that that residents consistently misperceived the likely source of the danger posed by both storms, with residents for whom the greatest objective threat was from water believing it was from wind. While we lack specific objective information about the actual primary threat faced by each respondent, we can form tentative inferences about the accuracy of risk beliefs by examining how they co-varied with factors inherently associated with water and wind risk, such as the respondent’s proximity to water (Q80), whether they lived in an evacuation zone (either objective or perceived; Q44); and building type (Q55).

The survey provided two measures of respondent’s beliefs about the relative threat posed by wind versus water: a question that asked which of six impacts posed the greatest threat from each storm (wind, flooding from storm surge, a combination of wind and surge, flooding from rain, tornadoes, or some other impact; Q32), and their subjective probabilities that would experience damage to home or safety from wind or flood (Q17-22). As noted above, for each hazard we asked respondents to assess the probability of property damage alone as well as the probability of that the damage would be severe enough to threaten personal safety. (e.g., Q17 v.
Q18). To construct a composite index, we first took the average of these probability assessments for flood, and then subtracted it from the corresponding average for wind. In the Isaac surveys the flood threat was asked only in terms of storm surge, however in the Sandy surveys we solicited separate probabilities for the risk of flood from storm surge and that from rain. In this latter case we defined the subjective water threat as the larger of these two mean stated probabilities.

As we noted earlier almost all of the Isaac surveys were conducted among individuals living in either Zone A or Category 1 surge zones where evacuations had been ordered in advance of the storm (see Appendix 2). Despite this location, 56% of respondents saw the greatest threat they faced was that of wind, while only 33% identified either surge flooding or combined wind and surge flooding as the major threat. Likewise, the mean stated probability of damage from wind was 7% higher than that for water across Isaac respondents.

Of course, one explanation for this result is that respondents were unaware that they were living in flood-prone areas (a common finding in past evacuation studies; e.g., Baker 2005a, b; Arlikatti, et al. 2010). To test for this, in Figure 5a we plot the distribution of primary threat beliefs by two indicators of water threat that would have been salient to residents: whether or not they had heard they were living in an area where evacuations had been ordered (Q44), and whether they were living within 500 feet of the Gulf (or, in the Louisiana sample, Lake Ponchartrain), as computed from geocoded linear distance (N=40 within 500 feet and N=314 beyond 500 feet).
The figures show that while living adjacent to the water indeed heightened concerns about flooding, a plurality—40% within 500 feet of the water—still believed that the primary threat was from wind, and beliefs about the larger threat of wind were actually higher among those who had heard that they were living in an area where evacuations had been ordered.

Because we gathered a richer array of measures about location and beliefs in the Sandy study, it allowed us to undertake a more detailed analysis of wind-versus-water misperceptions. In Figure 5b we plot two measures of the relative degree to which residents believed the greatest threat was from wind over water as a function of the distance of a residents’ home from a water body (Q80): the wind-bias index described above (the difference between the subjective probability of damage from wind versus water), and the difference between the proportion of respondents who identified wind as the greatest source of threat versus any water threat (Q32; surge, wind and surge, rain). While here we see that, indeed awareness of the threat of water grew as the respondent’s proximity to water grew, both the wind-bias indices are always strictly positive; even those living on the water believed that the greater threat they faced was from wind rather than water.

Because the probability-based wind bias index appeared to be the measure of relative belief that was most responsive to variation in objective risk, as a final analysis on the Sandy data we regressed this bias measure against a battery of indicator-coded variables that capture the normative drivers of the relative risk of wind versus water (distance to water (Q80) and building structure type (Q55)), and individual difference factors that might drive perceptions, including gender (Q86), education (Q75), age (Q72) ownership of a flood policy (Q60), and whether the respondent had previous experience living through a hurricane (Q63, 64). In this analysis the effect of distance was captured by four binary (indicator) variables that contrasted beliefs at each
successive distance with those held by waterfront residents. The results of this analysis, reported in Table 2, supports only one marginally-significant moderator of the tendency to believe that wind is the main threat posed by the storm—the respondent’s age. Controlling for other factors, older respondents were more inclined to see wind as the greater risk over water. In contrast, there was no significant effect of increasing distance from a waterfront location, storm experience, housing type, or education, or ownership of a flood policy. The absence of an effect of ownership of a flood policy would seem particularly surprising; even those who are sufficiently concerned about the threat of floods that they paid to insure against it believed that the greatest threat Sandy posed was from wind, not water.

Finally, there was also suggestive evidence that residents underestimated the likely duration of the impact of each storm. In our Sandy survey (though not for Isaac) we asked residents how long they expected to be without power during and after the hurricane (Q42). In Figure 6 we plot the distribution of answers broken down by states where the path of the storm suggested the greatest impact would lie (New Jersey and Delaware), and those where less of an impact was anticipated (Maryland and Virginia). The data suggest that residents were relatively optimistic about the duration of impact; the majority of residents thought either that if they lost power it would either be for less than two days (with 20% in all four states believing they would never lose power), or they held no belief about duration. In contrast, only 28% of coastal respondents in New Jersey and Delaware expected that they might be without power for more than 2 days—only slightly more than the expectations of residents in Maryland and Virginia
(22%), where there would have been objective reasons to expect a smaller impact. What is notable about this optimism is that as Sandy approached residents were widely warned to prepare for outages that could last 7-10 days, or the longest that had been experienced during Hurricane Irene the year before (see http://abcnews.go.com/US/hurricane-sandy-jersey-prepares-10-day-power-outages/story?id=17579827#.UZVdQbWR-O0). The optimistic beliefs, however, imply that many respondents either failed to hear such warnings, or believed that if there were long outages they were going to be experienced by people other than themselves.

**Protective Actions**

*Short-term preparation.* Although respondents’ beliefs about the threats posed by Isaac and Sandy departed in important ways from actual risks, an overwhelming proportion of respondents undertook at least some short-term preparatory action in advance of both storms, and almost all felt well prepared for the storms by the time that they arrived. The evolution of preparedness levels is depicted in Figure 7, which plots the percentage of respondents for Isaac and Sandy (pooled) who indicated taking at least some preparatory action (Q37) and those who felt they were ready for the storm over time (Q40).

The optimistic assessments of likely durations of power outages are consistent with those uncovered by Baker (2005a, b) in pre-storm surveys among residents in Nassau and Suffolk Counties in Long Island, where only 4% of respondents in Nassau and 15% in Suffolk believed they would lose power for more than 2 days in the advent of a Category-1 Hurricane—the strength of Sandy.
virtually all respondents took the storm seriously enough to undertake preparations—and to carry out these steps early. For example, when Sandy surveys began on the evening of October 26th—72 hours before the storm made landfall—over 75% of respondents had already taken some preparatory action, and by the time the storm arrived on the 29th over 94% felt sufficiently well prepared to endure whatever Sandy had to offer.

On the other hand, an analysis of the kind of preparations that were being taken provides a less encouraging view of readiness. In Figure 8 we plot the time course of undertaking four major protective actions (Q37), pooling over storms: buying household supplies (e.g., groceries), putting up removable storm shutters (if owned), purchasing or readying a power generator, and developing an evacuation plan if needed (e.g., securing a hotel reservation).

