

**Risk Perceptions and Preparedness among Mid-Atlantic
Coastal Residents in Advance of Hurricane Sandy**

Preliminary Report

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Abstract

The findings of a real-time survey of the risk perceptions and preparatory actions of residents in the Middle-Atlantic states as Hurricane Sandy approached the coast in October of 2012 are reported. The data reflect a sample of 538 coastal residents—mostly single-family homeowners—from southeastern Virginia to the New Jersey suburbs of New York. The data suggest that while there was universal awareness of the threat that Sandy posed and almost all took some preparatory action, there was also widespread confusion about the nature of warnings issued about Sandy, and preparation that was insufficient for the threat Sandy posed. For example, as short as 6 hours before landfall and after tropical-storm force winds had been affecting the coast for a number of hours, 40% of respondents mistakenly believed they were under a hurricane watch (instead of a hurricane-force wind warning). Likewise, most coastal residents misconstrued the primary threat of Sandy as coming from wind rather than water. Protective actions that would be seen as costly were limited. For example, only 37% of homeowners with removable storm shutters put them up, and 54% of residents whose homes were within a block of a body of water indicated that they owned flood insurance policies.

On October 29, 2012, Hurricane Sandy made landfall on the coast of southern New Jersey, bringing storm-force winds to an 800-mile stretch of coastline from North Carolina to New England. By many metrics the scale of Sandy's impact was unprecedented. A record 14-foot storm tide inundated the southern tip of Manhattan, plunging much of the southern part of the country's largest city into darkness and disabling its subway system. At its peak, an estimated 5.5 million homes in the Northeast and Middle Atlantic were without power, and many continued to be so weeks after the event. Storm surges inflicted catastrophic damage to coastal communities stretching from New Jersey to western Long Island. While the total monetary damage induced by the storm is still uncertain at the time of this writing, early estimates placed it between \$50 and \$70 billion, making Sandy the second-most costly disaster in United States history after Hurricane Katrina.

Sandy was also an exceptional meteorological event from another perspective: the mixed tropical/non-tropical nature of the storm, and the absence of traditional hurricane warnings in the areas threatened by the largest impacts. Because forecast models predicted that Sandy would complete a transition to an extra-tropical cyclone prior to landfall, the National Hurricane Center made an unprecedented—and potentially controversial—decision not to issue hurricane watches or warnings along the Mid-Atlantic or New England as the storm approached, allowing these areas to be subject to “high wind,” “coastal flood” and other watches and warnings issued by local weather service offices. This anticipated change-over was also manifested in mixed communications about just what kind of storm Sandy was: while the National Hurricane Center continued to describe Sandy as a hurricane up until landfall, mass media adopted a number of new names for the system, including “Superstorm Sandy” and— facetiously—“Frankenstorm Sandy” (by virtue of its proximity to Halloween).

How did these unique features of Sandy affect coastal residents' perceptions of the storm and the level of preparations taken? In this paper we describe the preliminary findings of a study of the perceptions and preparedness decisions made by Mid-Atlantic coastal residents just prior to Sandy's landfall in New Jersey. The study was an element of a three-year program of research designed to understand hurricane risk response using "real time" surveys of residents in threatened locations conducted in the days leading to a storm's impact on the coast. Our survey findings about preparations for Sandy can thus be viewed in the comparative context of how coastal residents have responded to other recent storms—most notably Irene in 2011, which affected much of the same area.

The work uncovers a potentially disquieting view of the quality of risk perceptions and preparations that arose in advance of Sandy. On the surface, public awareness of the storm and the threat it posed could not have been stronger. Well over 90% of surveyed coastal residents from Virginia to New York took some kind of protective action, and—as had been observed in previous storms such as Irene—residents tended to greatly *over*-estimate the probability that their homes would be affected by hurricane-force winds. Yet, beneath this surface concern was evidence that many residents were not fully aware of what they were up against. Most misunderstood what warnings they were under, how strong a storm Sandy was and the greatest risk that it posed, and how long impacts would persist. Residents who indicated that they lived within one block of the water, for example, felt that the greatest threat the storm posed was wind rather than water, and only 18% of surveyed residents who said that public officials had issued evacuation orders in their specific community expressed an intention to leave. There was also suggestive evidence that residents' experiences with Irene in 2011—where most would have experienced the storm but suffered no personal loss—were of little help in encouraging either

short- or long-term preparation (such as purchasing flood insurance policies), and, in fact, may have dampened concern.

Meteorological Background and Research Methodology

Hurricane Sandy developed from a tropical wave in the South-Central Caribbean on October 22, and rapidly intensified to a strong category-2 hurricane just before hitting the coast of southeastern Cuba shortly after midnight on October 25. At this time forecasters recognized that Sandy posed a potential threat to the Middle-Atlantic states as either a tropical or strong extra-tropical system, and beginning with the 11AM advisory on the 25th, residents on the east coast of the United States were advised to monitor the progress of the storm. Beginning with the 5PM advisory on October 26, tropical storm warnings which had been posted along the Florida east coast were extended north to Duck on the North Carolina outer banks. The advisory also indicated that gale watches had been issued for unspecified areas further north, but that residents should consult statements issued by local weather service offices for details.

The reason that warning responsibility was transferred to local weather offices north of the Outer Banks was explained in a statement issued by the National Hurricane Center (NHC) on October 27:

“Because Sandy is expected to transition [from a tropical to extra-tropical cyclone] before reaching the coast, the NWS has been using non-tropical wind watches and warnings, issued by local NWS Weather Forecast Offices (WFOs), to communicate the wind threat posed by Sandy in the Mid-Atlantic States and New England. (This is why NHC’s tropical storm warnings extend only into North Carolina.) The NWS plans to continue using non-tropical watches and warnings issued by local offices in the Mid-Atlantic States and northward throughout this event. By using non-tropical warnings in these areas from the start, we avoid or minimize the significant confusion that could occur if the warning suite changed from tropical to non-tropical in the middle of the event.”

While traditional NHC hurricane watches or warnings were never issued in either the Middle-Atlantic states or New England, subsequent advisories emphasized the significant threat

the storm posed to the region. For example, the 5PM advisory on the 28th warned that Sandy would bring “life-threatening storm-surge flooding to the Mid-Atlantic Coast including Long Island Sound and New York Harbor,” as well as “coastal hurricane winds and heavy Appalachian Snows.”

