

Motivating Action under Uncertain Conditions: Enhancing Emergency Briefings during Coastal Storms

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ABSTRACT

Coastal flood risk communication is most effective at motivating action when the medium and timing of delivery provide understandable information with clear directives when residents need it most. The U.S. National Weather Service (NWS) has many useful coastal flood forecast tools and products, but how and when this information is delivered are of critical importance. To assess how coastal residents understand and interpret NWS coastal flood products and the best mechanisms for delivery, five focus groups (including residents and emergency managers) in Monmouth and Ocean Counties in New Jersey were conducted. These focus groups employed a scenario-based approach that walked participants through the seven days leading up to Hurricane Sandy. Results support the use of emergency briefing packages as a preferred method for disseminating storm and flood risk information. However, changes to improve visual clarity, provide more succinct information, and localize messages must be undertaken for risk communication to be effective. Further, while residents prefer storm information four to five days prior to storm landfall, emergency managers preferred information seven days prior in order to have time to disseminate information to the community. Findings from this study, which include proposed revisions to NWS products, are expected to improve risk communication and community resiliency in the face of coastal storm threats.

1. Introduction

To advance high-impact weather event preparation and response, and to minimize losses in the United States, the Department of Commerce set an agency goal to improve weather forecast model accuracy (Department of Commerce 2016; see also

<https://www.performance.gov/content/improve-forecasting-accuracy-and-lead-times-severe-weather>). While improved forecast accuracy is a recognized and enduring goal, hazard risk communication cannot be ignored. Even the most accurate forecast will fail in its ultimate objective to minimize loss if it is not effectively communicated, lacks the information sought or needed by the intended audience, or the public does not heed directives to prepare or evacuate.

Past research has documented factors that have contributed to a lack of appropriate action by the public, even with accurate warnings. Some factors relate to

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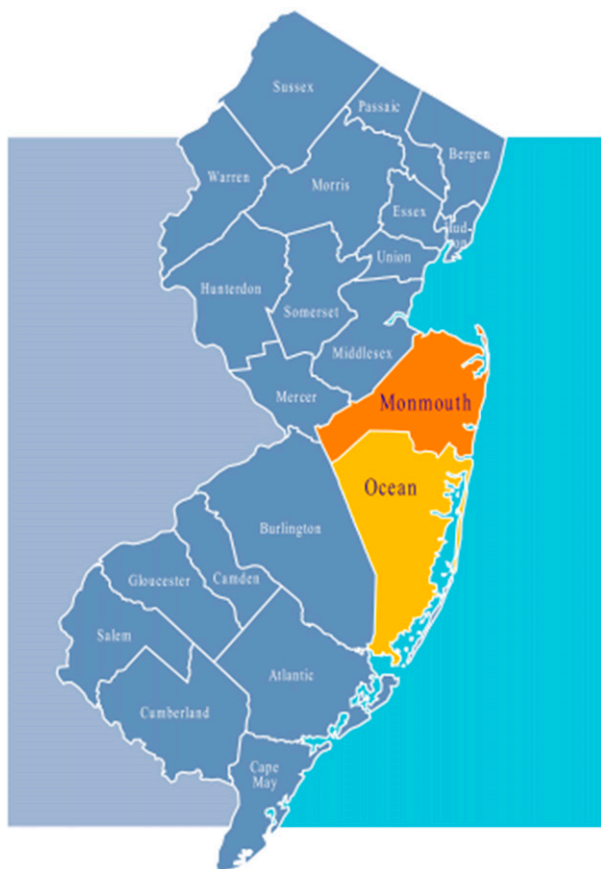


FIG. 1. Map of the two counties involved in this study—Monmouth and Ocean Counties, New Jersey.

characteristics of the public at risk, including past experience (Zaalberg et al. 2009; Dillon et al. 2011) and influences from friends, family, or other social networks with which an individual is associated (Perry et al. 1981; Parker and Handmer 1998; Sharma and Patt 2012). The ability to take action can differ for a variety of reasons, including, among others, a lack of transportation or limited physical mobility (Laska and Morrow 2006; Fjord 2007; Renne et al. 2009). Other factors relate to the messages themselves, such as the framing of the message, its source, and consistency among sources (Mileti and Sorenson 1990). As a government agency providing valuable information to the public, the U.S. National Weather Service (NWS) serves as a primary source for weather forecasts and warning messages. These messages may be received directly by the public or redistributed through key partners, including media, emergency management, and other community organizations. Thus, the manner and clarity in which the NWS frames the content of its severe weather messaging is a critical and controllable component of motivating actionable response for protection of life and property.