The data show a disconcerting pattern of preparation: while the vast majority of respondents sought basic supplies in advance of each storm (6 hours before landfall 88% reported doing so), more effortful actions were comparatively limited. For example, across time periods only 25% of respondents had made plans for where they would go if evacuation was ordered or needed, and in the last survey period when each storm was within 6 hours of predicted landfall, less than 55% of residents who owned removable window protections (such as shutters) had putting them up, and 11% had secured or prepared electric generators.

Perhaps even more alarming was the observed limited compliance with evacuation advice. Though the survey methodology precluded us from directly measuring the percentage of respondents who actually complied with evacuation advice, it nevertheless provided two implicit measures: the change in the percentage of respondents who believed they were living in
communities where evacuation had been advised yet who were still home to answer the survey as the time of landfall approached, and the change in the successful home contact rate (from Figure 2). Because home telephones were randomly dialed, increasing actual evacuation rates over time should be mirrored by a decrease over time in the percentage of the sample who indicated that they were living in evacuation areas (or were home at all).

In Figure 9 we plot the evolution of these implied compliance measures as well as

Insert Figure 9 about here

stated intentions to leave among those living in advised evacuation areas (from Q44, 49). Hurricane evacuation advisories are typically issued at least 36 hours before a storm’s anticipated landfall, and, consistent with this practice, we see a sharp increase in awareness of evacuation warnings after this, 30 hours before landfall. What is potentially disturbing, however, is that the data suggest that there was limited apparent compliance with this advice. Among those respondents who believed that they were living in communities where evacuations were ordered, the percentage who stated they intended to leave was, ironically, highest (55%) before a significant proportion were even aware that orders had been given (36 hours before landfall)---with this percentage decreasing over time as awareness of orders grew. While we do not have direct measures of the percentage of actual compliance, further indications that the actual rate of evacuation was quite low is reflected by the absence in a decline in the percentage of respondents who were home to answer the survey as the time of landfall approached---that the time Moreover, this low intended compliance was mirrored by the high percentage of respondents who believed they were living in evacuation areas yet who were still home to answer the phone as the storm approached. Thirty hours before landfall when warnings were
first given, for example, 54% of respondents believed that they were living in communities where evacuations had been advised, and 6 hours before landfall, this was still 49%--a number that suggests limited actual evacuation. Likewise, as we noted earlier, during the course of the whole survey we never saw a decrease in the home telephone contact rate (Figures 2,9), suggesting that the 55% intention rate measured 36 hours before landfall likely overstated the actual rate (both ordered and non-ordered).

One possible explanation for the lack of intentions to take effortful actions is that residents believed that their particular homes were at limited risk of damage from either wind (for those who owned shutters) or flooding. To explore this, we analyzed the bivariate relationships that existed between the conditional likelihoods of installing shutters (given ownership(Q34,35,37) and evacuation intention (given living in an advised evacuation area, Q44,49) by respondents’ beliefs about the probability that their home would suffer damage from either winds (for shutters) or flooding (for evacuation). The data show only a weak association between the two constructs. For shutters, there was no significant relationship between shutter usage and subjective damage likelihood ($\chi^2 = .48 (1,N=184); p>.1$). For example, 59% of those who believed that there was a greater than a 50-50 chance of experiencing wind damage to their homes (N=32) put up their shutters, which was only nominally higher than that observed among people who believed there was less than a 50-50 chance (N=152; 52%). For evacuation there was a significant positive effect of risk beliefs on evacuation intentions ($\chi^2 = 8.44 (1,N=284); p=.014$), but it was small in absolute terms; across all times periods and storms, 38% who thought there was greater than a 50-50 chance of experiencing damage from rain or surge flooding (N=50) expressed an intention to evacuate, compared to 20% among those who thought there was less than a 50-50 chance (N=234).
Long-term protection

The storm surveys also explored the degree to which residents had invested in long-term protection prior to Isaac and Sandy. This was either in the form of making improvements to their homes that would make them more resilient to damage from storms or owning flood-insurance policies (Q65, 59, 60 respectively). The data suggest a troubling absence of such long-term investments in protection. Among respondents threatened by Sandy who had lived in their homes more than 11 years, only 17% reported having invested in storm-safety improvements in their homes (19% for all tenures). The percentages for Isaac was somewhat higher (38% for those in their homes more than 11 years, 35% overall), but still low considering frequent incidence of hurricanes along the central Gulf Coast.

Ownership of federal flood policies was also limited. For example, in areas threatened by Sandy only 53% of those living within a half mile of water (bay or ocean) indicated that they owned flood policies (54%, including those who were uncertain whether the coverage was separate from the regular homeowners’ policy), with this percentage only slightly higher (57%, 59% adjusted for uncertainty) among those who indicated living within one block of water. In areas threatened by Isaac, ownership of flood policies among those living in proximity of water was higher, but still far from complete; among those living within a half mile of open water, only 70% indicated that they had purchased a federal flood policy. Although this incidence of flood insurance purchase might seem to be acceptable, it is certainly lower than desirable.

What explains the low ownership of flood policies among those at high risk from flood? One contributing mechanism may have been a mistaken belief among residents that their regular homeowners’ policies covered them for flood losses. Specifically, across our whole sample, among the 42% who expressed the belief that they were insured against flood losses, only 51%
indicated that they own a separate federal flood policy, with 3% being unsure. This implies that potentially half of the respondents who thought that they were covered in the event of a flood loss, were, in fact, not.

**Discussion**

One of the greatest challenges facing forecasters and emergency management officials worldwide is to design natural-hazard communication strategies that successfully encourage individuals in threatened areas to take appropriate protective actions—both in their short-term responses to immediate as well as their long-term decisions about housing and personal risk management (Morss, et al. 2010; Demuth et al., 2012). The enormous property losses that have occurred as a result of tropical cyclones in recent years, however, suggest that communication efforts have not been as effective as they might be. Individuals living in areas prone to flood risk have been found to chronically under-insure (e.g., Kousky and Michel-Kerjan 2012), and individuals fail to evacuate in the face of explicit warnings when faced with hurricane risks (Baker 1991, Huang, et al. 2012).

What makes this problem particularly vexing in the case of tropical cyclone threats is recent years have witnessed large gains in public awareness of these storms. When hurricanes approach coastlines in the United States they are major media events; in our work not a single respondent was unaware that their locations were threatened either by Hurricane Isaac or Sandy, and the vast majority reporting keeping regularly abreast of the latest storm news as each approached, with over 80% indicating their latest information was less than 2 hours old. Yet somehow this ubiquitous awareness did not translate into uniformly appropriate protective actions; only 55% of the respondents we sampled whose homes were equipped with removable window protection installed it as the storms approached, and only a small proportion of those
who believed that they were living in areas where evacuations had been advised expressed an intention to leave; we had no problem finding residents in evacuation areas at home to answer their phones as each storm approached.