Survey Methodology

Beginning the evening of October 26 and continuing through later afternoon on October 29, telephone surveys were conducted among random samples of residents in coastal southeastern Virginia, Maryland, Delaware, and New Jersey, including suburban New York City. Each survey interview lasted approximately 25 minutes, during which time respondents were asked to respond to between 60 and 82 questions depending on screening patterns. The survey, reproduced in the Appendix, asked a variety of questions that fell into seven domains:

1. Objective storm and warning knowledge (e.g., knowledge of storm strength, time until impact, current warnings);
2. Threat perceptions (e.g., judged probability of hurricane-force winds and damage due to wind, surge flooding, or rain flooding);
3. Information sources (e.g., media usage and exposure to forecast graphics);
4. Short-term preparation actions and evacuation intentions (e.g., storm-related purchases of food, water, batteries; filling the car with gasoline);
5. Longer-term preparation (e.g., supplies on hand before the storm, ownership of flood insurance);
6. Expectations of government aid; and
7. Socio-demographics and previous storm experience.

The surveys were conducted during three time blocks, between 8 and 11AM, 11AM and 5PM, and 5 and 10PM so as coincide with the storm and warning information conveyed in the 5AM, 11AM, and 5PM NHC advisories. The telephone surveys were conducted by the firm of Kerr and Downs who drew a random sample of published telephone numbers for residents in coastal ZIP codes. The firm was able to complete, on average, 60 fully-completed surveys within each of nine time blocks, yielding 538 total surveys over the course of 3 days.

The sample primarily consisted of adult homeowners living in coastal counties of the four surveyed states. Within the sample, 65% were male, 73% were between the ages of 30 and 70, 72% had completed at least some college degree, 81% lived in single-family homes, 89% were owners, and 47% reported incomes of over \$80,000. The final data set consisted of 130 surveys from New Jersey, 144 from Delaware, 106 from Maryland, and 158 from southeastern Virginia.

Findings

As noted above, the survey examined a wide range of issues related to storm preparation. In this report we summarize those data that address three core questions:

- 1) How knowledgeable were residents about the strength of Sandy and NWS warnings?
- 2) What were respondents' beliefs about the threats Sandy posed, and the likelihood of experiencing damage? and
- 3) What kinds of preparations did residents adopt in the face of the storm?

Accuracy of Beliefs about Storm Characteristics and Warnings

After emerging from the coast of Cuba on the October 25th Sandy weakened to a category-1 hurricane on the Saffir-Simpson scale, and retained this classification with maximum winds of 75 mph for the first three days of the survey period. On the morning of the fourth day

of the survey (October 29th), however, Sandy strengthened with maximum winds reaching 85 mph in the 5AM advisory and 90 mph in the 11AM advisory.

How accurate were residents' beliefs about Sandy's strength? In Figure 1 we plot the time-course of expressed beliefs of the Sandy's maximum winds. To reflect the heterogeneity that existed in wind-speed beliefs, the figure plots the relative frequency of judgments of wind strength that were accurate, too low, too high, or unknown.

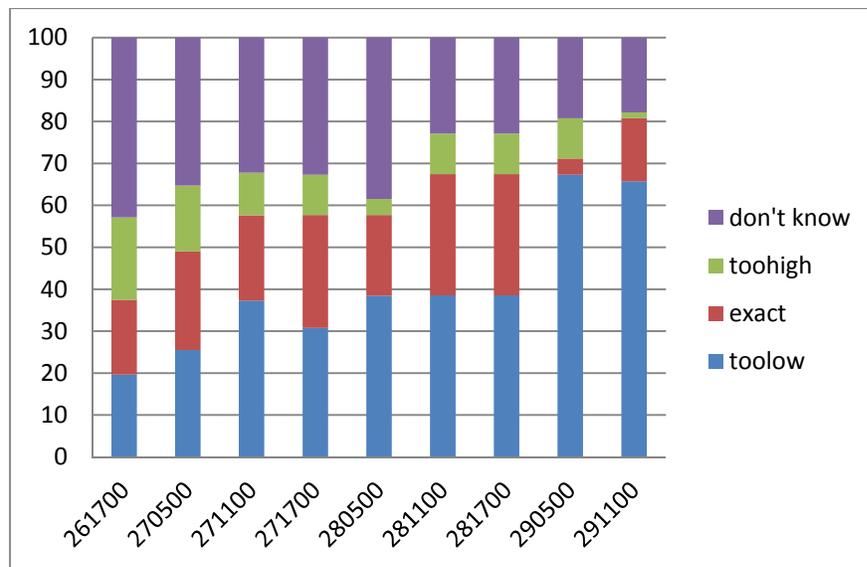


FIGURE 1: ACCURACY OF ESTIMATES OF SANDY'S MAXIMUM WIND SPEED OVER TIME

The data suggest that the accuracy of residents' beliefs of Sandy's strength was quite poor, particularly on the day of landfall. For the duration of the storm threat, the modal response among respondents was either that they did not know what the maximum wind speed was (with percentages approaching 40% as late as the morning of the 28th) or they provided estimates that were too low. This under-estimation of maximum wind speed was most acute on the day of landfall (the 29th) when Sandy's strength increased—a fact that was lost on over 80% of respondents.

An alternative view of this under-estimation bias is given in Figure 2, which plots the average wind speed belief among respondents who gave too-low versus too-high estimates.