Research about risk messaging has found that poorly designed graphics can lead to confusion, hamper risk communication, and impede decision-making (Tufte 2001). As a result, forecasters “need to test how their forecast messages are received and interpreted” (Morrow et al. 2015, p. 38), and they need to address different public sectors that have a range of demographic and socioeconomic characteristics. This testing should consider different spatial contexts, as risk will vary geographically, and different temporal contexts, as risk perceptions may vary over the course of a storm event. Specifically, how risk perceptions evolve over the time leading up to a storm event is still an area requiring more investigation, especially with regard to “the suitability of preparation actions” (Meyer et al. 2014, p. 1390). These perceptions are affected by both cognitive and situational factors (Tobin and Montz 1997). While NWS forecasters have no control over the broader situation of those who are at risk, they can influence cognition. Specifically, they can influence how messages are understood and how they “evoke . . . emotional responses that promote protective action” (Morrow et al. 2015, p. 38).

a. Hurricane Sandy and the study area

Monmouth and Ocean Counties, the focus of this study, are located in coastal New Jersey (Fig. 1). Both counties were especially hard hit by Hurricane Sandy, which made landfall on 29 October 2012 near Brigantine, New Jersey, just to the northeast of Atlantic City, drifting northward for the next two days. The storm destroyed homes and businesses in Ocean County on the Barnegat Peninsula near Brick, New Jersey. Twenty-foot waves breached the barrier island, flooding inland areas and depositing up to four feet of sand. Coastal winds exceeded 80 mph. All routine activity ceased due to widespread power outages and closures of roads, bridges, and transit systems. Both communities organized strong recovery responses after the storm. They were selected for this project because of the significant impacts they experienced and because the cohesive community responses to the flood events were anticipated to facilitate recruitment of study participants.

b. NWS information during Hurricane Sandy

During the days leading up to Hurricane Sandy, the NWS Weather Forecast Office (WFO) in Mt. Holly, New Jersey, disseminated information directly to the public by several means, including forecasts and statements posted on its website. The WFO issued its first briefing seven days prior to the storm, thereby initiating a campaign of focused public briefings regarding the potential for a significant weather event.

TABLE 1. NOAA/NWS products used during the coastal storm scenario during the focus group sessions in round 1 and round 2. T-*n* refers to the number of days prior to hurricane landfall.

Round 1: 3 groups: Residents (Monmouth and Ocean Counties) and emergency managers	Round 2: 2 groups: Residents (Monmouth and Ocean Counties)—with revised documents
NHC track forecast cone (T-6, T-4, T-1)	NHC track forecast cone (T-6, T-4, T-1)
Surface prognosis map (T-6)	Surface weather patterns (T-6)
Precipitation forecast map (T-4, T-1)	5-day precipitation forecast (T-4, T-1)
Extratropical surge forecast map (T-4, T-2)	Observed and forecast water levels (T-4, T-2)
Wind speed/direction forecast map (T-2, T-1)	Wind speed/direction forecast map (T-2, T-1)
Coastal flood watch/flood warning (T-2)	Coastal flood watch/flood warning (T-2)
Emergency briefing (T-6, T-1)	Emergency briefing (T-6, T-4, T-1)

These briefings contained information from the National Oceanic and Atmospheric Administration (NOAA)/NWS describing the components of the storm, such as wind speed and gust maps, temperature maps, precipitation forecasts, extratropical surge forecast graphics, and other products and information. The briefings were packaged in a PDF file that contained these forecast products along with text and other information about the storm. As the event progressed, the NWS WFO issued daily briefings with increasingly detailed information. The WFO began sharing updates about the availability of new briefings via social media such that the briefings, which had historically been intended as a tool for emergency managers (EMs), became more widely accessible to public audiences. Notably, within the two days leading up to landfall, the Meteorologist-in-Charge (MIC) of the Mt. Holly WFO included a personal plea in the briefing, a strongly worded personal request for residents to take the storm seriously and evacuate if told to do so.