The goal of this research was to complement earlier attempts to better understand the factors that underlie decisions to undertake protective action in the face of hurricane threats by reporting the findings of two “real time” surveys of coastal residents as hurricanes Isaac and Sandy approached the United States in 2012. The data provide the first look at how hurricane threat perceptions evolve over time in response to warnings as storms approach the coast, and how protective decisions are being made when the storm’s outcome is still in doubt.

The findings provide what might be seen as a disquieting—and in some cases paradoxical—view of hurricane threat perceptions and response. As noted above there was universally-high awareness about the threat posed by Isaac and Sandy as each approached the coast, but there also evidence that residents held poor mental models of both the nature and duration of the personal impacts that the storms could have. One of the surprising results was that individuals over-estimated the probability that their locations would be impacted by winds of hurricane force (75mph or more) compared to scientific estimates provided by the National Hurricane Center, yet this pessimism did not translate to correspondingly high degrees of worry about the damage that such winds might cause, or induce residents to take the kind of protective actions that such beliefs would seem to warrant. Only a fraction of those owning removable storm shutters put them up, few secured securing generators in anticipation of long power outages, and roughly only 20% made evacuation plans should it be needed.

There was also little evidence in the data that preparation was inhibited by social pressures, by beliefs that certain measures would be ineffective, or by barriers to undertaking
them (Lindell and Perry 2012). For example, when respondents who were aware they were living in evacuation areas why they did not intend to leave (Q53), only 1% cited physical limitations, 1% that they were advised to stay by friends or relatives, and 7% that they desired to protect their homes. The most common reason was a belief that there was simply no need to; 75% indicated that they felt safe staying put.

Were these feelings of safety misplaced? One of the major findings of our work was that many residents misconstrued the primary _locus_ of the threat posed by hurricanes as coming from wind rather than water. This is a bias, we should note, that has been observed in other contexts. For example, in surveys among Texas residents after Hurricanes Lili, Bret, and Rita, Lindell and Prater (2008), for example, found that coastal residents similarly underestimated the risks posed by storm surge relative to wind, and concern about wind damage was more strongly associated with intentions to evacuate from future storms. Likewise, an excessive focus on wind rather than flooding risk was been cited as a major cause of lives lost in France during cyclone Xynthia in February of 2010 (Vinet, et al. 2012). What was particularly notable was that we observed the tendency to underestimate the relative threat posed by water in Isaac and Sandy even among those for whom the threat should have been most salient; for example, in our Sandy survey even people having waterfront properties and who held flood insurance policies felt that there was a higher probability that their homes would suffer damage from wind than flooding.

While the forces that gave rise to these poor mental models are uncertain, we can offer some speculations. First, some of the findings might be explained by endemic biases in how people perceive and respond to risk that have been observed in other contexts. For example, it has long been observed that when responding to hazards—be they natural or health or man-made—people are prone believe that they will be less likely to suffer harm than others—an effect
termed the optimistic bias (Trumbo, et al. 2011; Weinstein 1980). The optimistic bias provides a natural explanation for why residents might display upwardly-biased beliefs that the storms would bring hurricane-force winds to their locations, but then express limited concern that such winds would cause personal harm.

But while inherent optimism might explain some aspects of the data, we suggest that other observed biases may have their root in how the risks of hurricanes are often communicated to residents. For example, one factor that would seem likely to contribute to an overweighing of wind over water risk is that that storm intensity is currently exclusively conveyed by NOAA by the Saffir-Simpson scale, which describes the maximum sustained winds a storm possesses, not its maximum storm surge or flood threat. While the National Hurricane Center made clear efforts to warn residents of flood risk as each storm, our surveys revealed that residents nevertheless had a higher awareness of their maximum winds rather than flood potential. Specifically, when respondents were asked to report what they believed Isaac’s and Sandy’s maximum winds and predicted maximum storm surges to be, respondents were much better at the former than the latter; whereas 88% of respondents in Isaac and 79% in Sandy could recall the wind forecast (Q7), only 67% in Isaac and 63% in Sandy could recall the storm surge forecast (Q9). Simple greater mental availability of the wind threat could explain at least some of the bias.

Another likely contributing factor is that in many cases wind damage is inherently easier to mentally simulate than flooding damage (Meyer 2006). Whereas we experience (modestly) high winds and see its consequences on a regular basis, flood events are rare. Mental simulation of flood losses would be particularly difficult for individuals whose homes are not in beach-front locations were surge risks might easily be imagined. A New York resident living in a high rise
lower Manhattan during Sandy might thus be forgiven for overlooking “storm surge risk” as a major personal threat, when, in fact, it was the greatest threat faced during the storm due both to flooding that could prohibit escape from the building and make it uninhabitable for long periods.

What might be done to improve residents’ mental models of tropical cyclone threats? As a starting point, the findings of this work strongly support recent calls for hurricane communication to focus less on a hurricane’s maximum wind strength (which is typically found in small areas near the center) and more on the impacts that residents living in different areas are likely to experience, particularly with respect to flood (e.g., Demuth et al., 2012; Huang, et al. 2012), or other attributes of a hurricane’s windfield such as size, duration, or directional uniformity (Czajkowski and Done 2013). Achieving this goal, however, is unlikely to be easy, as it will almost certainly require more than emphasizing flood risks in advisories and disseminating flood-risk maps to residents. As Hurricane Isaac approached the Louisiana coast, for example, the National Hurricane Center’s advisories emphasized flooding (from surge and rain) as the primary threat posed by the storm (e.g., Advisory 28, August 27), and in Sandy the advisory headlines similarly emphasized surge risks. Likewise, residents cannot be assumed to develop better intuitions simply by providing better maps and evacuation-education programs before storms; prior research suggests that many residents do not know their evacuation zone, even when aided by a map (e.g., Baker 2005a, b; Arlikatti, et al. 2010; Zhang, et al. 2004).

Hence, if there is to be a solution, it will likely require an orchestrated suite of communication activities that both characterize the strength of a storm in terms of both its size and nature of impacts rather than just wind strength. For example, the UK Met Office has recently experimented with the use of color-coded “risk grids” that simultaneously convey the
probability and severity of storm impacts (Demeritt 2012), and Morss, et al. (2010) provide further support for the ability of individuals to utilize probabilistic forecasts.

Likewise, official could consider exploring tools that would allow residents to more easily mentally simulate how storms could induce damage. To illustrate, in Sandy one of the greatest sources of personal property losses was from private automobiles---a loss that could easily have been avoided had residents simply known the damage that flood waters can do to a car, and move them out of harm’s way as the storm was approaching.

Of course, there are likely strong limits to what better education and more targeted communication might hope to achieve. In many cases the greatest source of decision errors in the face of hazards is that individuals are uncertain about the correct course of action, and end up choosing familiar default options that are decidedly sub-optimal for a given situation—since as choosing to stay when one is unsure whether to evacuate or not, or in the tragic case of Hurricane Sandy, choosing to evacuate by taking a familiar road that goes through an unmarked surge zone (e.g., http://www.ibtimes.com/glenda-moore-staten-island-mother-who-lost-2-sons-hurricane-sandy-returns-site-tragedy-858289.)