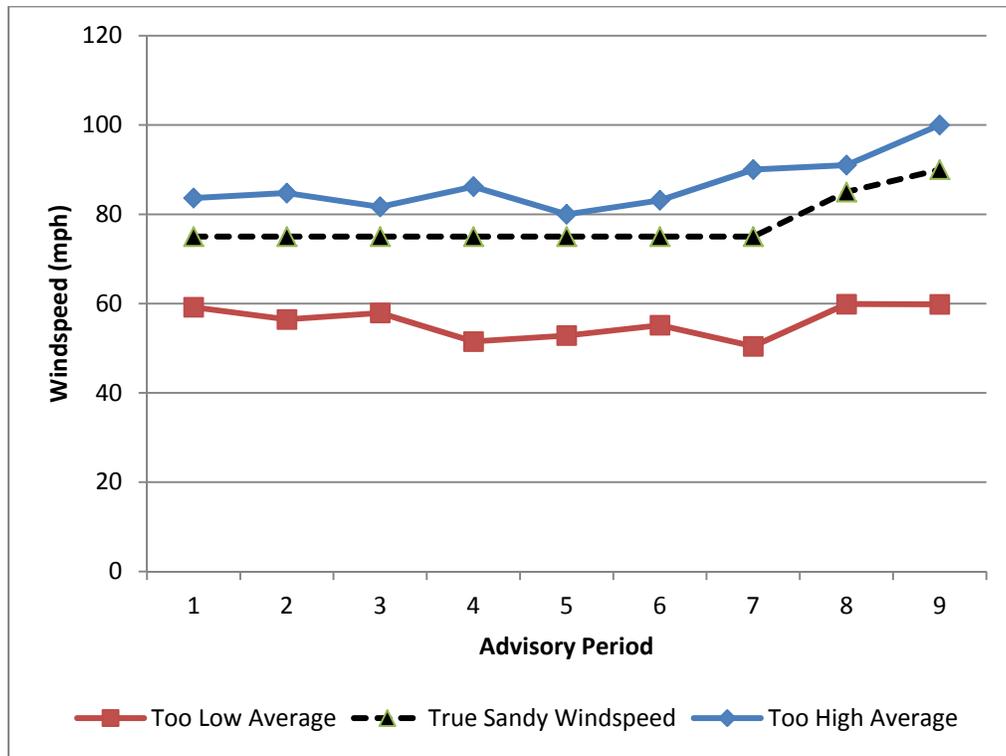


FIGURE 2: MEAN ESTIMATED WIND SPEEDS BY ERROR TYPE

The figure suggests that not only were under-estimation errors more frequent than over-estimation errors, but the former were also larger in magnitude when they occurred.

Specifically, the mean under-estimation error across all advisory periods was 22 mph while the mean over-estimation error was 9 mph—with the underestimation error increasing on the day of landfall.

More disturbing was that respondents also displayed erroneous beliefs about the storm warnings that had been issued for their location. As noted above, the warning policy under Sandy was an unusual one in that traditional tropical cyclone warnings had not been issued for the study area. Instead, threatened locations were put under a cacophony of non-tropical watches and warnings issued by local weather-service offices. These included watches and warnings for

high surf, coastal flood, non-coastal flood, and high winds. In Figure 3 we plot the time course respondents' beliefs about the kind of warning they were currently under.

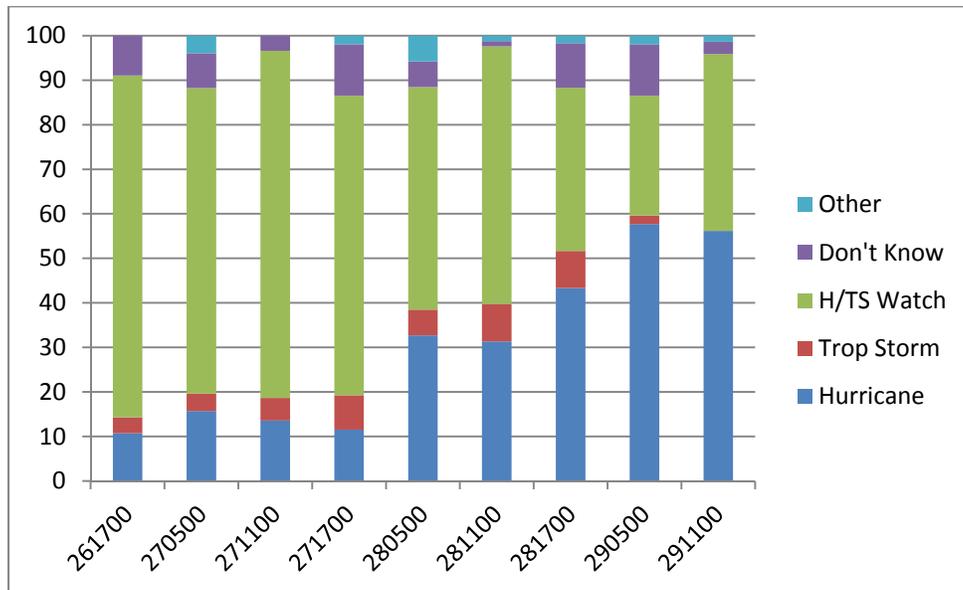


FIGURE 3: BELIEFS ABOUT THE NATURE OF CURRENT STORM WARNINGS OVER TIME

The data show a surprising pattern: for most of the storm threat, residents held the misperception that they were under a hurricane watch, and many continued to hold this belief until the storm was already upon them on the afternoon of the 29th. It should be noted that under normal warning policies, a hurricane watch—had one been issued—would have been switched to a warning 36 hours before the onset of hurricane-force winds, most likely on the 28th. Yet on October 28, the percentage of respondents who believed that they were under a hurricane warning was only 36% and this percentage rose above 50% only on the day of landfall.

The natural hypothesis for explaining this misperception was that respondents were confused by the myriad of non-tropical storm warnings that were being issued, and in the absence of more concrete guidance they, in essence, made up their own warnings. To investigate this possibility more deeply, in Figure 4 we plot the analogous time-course of warning beliefs

among a sample of New Yorkers measured during the approach of Hurricane Irene the year before.

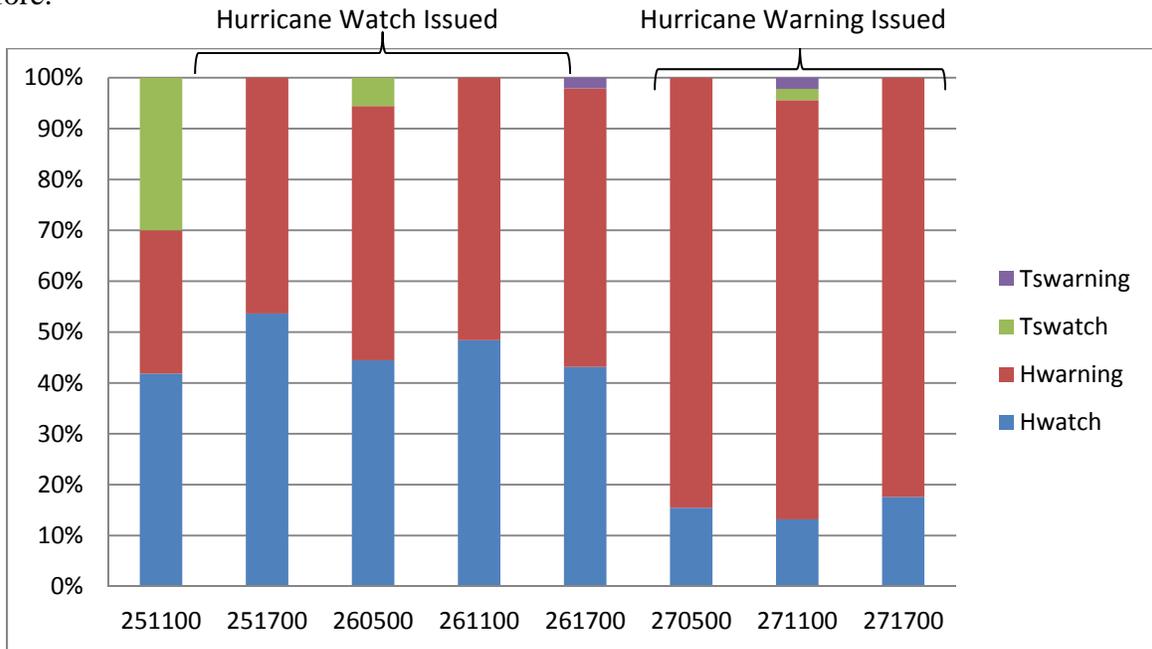


FIGURE 4: BELIEFS ABOUT THE STORM WARNINGS OVER TIME, HURRICANE IRENE (2011)