In this case we follow Thaler and Sunstein (2008) and others by suggesting that communities work to develop stronger sets of “decision defaults” that reduce the uncertainty that typically accompanies individual decisions about when and how much to prepare. For example, Kunreuther and Michel-Kerjan (2009) have argued in support of long-term flood insurance contracts that have automatic annual decisions about renewal. Similar mechanisms could be extended to short-term preparedness, such as communities developing a program that annually distributes hurricane kits to all residents from which households can opt-out—shifting the focus of decision making from that of whether one should prepare to whether one should not prepare.
Finally, our hope is that this research will spawn additional attempts to conduct real-time measurement of responses to natural hazards. The technical challenges of doing such work, however, are formidable. One of the limitations of relying on landlines as used here that we noted at the outset is the risk of sample-selection bias as storms approach; those who are more concerned with risk will be more likely to evacuate their homes, possibly resulting in a biased view of actual intended evacuation and storm preparation levels. While we offered evidence that in the case of Isaac and Sandy there was little sample attrition (e.g., home contact rates on the last day were not significantly different than the first), this cannot be expected to be the case in general given more severe storms. Likewise, another source of bias is the fact that wireless phones are increasingly replacing landlines as the major telecommunication channel used by households, particularly those who are younger (in 2012 the CDC estimated that 34% of U.S. households have only wireless phone service; Blumberg and Luke, 2012).

As such, consideration needs to be given to alternative contact methods, such as brief surveys delivered to smart phones. Those methods, however, will have their own challenges, at least at this point in time. Aside from the pragmatic difficulties of implementing surveys on mobile phones (which are restricted under the Telemarketing Consumer Protection Act of 1991), there would be a loss of precise locational information, which is critical if one hopes to map risk perceptions to objective risk. One possibility might be to integrate real-time surveys into weather and protection-related smart-phone apps where respondents give prior consent to responding to brief surveys and surrendering GPS location information. Such an approach might allow future researches not just to replicate the work reported here, but also investigate spatial dynamics such as movement after warnings have been issued.
References


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Blake, Eric S; Christopher Landsea, and Gibney (2011) , “The Deadliest, Costliest, and Most Intense Tropical Cyclones from 1851 to 2010”, NOAA Technical Memorandum NWS NHC-6, the National Hurricane Center, Miami.


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### Table 1: Respondent Socio-Economic / Demographic Profile Summary

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Isaac Survey Respondents (%)</th>
<th>Isaac Survey Counties (%)</th>
<th>Sandy Survey Respondents (%)</th>
<th>Sandy Survey Counties (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeowner Status*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeowner</td>
<td>93</td>
<td>59</td>
<td>89</td>
<td>57</td>
</tr>
<tr>
<td>Rent</td>
<td>6</td>
<td>27</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Other / Refused / Vacant (counties)</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Age*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 30</td>
<td>3</td>
<td>40</td>
<td>4</td>
<td>39</td>
</tr>
<tr>
<td>30 to 60 (respondents) / 30 to 59 (counties)</td>
<td>52</td>
<td>41</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td>61 to 80 (respondents) / 60 to 79 (counties)</td>
<td>34</td>
<td>16</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>Over 80 (respondents) / 80+ (counties)</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Other / Refused</td>
<td>5</td>
<td>-</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Race*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American or Black</td>
<td>13</td>
<td>22</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>White or Caucasian</td>
<td>83</td>
<td>71</td>
<td>83</td>
<td>69</td>
</tr>
<tr>
<td>Other / Refused</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Education Level**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some high school / high school graduate</td>
<td>25</td>
<td>42</td>
<td>26</td>
<td>41</td>
</tr>
<tr>
<td>Some college / college graduate</td>
<td>53</td>
<td>46</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>Post graduate</td>
<td>14</td>
<td>7</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Other / refused / Less than high school (counties)</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>6</td>
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<tr>
<td>2011 Total Household Income**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than $15,000</td>
<td>5</td>
<td>13</td>
<td>2</td>
<td>11</td>
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<tr>
<td>$15,000 to $39,999 (respondents) / $15,000 to $34,999 (counties)</td>
<td>16</td>
<td>23</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>$40,000 to $79,999 (respondents) / $35,000 to $74,999 (counties)</td>
<td>25</td>
<td>33</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>Over $80,000 (respondents) / Over $75,000 (counties)</td>
<td>21</td>
<td>31</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>Other / refused</td>
<td>33</td>
<td>-</td>
<td>51</td>
<td>-</td>
</tr>
<tr>
<td>Resident type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live here year-round</td>
<td>98</td>
<td>N/A</td>
<td>97</td>
<td>N/A</td>
</tr>
<tr>
<td>Vacationing</td>
<td>2</td>
<td>N/A</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>Other / refused</td>
<td>0</td>
<td>N/A</td>
<td>2</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* County data from 2010 census  
** County data from 2007 to 2011 American Community Survey. Education level based upon total population that is 25 years and over (approximately 88% of the total adult population). 2011 Total Household Income based upon occupied (owner and renter) housing units income data in 2011 inflation-adjusted dollars.
Table 2: Regression of Wind-Water Belief Bias: Hurricane Sandy

<table>
<thead>
<tr>
<th>Predictor*</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>t value</th>
<th>Pr &gt; t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family Home</td>
<td>5.163176</td>
<td>3.256452</td>
<td>1.59</td>
<td>0.114</td>
</tr>
<tr>
<td>Within 1 block of water</td>
<td>-5.710127</td>
<td>3.828923</td>
<td>-1.49</td>
<td>0.137</td>
</tr>
<tr>
<td>Within 1 mile of water</td>
<td>-5.827326</td>
<td>3.153236</td>
<td>-1.85</td>
<td>0.065</td>
</tr>
<tr>
<td>Have a separate flood policy</td>
<td>-4.323446</td>
<td>3.157173</td>
<td>-1.37</td>
<td>0.172</td>
</tr>
<tr>
<td>Education Level</td>
<td>-1.492738</td>
<td>1.303257</td>
<td>-1.15</td>
<td>0.253</td>
</tr>
<tr>
<td>Age</td>
<td>2.219887</td>
<td>1.03686</td>
<td>2.14</td>
<td>0.033</td>
</tr>
<tr>
<td>Male</td>
<td>.0377965</td>
<td>3.149295</td>
<td>0.01</td>
<td>0.990</td>
</tr>
<tr>
<td>Experienced Hurricane in Past</td>
<td>-2.603693</td>
<td>3.200698</td>
<td>-0.81</td>
<td>0.416</td>
</tr>
<tr>
<td>Constant</td>
<td>9.720106</td>
<td>7.77089</td>
<td>1.25</td>
<td>0.212</td>
</tr>
</tbody>
</table>

*Single family home = 1 for Q55 “detached single family home”, 0 otherwise (81% of the home type observations for Sandy are detached single family home); Within 1 block of water =1 for Q80 “directly on the water” and “within 1 block of water”, 0 otherwise; Within 1 mile of water = 1 for Q80 “within ½ mile of the water” and “within 1 mile of the water”, 0 otherwise; Over 1 mile of water = 1 for Q80 “more than 1 mile of the water”, 0 otherwise and is the omitted dummy category. Have a separate flood policy = 1 for Q60 “yes”, 0 otherwise; education level = Q75 discrete values 1 to 5; age = Q72 discrete values 1 to 6; male = 1 for Q86 “male”, 0 otherwise; and experienced hurricane in past = 1 Q63 “yes” or Q64 “yes”, 0 otherwise.
Figure 1. Storm Paths and Coastal Counties Surveyed. Storm paths indicate timing of survey in hours prior to landfall and wind intensity of at the storm’s center.
Figure 2: Successful Telephone Contact and Conditional Survey Completion Rates by Hours before Landfall (X-axis), Isaac and Sandy
Figure 3: Respondents’ beliefs about the probability that their homes would experience hurricane winds of 75mph or higher (red line) and corresponding objective probabilities (blue line) by hours until expected landfall (x-axis). Isaac data cover only the last 36 hours because of a survey error in which the wind-speed question was not asked in the first survey wave.
Figure 4: Evolution of perceptions of personal risk as a function of hours until expected landfall for Isaac (top) and Sandy (bottom). Safety rating is a rating on a 1-100 scale of how safe respondent felt riding out the storm in their home with 0 not safe at all and 100 certain will be safe. Property risk is the judged probability that the storm’s winds would induce property damage, personal risk the probability that the damage would severe enough to threaten personal safety with 0 no chance of damage or danger and 100 certain of damage or danger. Worry is the percentage of respondents who indicated that they believed that the storm would hit and pose a danger to them.
Figure 5: Beliefs about the most likely source of damage from Isaac (5a; top) and Sandy (5a; bottom) by reported distance to ocean or bay. Graph for Isaac (5a) plots beliefs about the greatest threat by distance to coast. Graph for Sandy plots two different measures of beliefs of the threat of wind v. water. Blue bars plot the difference in the percentage who identified wind as the greatest versus that who identified any one of three water threats. Red bars plot the difference in mean stated damage probability from wind minus that from water (stated maximum of either surge or rain).
Figure 6: Expected durations of power loss by state, Hurricane Sandy
Figure 7: Percentage who indicated taking some kind of protective action (top line) and who felt they had enough supplies on hand should the storm strike today (lower line) by hours until landfall, pooled over storms.
Figure 8: Percentage taking different preparation actions as a function of hours until expected landfall, pooled over storms. “Evac plan” refers to making plans for where to go should evacuation be ordered or needed; “Supplies” refers to purchased supplies for the home such as food, water and batteries; “Shutters” refers to any removable window covering conditional on ownership, “generator” refers to purchasing or readying a generator.
Figure 9: Intended and inferred actual measures of evacuation for the last 48 hours until landfall, pooled over storms. Blue line is the percentage of respondents living in communities where evacuation had been advised who stated an intention leave (percent intention given awareness). Red line is the percentage of respondents called who were indicated they were living in an evacuation area (percent aware). Green line is the pooled at-home successful contact rate (pooled from Figure 2).
Appendix 1

Hurricane Sandy Real-Time Survey

1. Have you heard that a tropical cyclone named Sandy might pose a threat to parts of the East Coast?

   ☐ 1. Yes
   ☐ 2. No

   [IF THE ANSWER IS 2, THEN SKIP TO QUESTION 89]

2. The last you heard, was it a tropical storm, a hurricane, or something else? (if something else - PROBE)

   ☐ 1. Tropical Storm
   ☐ 2. Hurricane
   ☐ 3. Northeaster
   ☐ 4. Hybrid Storm
   ☐ 5. Don’t Know/not sure
   ☐ 6. Other

   [IF THE ANSWER IS 1 OR 3 OR 5-6, THEN SKIP TO QUESTION 5]

3. 

4. As you may know hurricanes are rated on a five category scale, where Category 1 is the weakest and category 5 is the strongest. The last you heard, what was the category of the storm that’s out there now?

   ☐ 1. Category 1
   ☐ 2. Category 2
   ☐ 3. Category 3
   ☐ 4. Category 4
   ☐ 5. Category 5
   ☐ 6. Don’t Know/not sure

5. How strong was the storm in miles per hour? (Record response in MPH. Take midpoint if range given.)

   (5 = Don’t Know, 8 = Haven’t heard/seen)

   MPH .......... _____

6. What type of storm is it forecast to be when and if it makes landfall?

   ASSIST IF NECESSARY.
If they offer hurricane, prompt them for category (1-5), and then mark either the category or unknown category.

If they offer an answer that fits tropical depression, tropical storm, nor’easter, hybrid, or other kind of mixed storm, accept that.

If they ask for suggestions, offer tropical depression, tropical storm, hurricane, nor’easter, hybrid storm, or something else—and then follow up with categories if they select hurricane.

- A tropical depression
- A tropical storm
- A hurricane of unknown category
- A category 1 hurricane
- A category 2 hurricane
- A category 3 hurricane
- A category 4 hurricane
- A category 5 hurricane
- A nor’easter
- A hybrid storm (uses the word hybrid)
- A mixed storm (accept answers that indicate hurricane and something else and do NOT use the word "hybrid")
- Don’t know
- Haven’t heard/seen

7. How strong are the winds expected to be when and if the storm makes landfall? READ

- < 39 miles per hour
- 39 to 73 miles per hour
- 74 to 95 miles per hour
- 96 to 110 miles per hour
- 111 to 130 miles per hour
- 131 to 155 miles per hour
- > 155 miles per hour
- Don’t know
- Haven’t heard/seen

8. How long do you think it will be before the storm could begin affecting your location with dangerous winds and flooding? READ IF NECESSARY

- Already has
- 0-6 hours
- 7-12 hours
- 12-24 hours (1 day)
9. How high, in feet, did the forecast say the storm surge will be along the coast near your location, when and if the storm makes landfall? (READ IF NECESSARY)

- 1. Less than 5 feet
- 2. 6-10 feet
- 3. 11-15 feet
- 4. 16 to 20 feet
- 5. more than 20 feet
- 6. Don’t Know/not sure
- 7. Haven’t heard/seen

10. Have you seen any maps or graphics that include a cone or shaded area that shows the path of where the storm may go?

- 1. Yes
- 2. No
- 3. Don’t Know/not sure

[IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 12]

11. Is your home currently in the cone or shaded area that shows the path of where the storm may go?

- 1. Yes
- 2. No
- 3. Don’t Know/not sure

12. Have you seen any graphics that show several different tracks where the storm might go, based on a number of different computer models? Sometimes the graphic is called a spaghetti map because of the way it looks.