Unlike Sandy, in advance of Irene the National Hurricane Center issued traditional hurricane warnings up to 36 hours before the storm was expected to make landfall in the New York metropolitan area. The figure reveals two key features. First, like in Sandy, a day before any warnings had been issued in the New York area, a significant proportion—over 40% of respondents—believed that they were under a hurricane watch—a belief that was possibly fostered by news reports that the storm posed a threat to the area, and by hurricane watches having been issued in North Carolina. But more critically, when hurricane warnings were actually issued on August 27th—a day before Irene was to hit—there was extremely high awareness of this fact, with almost 80% of respondents correctly indicating that a hurricane warning had been issue for their area. By stark contrast, a day before Sandy’s landfall fewer than 60% percent believed that they were under the equivalent of a hurricane warning.

Risk Perception and Beliefs about Impacts

Did the misperception of Sandy's strength and the nature of warnings translate to biased beliefs about the material threat that the storm posed to their locations? The answer was mixed. On one hand, mirroring a pattern that we have consistently observed in real-time surveys of responses to other hurricane threats, there was strong evidence that respondents systematically over-estimated the probability that their home locations would experience hurricane-force winds, and also expected the storm to arrive at their locations sooner than implied by NHC wind forecasts. Yet, at the same time, few—even in the most threatened areas—felt that the storm posed a threat to their home's safety. To illustrate this apparent inconsistency, in Figure 5 we plot the time course of three measurements of risk perception: the subjective percentage probability that a respondent's home would experience hurricane-force winds, the subjective probability that these winds would cause damage to the respondent's residence and/or possessions, and a subjective rating on a 100-point scale of how safe the respondent would feel about riding out the storm in their homes. In addition, these three measures are juxtaposed to an *objective* measure of threat: the objective probability derived from National Hurricane Center wind forecasts that a given location would experience hurricane-force winds.

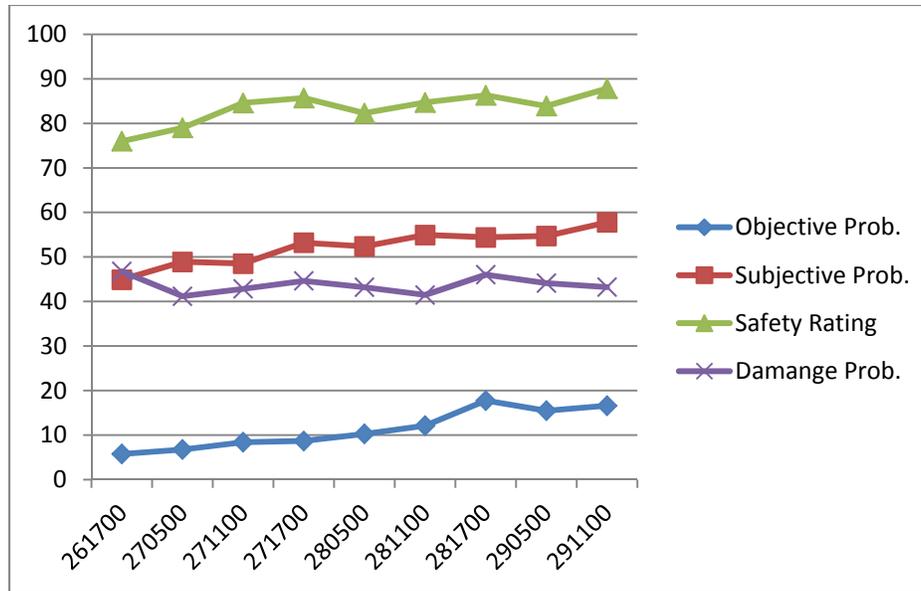


FIGURE 5: OBJECTIVE AND SUBJECTIVE PERCENTAGE PROBABILITIES OF HURRICANE-FORCE WINDS, POOLED ACROSS STATES

Objective benchmarks were constructed using the published cumulative hurricane-force wind probability in a given advisory for the city closest to a resident’s location—Norfolk for southeastern Virginia, Ocean City for Maryland and Delaware, and either Atlantic City or Newark for New Jersey.

The data show a simple—and possibly paradoxical—pattern of risk perception. On one hand, subjective beliefs about the probability of hurricane-force winds were considerably in excess of the objective odds that respondents actually faced, with subjective estimates averaging five-times those of the objective estimates. On the other hand, this expected prospect of experiencing hurricane-force winds was not one that produced high levels of worry among respondents. Respondents’ beliefs about the probability of experiencing hurricane winds was systematically higher than their beliefs that such winds might cause damage, and most expressed extremely high degrees of confidence that they would be safe riding out the storm in their homes.

To provide a more direct measure of the degree of concern respondents felt for the storm, Figure 6 plots a histogram of the distribution of answers given when respondents were asked which of four possibilities were the most likely outcome of the storm: that it would hit and they would be in danger, that it would hit but that they would not be in danger, that it would not hit but if it did they would *potentially* be in danger, and that they were unsure what would happen. In addition, we partition these responses into two groups that might be thought of as having objectively higher versus lower real risk exposures: respondents who lived within a half-mile of the ocean in coastal Delaware or New Jersey (higher risk), and all other respondents (lower risk).