- 1. Yes
- 2. No
- 3. Don’t Know/not sure

13. Has the National Hurricane Center issued a watch or warning for your location for this storm?

- 1. Yes
14. What kind of watch or warning is your home currently under? READ

- [ ] Hurricane Watch
- [ ] Hurricane Warning
- [ ] Tropical Storm Watch
- [ ] Tropical Storm Warning
- [ ] Don't Know/not sure
- [ ] Other

[IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 16]

15. _______________________________________________________________________

16. Using a percentage scale from 0 to 100, what do you think the chances are that the storm will cause hurricane conditions at your home, with winds of 75 MPH or more? 0 percent would mean that you feel there is no chance that your location will have hurricane force winds, and 100 means you are absolutely certain your location will definitely have hurricane force winds.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don't Know

Percent Scale Score .......... _____

17. Using the same 0-100 scale, what do you think the chances are that wind from the storm will cause significant damage to your home or possessions, such as damage to your roof or windows? 0 percent would mean that you feel there is no chance of significant damage to your home from wind, and 100 means that you are certain your home will experience significant damage because of wind from the storm.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don't Know

Percent Scale Score .......... _____

18. Using the same 0-100 scale, what do you think the chances are that wind from the storm will cause enough damage to your home that it will pose a serious threat to your safety if you stay in your home during the storm? 0 percent would mean that you feel there is no chance of
danger to your safety due to wind from the storm and 100 would mean that you are certain that wind from the storm will make it dangerous for you to be in your home during the storm.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don't Know

Percent Scale Score .......... _____

19. Using the same 0-100 scale, what do you think the chances are that flooding caused by storm surge or waves from the storm will cause significant damage to your home or possessions? 0 percent would mean that you feel there is no chance of significant damage to your home from flooding, and 100 means that you are certain your home will experience significant damage because of flooding.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don't Know

Percent Scale Score .......... _____

20. Using the same 0-100 scale, what do you think the chances are that storm surge or waves from the storm will cause dangerous flooding in your home that will pose a serious threat to your safety if you stay in your home during the storm? 0 percent would mean that you feel there is no chance of dangerous flooding in your home and 100 would mean that you are certain that your home will experience flooding that will be a danger to your safety.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don't Know

Percent Scale Score .......... _____

21. Using the same 0-100 scale, what do you think the chances are that flooding caused by heavy rains from the storm will cause significant damage to your home or possessions? 0 percent would mean that you feel there is no chance of significant damage to your home from flooding, and 100 means that you are certain your home will experience significant damage because of flooding.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don't Know
22. Using the same 0-100 scale, what do you think the chances are that heavy rains from the storm will cause **dangerous flooding** in your home that will pose a serious threat to your safety if you stay in your home during the storm? 0 percent would mean that you feel there is no chance of dangerous flooding in your home and 100 would mean that you are certain that your home will experience flooding that will be a danger to your safety.

(Assist: Would you think it's more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77= Don't Know

23. We're interested in knowing something about where you tend to get information about storms.

How long ago did you see or hear **NEW INFORMATION** about the storm? This could be from any source, such as watching TV, searching the Internet, or talking to people.

READ

- [ ] 1 Within last 2 hours
- [ ] 2 Within last 6 hours
- [ ] 3 More than 6 hours ago
- [ ] 4 Don't know

24. What was the source of that information? (READ IF NECESSARY)(ACCEPT MORE THAN 1)

- [ ] 1 Television
- [ ] 2 Internet
- [ ] 3 Radio
- [ ] 4 Friends/Neighbors
- [ ] 5 Social media such as Facebook or Twitter
- [ ] 6 Don’t Know/not sure
- [ ] 7 Other

25.

26. Have you spoken with, emailed, texted anyone, or used social media today to share information about the storm, such as where the storm is or what people are doing to prepare?

- [ ] 1 Yes
- [ ] 2 No
- [ ] 3 Don't Know/not sure
27. Were those conversations mostly about the storm itself, such as facts about how strong it is and where it is located, or more about personal reactions to the storm, such as whether to start preparing? (ACCEPT MORE THAN 1 ANSWER)

- 1. Facts about the storm
- 2. How to prepare
- 3. Other

28.

29. In general, how much are you currently relying on each of the following sources to get information about the storm? Would you say you’re relying none at all, somewhat, or a great deal on:

READ

1 = Not at all
2 = Somewhat
3 = A great deal
9 = Don’t know

[READ ANSWERS IN RANDOM ORDER]

Television ................................................................. _
Internet ................................................................. _
Radio ................................................................. _
Friends/Neighbors/Family ....................................... _
Social Media such as Facebook or Twitter .. _

30. Considering both wind and water, on a 0 to 100 scale, how safe do you feel about staying in your home through the storm. 0 percent means you’re certain that it will not be safe for you to stay in your home, and 100 would mean you are certain it will be safe.

(Assist: Would you think it’s more or less than 50%? INCREASE/DECREASE BY 10% UNTIL RESPONDENT AGREES - TAKE MIDPOINT OF ANY RANGE...)

77 = Don’t Know

Percent Scale Score ......... ____

31. Which of the following statements best describes your feelings about this storm?

- 1. If it hits my location, I will be in danger, but I don’t think it’s going to hit
- 2. Even if it hits my location, I don’t think it will be a danger to me
It will probably hit my location and pose a danger to me
I don’t know if it is going to be a danger to me or not
32. Do you think the **greatest** risk to your home would be damage due to wind, flooding from storm surge and waves, a combination of wind and surge, or something else?

- [ ] Wind
- [ ] Flooding/storm surge/waves
- [ ] Combination of wind and flooding from storm surge
- [ ] Flooding from rainfall
- [ ] Tornadoes
- [ ] Don't Know/not sure
- [ ] Other

33. __________________________________________________________________________________________

34. Does your home have any sort of window protection such as shutters, plywood panels, or hurricane-proof glass?

- [ ] Yes
- [ ] No
- [ ] Don't know

[IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 37]

35. What kind of protection is it?

- [ ] Plywood panels
- [ ] Other shutters or panels
- [ ] Hurricane-proof glass
- [ ] Combination of types
- [ ] Don't know

36. Is the protection something that is permanently in place or something you have to put in place when a storm threatens?

- [ ] Permanent
- [ ] Temporary
- [ ] Combination of types
- [ ] Don't know

37. Have you done any of the following to prepare for the storm? **READ**

[READ ANSWERS IN RANDOM ORDER, EXCEPT THE LAST 1]

- [ ] Purchased supplies for the home SUCH AS food, water and batteries
- [ ] Filled car with gas
- [ ] Filled generator with gas (or readied generator)
- [ ] Put up storm shutters
☐ 5 Took in furniture or other outside precautions
☐ 6 Made reservations or plans in case evacuation is needed
☐ 7 Have not taken special preparations

[IF THE ANSWER TO QUESTION 36 IS NOT 2, THEN SKIP TO QUESTION 40]
[IF THE ANSWER TO QUESTION 37 IS 4, THEN SKIP TO QUESTION 40]
[IF THE ANSWER TO QUESTION 37 IS 4, THEN SKIP TO QUESTION 40]
[IF THE ANSWER TO QUESTION 37 IS 4, THEN SKIP TO QUESTION 40]
[IF THE ANSWER TO QUESTION 37 IS 4, THEN SKIP TO QUESTION 40]
[IF THE ANSWER TO QUESTION 37 IS 4, THEN SKIP TO QUESTION 40]

38. What is the main reason you haven’t put your window protection in place yet?

☐ 1 Storm is not strong enough
☐ 2 Storm will miss
☐ 3 Too soon; will wait until storm gets closer
☐ 4 Not effective/does not work well/broken
☐ 5 Too difficult to put up
☐ 6 Don’t know
☐ 7 Other

39. ____________________________________________________________

40. If the storm were to hit today, are there still some supplies that you would feel you would need to deal with the storm that you do not already have on hand in your home?