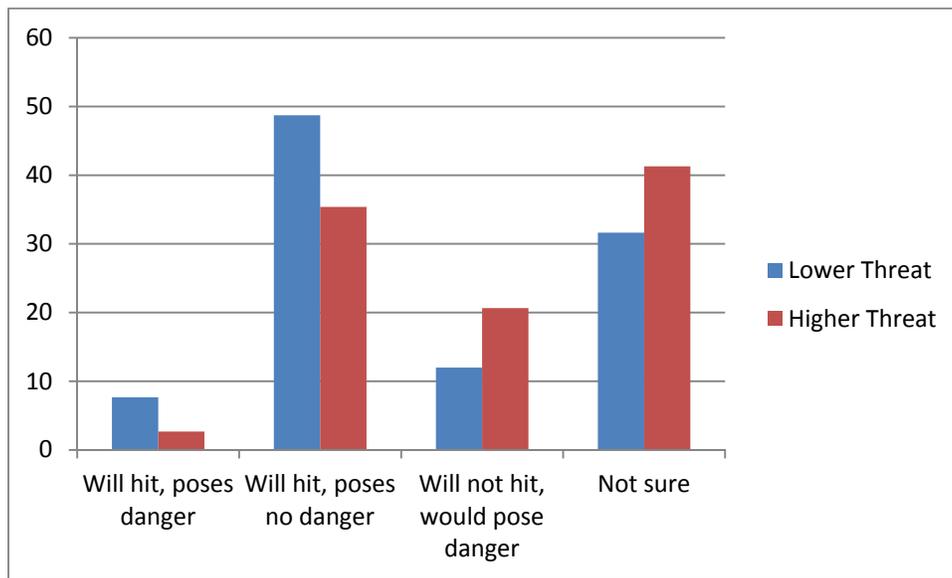


FIGURE 6: DISTRIBUTION OF EXPECTED STORM IMPACTS BY SHORE EXPOSURE OF HOME

These data reinforce the idea that few respondents were truly worried about their personal safety in advance of Sandy, even among those on the immediate coast in the areas that were forecast to absorb the brunt of the storm. Respondents had two modal responses to the storm threat: that it posed no danger, or they were simply unsure what the consequences would be.

More suggestive evidence that residents may have been overly optimistic about the impact that Sandy might have had is also evidenced by respondents' expectations of how long they were likely to be without electricity during and after the storm. In Figure 7 we plot the distribution of expected power-outage durations for two state groupings: New Jersey and Delaware, near the expected center of the storm's land fall, and Virginia and Maryland further to the south.

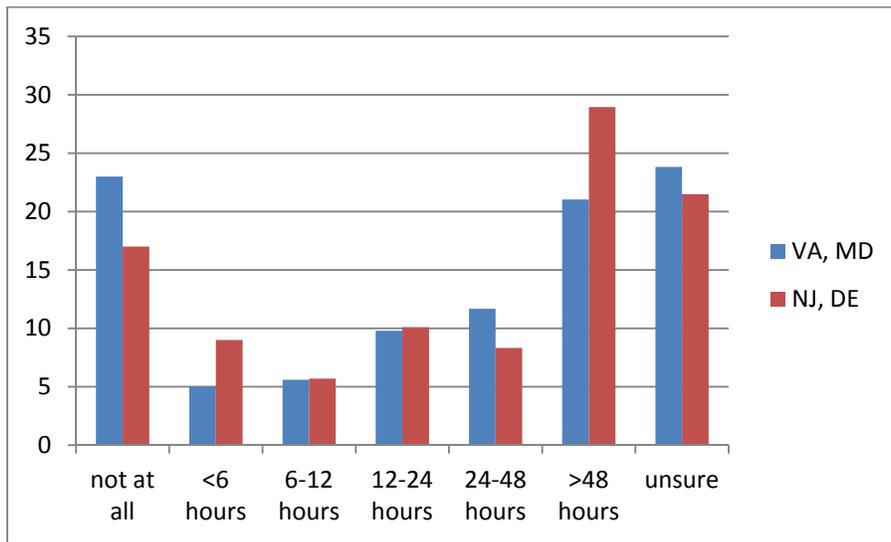


FIGURE 7: EXPECTED DURATIONS OF POWER LOSS BY STATE

The figure suggests the majority of residents were either unsure how long they would be without power or expected that if they lost it at all the inconvenience would be short duration; 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, where there would have been objective reasons to expect a smaller impact.¹

¹ One possible explanation for the optimistic assessments in New Jersey was that after Irene the year before, power was restored relatively quickly; in that state 50% of customers lost power, however 95% were restored within 5 days (New Jersey Board of Public Utilities, 2011).

How skilled were residents in assessing the likely *source* of danger from Sandy? The data provide evidence that residents over-estimated the threat posed by wind to that which ultimately caused the bulk of damage from the storm: storm surge flooding. In Figure 8 we plot the distribution of responses to a survey question that asked respondents to indicate which of six impacts posed the greatest threat from Sandy: wind, flooding from storm surge, a combination of wind and surge, flooding from rain, tornadoes, or some other impact. In the figure, the distribution is conditioned by a factor that should dramatically magnify the perceived importance of a flood threat: whether a respondent’s home was within a block of a body or water (ocean or bay).

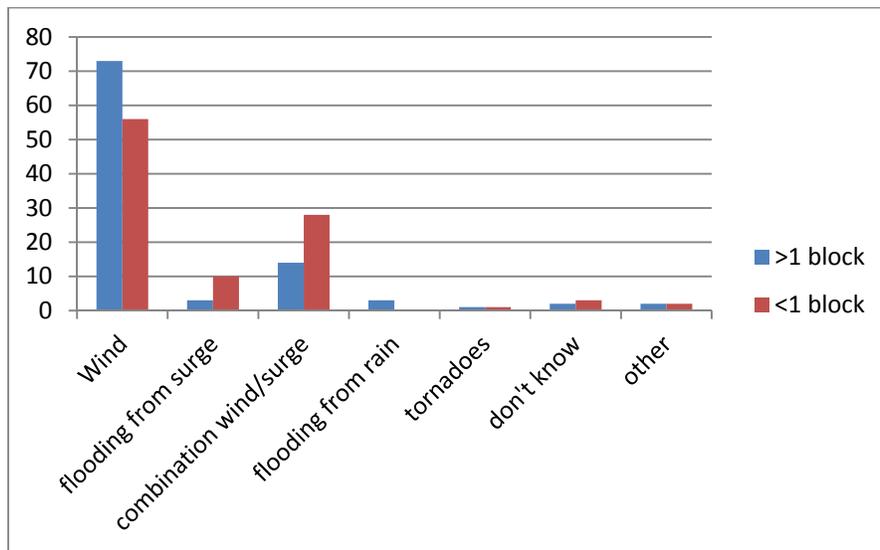


FIGURE 8: ASSESSMENTS OF THE MOST LIKELY THREAT POSED BY THE STORM BY DISTANCE TO WATER

The figure shows what might be seen as a disturbing result: even residents who lived within a block of the water—where flooding would have been the largest threat posed by the storm—saw the greatest threat posed by Sandy as coming from winds, not water. Additionally, for those within 1 block of a body or water (ocean or bay) and feeling that either flooding from surge or the combination of wind/surge was the greatest threat, the majority of these respondents

believed that the surge would be less than 10 feet high (34%) or were not sure of how high it would be (42%).

An additional surprising aspect of Figure 8 is that not only were respondents close to water not particularly concerned about surge risk, but all respondents were even less concerned about risk of flood from rain. This result is noteworthy given the primary source of flooding from Hurricane Irene the year before was from excessive rainfall, not storm surge (U.S. Department of Commerce, 2012).

One final question that the surveys allowed us to answer was the degree to which perceptions of the risk posed by Sandy were moderated by prior experience with hurricanes. As we noted earlier, the area affected by Sandy was also affected by another hurricane—Irene—the year before, hence a strong majority of respondents—76%--indicated that they had some experience living through hurricanes. Of those who experienced Irene, however, only a minority of households—37%—reported suffering any damage from the storm. To explore the effect that these different levels of experience may have had in risk perceptions in advance of Sandy, in Figure 9 we plot the mean stated probability that a respondent's household would experience either property or personal damage from one of three causes—wind, surge flooding, rain flooding—by three kinds of experience noted above: no experience, experience with damage, or experience without damage.

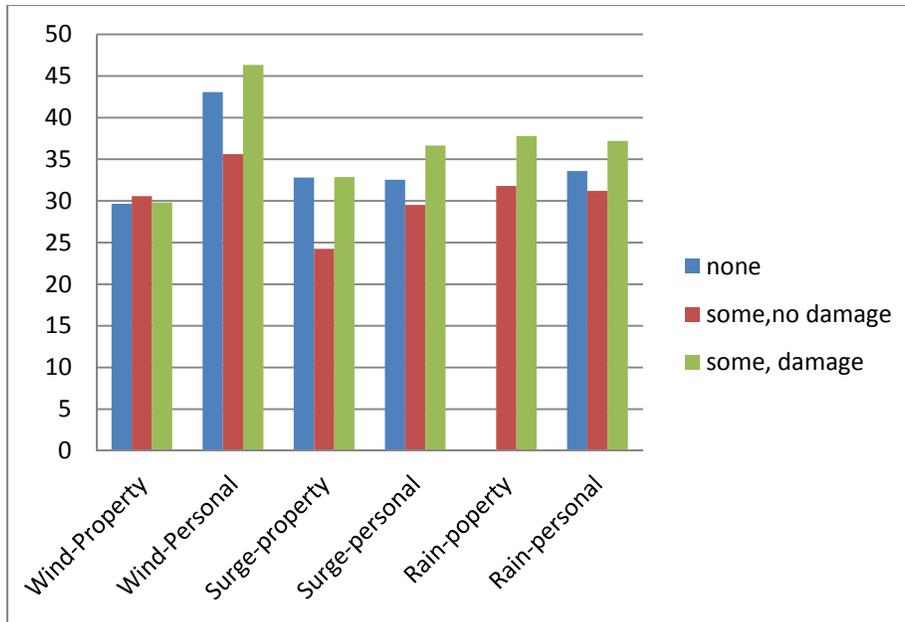


FIGURE 9: SUBJECTIVE PROBABILITY OF LOSSES FROM DIFFERENT SOURCES BY PRIOR HURRICANE EXPERIENCE

The figure yields two insights. The first is that it shows again that the major threat posed by Sandy was perceived to be its winds, not the threat posed by flooding. The second, more important, result is that perceptions of risk were consistently lowest among those had experienced a hurricane—for most, Irene the year before—but did not experience damage. In contrast, concern was heightened among those who had experienced damage from past hurricanes, and also—possibly surprisingly—among those who had no hurricane experience at all.

Preparedness

Survey responses provide a mixed assessment of the degree to which the misperceptions of the storm’s strength and expected impact affected preparations. On the positive side, an overwhelming proportion of respondents undertook at least some preparatory action, and almost all felt sufficiently well prepared for the storm by the time it arrived. The evolution of preparedness levels is depicted in Figure 10, which plots the percentage of respondents who

indicated taking at least some preparatory action and those who felt they were ready for the storm over time.

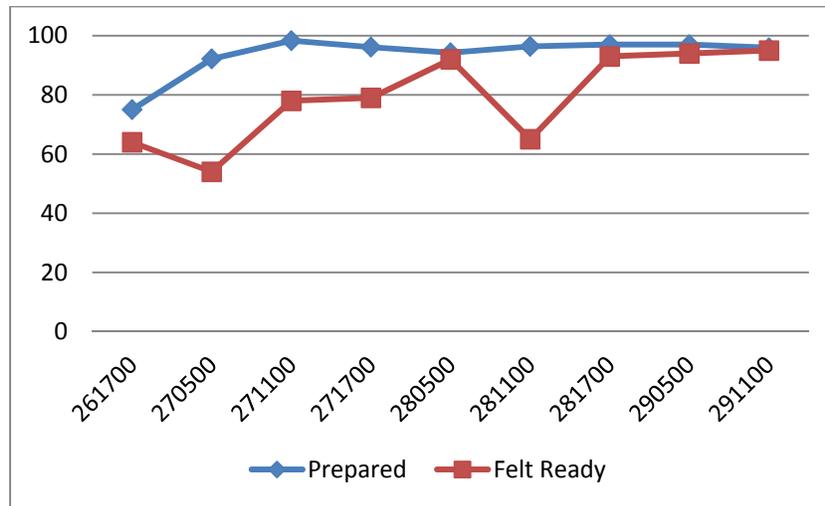


FIGURE 10: PERCENTAGE WHO PREPARED AND FELT READY

The data tell a clear and seemingly reassuring story: despite the confusion that may have existed about what warnings they were under or how strong Sandy was, virtually all respondents took the storm sufficiently seriously to undertake preparations—and early. When surveys began on the evening of the 26th—a full three days 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 well over 90% felt sufficiently well prepared to endure whatever Sandy had to offer.

On the other hand, a more detailed analysis of what these preparations were provides a less encouraging view of states of readiness. In Figure 11 we plot the relative frequency with which respondents indicated having undertaken one of six common storm protective actions: buying household supplies, filling their car up with gas, acquiring or preparing a generator, putting up removable storm shutters (if owned), taking in furniture, and making plans in case evacuation is needed (e.g., securing a hotel reservation).