☐ 1 Yes
☐ 2 No
☐ 3 Don’t Know/Not Sure

41. Before this storm began to threaten your area, did you already have on hand enough of the following items so that your household could manage on your own for at least three days?

1 = Yes
2 = No
9 = Don’t know

Non-perishable food .... _
Water .................................... _
Ice ........................................ _
Batteries ............................... _

42. How long do you expect being without electricity because of this storm?

☐ 1 Not at all
Less than 6 hours
6 to 12 hours
12 to 24 hours
24 to 48 hours
More than 48 hours
Don't know

43. Do you live in an area from which you might need to evacuate if this storm hits your location?

Yes
No
Don't Know/not sure
44. Have public safety officials issued an evacuation notice for anywhere in your community? That is, have they said that people in certain parts of your community should leave their homes and go someplace safer?

- Yes
- No
- Don't Know/not sure

[IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 49]

45. Did they recommend that people SHOULD evacuate from those areas or did they say it’s mandatory that they MUST evacuate from those areas?

- Should
- Must
- Don’t Know/Not Sure
- Other

46. __________________________________________________________________________________________

47. Does the evacuation notice apply to you? That is, do you live in an area from which officials said you SHOULD or MUST leave your home to go someplace safer?

- Yes
- No
- Don’t Know/Not Sure

48. How did you hear about the evacuation notice?

- Television
- Radio
- Internet
- Text or email alerts from officials (via phone)
- Friends/Relatives face to face, phone, or email
- Friends/Relatives via social media like Facebook or Twitter
- Police came into neighborhoods
- Telephone notification from officials

49. Do you currently plan to evacuate to someplace safer, either because you are asked to or for some other reason?

- Yes
- No
- Don’t Know/not sure

(Baker, 1991) [IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 53]
50. What is the main reason that you plan to evacuate? **DO NOT READ CATEGORIZE**

- [ ] 1. Friends/Relatives (advice, appeals)
- [ ] 2. Media (advice, appeals)
- [ ] 3. Public officials (advice, appeals, orders)
- [ ] 4. Concerns about safety (strength/track of storm, vulnerability of home)
- [ ] 5. Other

51. ___________________________  ___________________________

52. How many hours from now do you plan to leave? **READ**

- [ ] 1. Within 6 hours
- [ ] 2. 7-12 hours
- [ ] 3. 12-24 Hours (1 day)
- [ ] 4. more than 1 day
- [ ] 5. Depends on what storm does
- [ ] 6. Don’t know

*[IF THE ANSWER TO QUESTION 49 IS 1, THEN SKIP TO QUESTION 54]*

53. What is the main reason you don’t plan to evacuate? **DO NOT READ CATEGORIZE**

- [ ] 1. Friends/Relatives (advice)
- [ ] 2. Media (advice)
- [ ] 3. Public officials (advice, did not say evacuate)
- [ ] 4. Confident about safety (storm weak/will miss, home strong, location safe)
- [ ] 5. Too early to decide (storm might miss, weaken)
- [ ] 6. Unable to leave (no transportation, no place to go, no money, health, caregiver, job)
- [ ] 7. Unwilling to leave (protect home, possessions, pets, etc.)
- [ ] 8. Other

54. ___________________________

55. Which of the following types of structures do you live in? Do you live in a: **(READ)**

- [ ] 1. Detached single family home
- [ ] 2. Duplex or triplex home
- [ ] 3. Multi-family building - 4 stories or less (Apartment/condo)
- [ ] 4. Multi-family building - more than 4 stories (Apartment/condo)
- [ ] 5. Mobile or Manufactured home
- [ ] 6. Don’t know
56. Approximately what year was your home or apartment built?

(IF NECESSARY, SAY WAS IT BEFORE OR AFTER 1990? INCREASE/DECREASE BY 10 YEARS - TAKE MIDPOINT OF RANGE)

99 = Don't Know

Year ..............

57. Do you have a homeowner’s insurance policy that would pay for damages to your home or possessions if the current storm were to hit your area?

☐ 1. Yes
☐ 2. No
☐ 3. Not sure

[IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 62]

58. Most insurance policies have what they call a 'deductible.' You pay for losses up to the amount of the deductible and then insurance pays for the rest. Do you recall the amount of the deductible for your policy, or is it something you would need to look up?

99 = Would have to look it up

Amount of Deductible ..............

59. Does your policy cover damage to your home or possessions from flooding?

☐ 1. Yes
☐ 2. No
☐ 3. Not sure

60. Does your home have a separate flood insurance policy?

☐ 1. Yes
☐ 2. No
☐ 3. Not sure

61. If this storm caused serious damage to your home, what percentage of the cost to repair or rebuild your home do you think would be provided by government disaster assistance?

☐ 1. None
☐ 2. Less than 10% of the Cost
3. 11% to 50% of the Cost
4. More than 50% but Less than 100% of the Cost
5. 100% of the Cost
6. Don’t Know

62. How long have you lived in your present home?

1. Less than 5 years
2. 5 to 10 years
3. 11 to 20 years
4. More than 20 years
5. Don’t Know/Refused

63. Have you ever experienced damage from a hurricane, either while living in your present home or a different home?

1. Yes
2. No
3. Don’t Know
64. Have you ever experienced a hurricane which did not cause any damage, either while living in your present home or a different home?

- ☐ 1 Yes
- ☐ 2 No
- ☐ 3 Don’t know

65. Other than having window protection, have you ever modified your home to reduce the amount of damage you would experience from wind in a hurricane?

- ☐ 1 Yes
- ☐ 2 No
- ☐ 3 Don’t know

66. How many vehicles do you have in your household that could be used for evacuating, if necessary?

- ☐ 1 None
- ☐ 2 One
- ☐ 3 Two
- ☐ 4 More than two

67. How many people live in your household, including yourself?

- ☐ 1 1
- ☐ 2 2
- ☐ 3 3
- ☐ 4 4
- ☐ 5 5
- ☐ 6 6
- ☐ 7 More than 6
- ☐ 8 Don’t Know
- ☐ 9 Refused

[IF THE ANSWER IS 1, THEN SKIP TO QUESTION 70]

68. How many of these are children, 17 or younger?

- ☐ 1 None
- ☐ 2 1
- ☐ 3 2
- ☐ 4 3
- ☐ 5 More than 3
- ☐ 6 Don’t Know
- ☐ 7 Refused