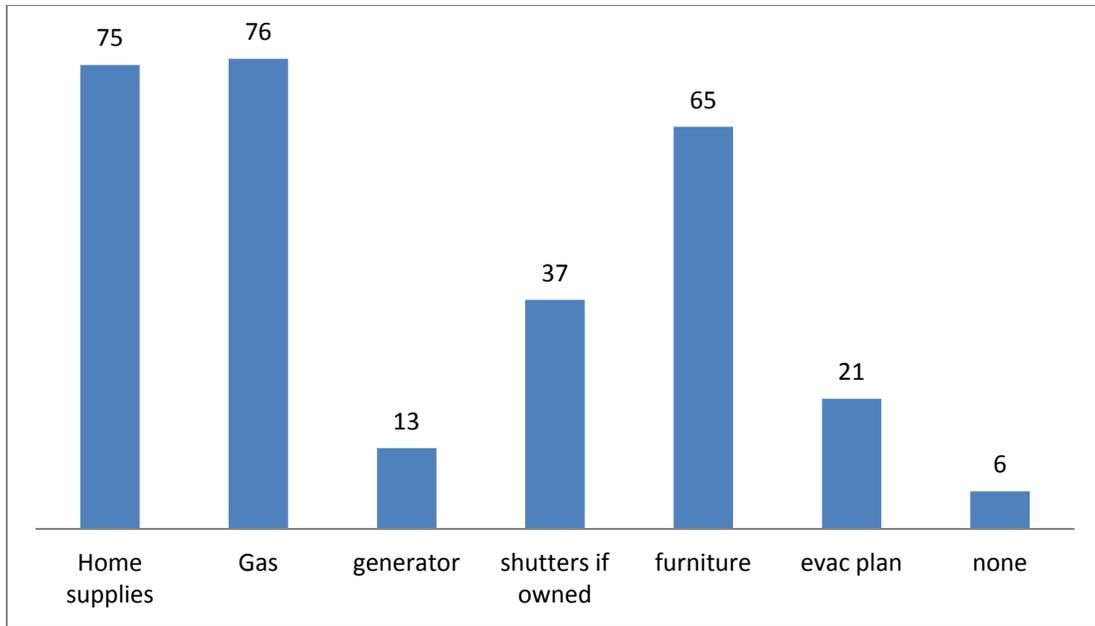


FIGURE 11: PERCENTAGE TAKING DIFFERENT PREPARATION ACTIONS

The figure suggests that while indeed, most undertook preparation, actions tended to be those involving little effort or permanence: buying extra supplies for the house, refueling a car, or taking in the lawn furniture. In contrast, the incidence of more costly actions that might prove essential given a much stronger events—such putting up removable storm shutters if they were owned or preparing an evacuation plan—was much lower.

What would seem particularly surprising was the observed reluctance of those who owned removable shutters to put them up. Unlike in areas with frequent hurricane risks such as Florida, ownership of storm shutters is comparatively rare in the Middle-Atlantic states; in our sample only 10% of respondents owned them. Ownership was presumably limited to those who felt that they faced a recurrent risk of window damage from high winds. Yet, as Sandy approached, less than half put them up, despite the fact that, as noted above, most thought that the greatest threat posed by Sandy was her wind. Moreover, the reluctance was robust to the respondent’s judged probability that their home might suffer damage from wind: Among

respondents who thought there was greater than a 50% chance that their home risked wind damage, 39% who owned shutters put them up. Respondents who thought the chance of wind damage was less than 50% put up their shutters at almost the same rate—34%.

The lack of high-effort preparation was also reflected in a reluctance among respondents to comply with evacuation orders. Within our sample 100 respondents indicated that they lived in communities from which evacuation had been advised. Of these, only 19% indicated that they planned to evacuate. Moreover, among the 50% of these who indicated that they believed the evacuation order was mandatory, and even smaller number—16%—planned to leave. We might note that this compliance rate was almost identical to that observed among those who indicated living in communities where evacuation had *not* been advised (19%). This rate of compliance, we might note, is lower than that which we observed in a similar survey conducted among New York residents in advance of hurricane Irene the year before, where 28% of those living in areas advised to evacuate (both on a mandatory and non-mandatory basis) had plans to leave.

Finally, our surveys also explored the degree to which respondents say they had invested in long-term protection prior to Sandy, either in the form of improvements to their homes that would make them more resilient to damage from storms or owning flood-insurance policies. The data suggest a disquieting absence of such long-term investments in protection. Within our sample, only 19% had invested in storm-safety improvements in their homes, and only 25% possessed Federal flood-insurance policies (with another 8% being unsure). Moreover, this low rate of ownership of flood policies was robust to measures of both objective and subjective flood risk. For example, only 54% of those *living within one block of water* indicated that they had flood policies, and ownership was only 28% among those who thought that there was more than

a 50% chance that they might suffer flood damage to either their homes or person from either storm surge or rain.

What explains the low ownership of flood policies among those at high risk from flood? One contributing mechanism may have been a mistaken belief that their regular homeowners' policies covered them for flood losses. Specifically, across our whole sample, among the 43% who expressed the belief that they were insured against flood losses, only 36% indicated that they own a separate Federal flood policy, with 5% being unsure. This implies that perhaps 59% (or more) of respondents who thought that they were covered in the event of a flood loss, in fact, were not.

Discussion

Hurricane Sandy was the second-most costly natural disaster ever to affect the United States. In her wake the storm left millions without power, and without means of transport, and a permanently altered coastline. She also triggered—perhaps at last—heightened awareness of the vulnerability of our populated areas to the risk posed by natural disasters—a risk that may be growing as a result of both climate change and our propensity to put more property at risk in coastal areas. How we will meet the challenge of adaptation is one of the most pressing problems facing populated areas as the century evolves.

In this paper we provide a glimpse into the behavioral challenges that await us to meet this protective challenge by reporting the preliminary findings of how coastal residents prepared for Sandy when her threat was imminent, but the nature and scale of impacts unknown. Sandy also provided something of a natural experiment in the effects of different warning strategies on preparation and the effects of prior experience on preparation. Specifically, despite the size and damage potential posed by Sandy, the National Hurricane Center made the exceptional decision

to allow coastal warnings to be handled by local National Weather Service offices under the name of high wind and coastal flood alerts. Likewise, Sandy impacted an area that just the year before had been impacted by another large hurricane, albeit with much smaller impact in Irene.

Several aspects of research findings would seem disconcerting. First, as some feared, the absence of traditional hurricane warnings appeared to produce confusion among residents about the exact nature of the threat they faced; just six hours before the storm was to make landfall and while coastal areas had already been experiencing tropical storm-force for a number of hours, 40% of respondents believed that their locations were merely under a hurricane watch (in fact, they were under a hurricane-force high wind warning). Few residents were aware of the ramp-up of intensity that took place in Sandy the morning of landfall.