69. How many of these are 80 years old or older?
70. Do you have a pet or pets in your home?

- Yes
- No
- Refused

71. Do you own your home or rent?

- Own
- Rent
- Other

72. On your last birthday, were you? READ

- Under 30
- 30 to 45
- 46 to 60
- 61 to 70
- 71 to 80
- Over 80
- Refused

73. Which race or ethnic background best describes you? (READ)

- African American or Black
- White or Caucasian
- Other
- Refused

74. Do you consider yourself Hispanic?

- Yes
- No
- Refused

75. Which category best describes your education level? (READ)

- Some high school
- High school graduate
☐ 3 Some college  
☐ 4 College graduate  
☐ 5 Post graduate  
☐ 6 Refused

76. Which of the following ranges best describes your total household income for 2011?

READ

☐ 1 Less than $15,000  
☐ 2 $15,000 to $24,999  
☐ 3 $25,000 to $39,999  
☐ 4 $40,000 to $79,999  
☐ 5 Over $80,000  
☐ 6 Don’t know/refused

77. Do you have an account with a social media site such as Facebook or Twitter?

☐ 1 Yes  
☐ 2 No  
☐ 3 Don’t Know

78. Do you live here year-round or are you vacationing?

☐ 1 Live here year-round  
☐ 2 Vacationing  
☐ 3 Other

79.

____________________________________________________________________________

80. How close is your home located to the nearest body of water?

☐ 01 Directly on the water  
☐ 02 With 1 block of the water  
☐ 03 Within 1/2 mile of the water  
☐ 04 Within 1 mile of the water  
☐ 05 More than 1 mile of the water

81. Which of the following best describes the type of water body your home is nearest?

☐ 01 Ocean  
☐ 02 Bay/Sound  
☐ 03 River/Stream  
☐ 04 Lake  
☐ 05 Canal  
☐ 06 Other
83. Thank you so much for your time. Can we call you back later, to see what you're thinking and what you're doing then?

    □ 1 Yes
    □ 2 No

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 85]

84. Would you mind giving us your cell phone number if you have one, in case you've evacuated by the time we call again? We promise NOT to give the number to anyone else. And we'll only use it if we call you again about this storm.

____________________________________________________________________________

85. Thank you very much. In case my supervisor needs to review my work on this survey, may I have your name?

____________________________________________________________________________

86. That concludes our survey. Thank you very much for your time and opinions!

    (INTERVIEWER: After you hang up, there is still more info to be recorded for this interview to be considered complete!!)

    Was the respondent male or female?

    □ 1 Male
    □ 2 Female
Appendix 2

Description of Survey Locations vis-à-vis objective Evacuation Zones in Isaac

In the Isaac survey, Florida interviews were conducted in the Category A evacuation zones in Escambia and Santa Rosa Counties, using GIS shape files. Escambia issued an “Order of Evacuation” for Zones A-C, and Santa Rosa issued a mandatory evacuation order for A-C. Zone A is similar to a Cat 1 evacuation zone for most hurricanes. Alabama interviews were conducted in coastal zip codes in Mobile and Baldwin Counties that did not extend inland of the state’s Evacuation Zone 1. The state ordered evacuation in Zones 1 and 2. Mississippi interviews were conducted in coastal zip codes, but in Harrison County parts of the zip codes used in early data collection included areas that extended inland of the cat 1-3 evacuation zone. Zip codes used in latter portions of the survey conformed more closely to portions of the cat 1-3 evacuation zones but excluded certain beachfront portions of Harrison. In Jackson County officials issued a mandatory evacuation south of US 90 and low-lying areas near streams and rivers north of US 90. Hancock issued a mandatory evacuation order for low-lying areas and mobile homes. Harrison called for evacuation of low-lying areas, but we weren’t able to ascertain whether it was mandatory. Officials also warned residents in Evacuation Zone 1-3 that they could become isolated and on their own, even if they didn’t flood. Louisiana interviews were conducted in waterfront (Gulf, river, or lake) zip codes of parishes which called for at least partial evacuation. Lower portions of Jefferson, the east bank of Plaquemines, St. Charles Parish, and parts of St. Tammany south of US 190 were included. Although zip codes did not conform precisely to areas told to evacuate, the zip codes used were mostly within the areas under evacuation. Most evacuations were mandatory.
Appendix 3
Survey and Related Figure Sample Sizes (n) per Survey Period

<table>
<thead>
<tr>
<th>Survey Period</th>
<th>48 hrs.</th>
<th>36 hrs.</th>
<th>30 hrs.</th>
<th>24 hrs.</th>
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Figure sample sizes exclude “Don’t Know” and/or blank responses to related survey questions. Note that the Figure 4 worry sample size value does contain the don’t know response from Q31 and Figure 5a has explicitly graphed these don’t know values.

* Data covers only the last 36 hours because of a survey error in which the wind-speed question was not asked in the first survey wave

** Per survey period sample sizes not utilized in figure
Sandy

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| Figure 4:           |         |         |         |         |         |         |         |         |       |       |
| Safety Rating       | 49      | 49      | 57      | 51      | 52      | 83      | 59      | 52      | 71    | 523   |
| Property Risk       | 38      | 43      | 54      | 46      | 46      | 80      | 55      | 47      | 65    | 474   |
| Personal Risk       | 40      | 40      | 56      | 45      | 45      | 81      | 54      | 46      | 64    | 471   |
| Worry               | 56      | 49      | 59      | 52      | 52      | 83      | 60      | 52      | 73    | 536   |

| Figure 5b.**        |         |         |         |         |         |         |         |         |       |       |
| Wind over any water stated as largest risk | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 503 |
| On water            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 46 |
| < 1 block           | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 45 |
| < ½ mile            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 83 |
| < 1 mile            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 59 |
| > 1 mile            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 270 |
| Wind over water damage probability | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 457 |
| On water            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 42 |
| < 1 block           | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 44 |
| < ½ mile            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 71 |
| < 1 mile            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 53 |
| > 1 mile            | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 247 |

| Figure 6**          |         |         |         |         |         |         |         |         |       |       |
| VA, MD              | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 214 |
| NJ, DE              | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 228 |

| Figure 7            |         |         |         |         |         |         |         |         |       |       |
| Did Preparation     | 56      | 50      | 59      | 52      | 52      | 83      | 60      | 52      | 73    | 537   |
| Felt Ready          | 54      | 48      | 59      | 52      | 52      | 82      | 60      | 52      | 73    | 532   |

| Figure 8            |         |         |         |         |         |         |         |         |       |       |
| Evacuation Plan     | 56      | 50      | 59      | 52      | 52      | 83      | 60      | 52      | 73    | 537   |
| Supplies            | 56      | 50      | 59      | 52      | 52      | 83      | 60      | 52      | 73    | 537   |
| Shutters            | 56      | 50      | 59      | 52      | 52      | 83      | 60      | 52      | 73    | 537   |
| Generator           | 56      | 50      | 59      | 52      | 52      | 83      | 60      | 52      | 73    | 537   |

Figure sample sizes exclude “Don’t Know” and/or blank responses to related survey questions. Note that the Figure 4 worry sample size value does contain the don’t know response from Q31 and Figure 6 has explicitly graphed these don’t know values.

** Per survey period sample sizes not utilized in figure