In terms of threat perception and preparedness, the view that emerged was mixed. On one hand, despite the confusion over warnings, participants were well aware that they were likely to experience a significant storm event (subjective probabilities of hurricane winds were, in fact, considerably higher than objective probabilities), almost all took some kind of protective action, and almost all felt sufficiently prepared for the storm as it approached. But a deeper look at the kinds of preparation that were taken belied this suggestion of prudence. Only a small percentage of respondents anticipated that they might be without power for a sustained duration, a majority of people who owned storm shutters did not put them up, and most who were aware that they lived in evacuation areas elected to stay. There was also limited indication that having lived through Irene the year before helped encourage long-term preparedness. One of our most alarming findings was that only 54% of respondents whose homes were within one block of a body of water indicated they had Federal flood insurance.

Finally, we should also emphasize that our data do not reflect the actions of individuals who might be expected to have limited awareness of storm threats or had little personally at risk from Sandy. The data were drawn from a survey of individuals who, one would think, should know better, and had much to lose: well-educated single-family homeowners between the ages of 30 and 70 with good incomes. Hence, if there is a bias in the sampling, it would seem to be in the direction of under-reporting preparation failures rather than over-reporting.

The research implies that we have much further to travel than some might have thought to reach the goal of fully preparing coastal populations for future storm threats. It is our hope that the findings of this research—while not offering solutions—will nevertheless be helpful in identifying key areas that future work in warning communication might target. There is no shortage of public awareness about approaching storms or the need to take preparatory action. The problem is that preparation appears more consistent with that which appropriate for the weakest rather than strongest instance of the hazards, both in the long and short run. Sandy was a harsh lesson in the risks of overlooking the latter.

References

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Appendix: 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. [Text for "Other"]

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.

- ₀₁ A tropical depression
- ₀₂ A tropical storm
- ₀₃ A hurricane of unknown category
- ₀₄ A category 1 hurricane
- ₀₅ A category 2 hurricane
- ₀₆ A category 3 hurricane
- ₀₇ A category 4 hurricane
- ₀₈ A category 5 hurricane
- ₀₉ A nor'easter
- ₁₀ A hybrid storm (uses the word hybrid)
- ₁₁ A mixed storm (accept answers that indicate hurricane and something else and do NOT use the word "hybrid")
- ₁₂ Don't know
- ₁₃ Haven't heard/seen

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

- ₁ < 39 miles per hour
- ₂ 39 to 73 miles per hour
- ₃ 74 to 95 miles per hour
- ₄ 96 to 110 miles per hour
- ₅ 111 to 130 miles per hour
- ₆ 131 to 155 miles per hour
- ₇ > 155 miles per hour
- ₈ Don't know
- ₉ 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**

- ₀₁ Already has
- ₀₂ 0-6 hours
- ₀₃ 7-12 hours
- ₀₄ 12-24 hours (1 day)
- ₀₅ 2 days
- ₀₆ 3 days
- ₀₇ 4 days
- ₀₈ 5 days
- ₀₉ more than 5 days
- ₁₀ Will not hit
- ₁₁ Don't Know/Not Sure
- ₁₂ Have not heard/seen

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
- ₂ No
- ₃ Don't Know/not sure

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

14. What kind of watch or warning is your home currently under? **READ**

- ₁ Hurricane Watch
- ₂ Hurricane Warning
- ₃ Tropical Storm Watch
- ₄ Tropical Storm Warning
- ₅ Don't Know/not sure
- ₆ Other

15. [Text for "Other"]

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

Percent Scale Score _____

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

Percent Scale Score _____

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. [Text for "Other"]

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

[IF THE ANSWER IS 2-3, THEN SKIP TO QUESTION 29]

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. [Text for "Other"]

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
- ₃ It will probably hit my location and pose a danger to me
- ₄ 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?

- ₁ Wind
- ₂ Flooding/storm surge/waves
- ₃ Combination of wind and flooding from storm surge
- ₄ Flooding from rainfall
- ₅ Tornadoes
- ₆ Don't Know/not sure
- ₇ Other

33. [Text for "Other"]

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

- ₁ Yes
- ₂ No
- ₃ Don't Know

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

35. What kind of protection is it?

- ₁ Plywood panels
- ₂ Other shutters or panels
- ₃ Hurricane-proof glass
- ₄ Combination of types
- ₅ 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?

- ₁ Permanent
- ₂ Temporary
- ₃ Combination of types
- ₄ 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]

- ₁ Purchased supplies for the home SUCH AS food, water and batteries
- ₂ Filled car with gas
- ₃ Filled generator with gas (or readied generator)
- ₄ 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. [Text for "Other"]

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
- ₂ Less than 6 hours
- ₃ 6 to 12 hours
- ₄ 12 to 24 hours
- ₅ 24 to 48 hours
- ₆ More than 48 hours
- ₇ Don't know

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

- ₁ Yes
- ₂ No
- ₃ 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?

- ₁ Yes
- ₂ No
- ₃ 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?

- ₁ Should
- ₂ Must
- ₃ Don't Know/Not Sure
- ₄ Other

46. [Text for "Other"]

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?

- ₁ Yes
- ₂ No
- ₃ Don't Know/Not Sure

48. How did you hear about the evacuation notice?

- ₁ Television
- ₂ Radio
- ₃ Internet
- ₄ Text or email alerts from officials (via phone)
- ₅ Friends/Relatives face to face, phone, or email
- ₆ Friends/Relatives via social media like Facebook or Twitter
- ₇ Police came into neighborhoods
- ₈ 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?

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

[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. [Text for "Other"]

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 CATEGORIES**

- 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. [Text for "Other"]

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
- ₇ Refused

[IF THE ANSWER IS 6-7, THEN SKIP TO QUESTION 62]

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?

- ₁ None
- ₂ 1
- ₃ 2 or more
- ₄ Don't Know
- ₅ Refused

70. Do you have a pet or pets in your home?

- ₁ Yes
- ₂ No
- ₃ Refused

71. Do you own your home or rent?

- ₁ Own
- ₂ Rent
- ₃ Other

72. On your last birthday, were you? **READ**

- ₁ Under 30
- ₂ 30 to 45
- ₃ 46 to 60
- ₄ 61 to 70
- ₅ 71 to 80
- ₆ Over 80
- ₇ Refused

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

- ₁ African American or Black
- ₂ White or Caucasian
- ₃ Other
- ₄ Refused

74. Do you consider yourself Hispanic?

- ₁ Yes
- ₂ No
- ₃ Refused

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

- ₁ Some high school
- ₂ 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. [Text for "Other"]

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

INTERVIEWER:

82. Was the respondent male or female?

- ₁ Male
- ₂ Female