The research reported here centers on evaluation of NOAA/NWS products issued in advance of the storm to understand 1) how residents in coastal New Jersey access and understand the products, 2) what kinds of actions the products prompt, and 3) how participants would adapt the products to make them more user friendly. In particular, the study evaluated a subset of the series of emergency briefing packages issued by the NWS during Hurricane Sandy that were distributed widely to emergency management personnel and through social media to the public. This study, then, examines factors relating to how messages are framed and conveyed, in order to facilitate public understanding and motivate action during coastal flooding events.

2. Data and methods

Data collection centered on discussions during scenario-based focus groups of residents and emergency managers, conducted in two rounds with the first round consisting of original NOAA/NWS products and the

second round consisting of revised products (Table 1). Four focus groups with residents from Monmouth and Ocean Counties were conducted: two in round 1 and two in round 2 (described below). An additional focus group was conducted for emergency managers from both counties in the first round only. A total of 40 residents and seven emergency managers participated in the focus groups. Recruitment for participants was achieved through outreach by local emergency management offices, the Jacques Cousteau National Estuarine Research Reserve, and other community organizations, including the locations where the focus groups were held (a local library and college) and regional groups that took initiative to share word of the event through social media.

A survey¹ was distributed prior to the start of each focus group that collected demographic data and information on respondents' length of time in the community, flood experience, perceived risk of flooding, sources for learning about hazardous weather, and typical actions taken during past events. Not all respondents answered all questions. Following the scenario presentation, participants were asked to complete a second short survey (postsession findings). Each participant was offered \$30 for participating.

The research team developed a 7-day scenario of Hurricane Sandy's approach to the New Jersey coast, using products that were issued by NWS during the course of the actual storm. Staff at the Mt. Holly WFO assisted in identifying the commonly issued coastal flood products and in locating archived products for use in the scenario. During each focus group session, the participants were led through the day-by-day coastal storm/flooding scenario. Each "day" a number of NWS forecast products were shown and questions were asked by the facilitator about participants' use and interpretations of the products—what they liked or did

¹ The survey was peer reviewed and evaluated by an institutional review board (IRB).

not like, what they were thinking or doing at that stage in the storm's progression, and what actions they took or would take in response to the products. In addition, at the end of the scenario, an emergency briefing package was shown that incorporated both graphics and text.

Round 2 was independent of the first, conducted at a later date with different participants. For round 2, some of the NOAA/NWS products were modified based on participant feedback and graphic design principles to enhance understandability. Round 2 differed from round 1 due to these revised products and revised emergency briefing packages. Three emergency briefing packages were shown throughout the scenario development in round 2, in contrast to round 1, when two were shown only at the end. The NWS forecast products used during the scenario and as part of the emergency briefing packages are listed in Table 1. In both round 1 and round 2, the emergency briefing packages were shown as distinct from the individual NOAA/NWS forecast products listed in Table 1, but the briefings did contain some of these other products. An overview of what was presented in the briefing packages, along with the content of each page (product, text, etc.), is listed in Table 2.

Following the sessions, audio recordings were transcribed and analyzed using NVivo software (QRS International 2012; Richards 1999). Themes for analysis emerged from the comments and suggestions made by focus group participants. Although several products were considered and revised in this project, the storm surge graphic and briefings are the focus of this paper because of their high potential for influencing decision-making during coastal flood events.

3. Results

a. Participant demographics

Participant characteristics of the focus groups were quite similar between rounds 1 and 2 (Table 3). The majority of residents were female and the majority of emergency personnel were male. More than three-quarters of all respondents had bachelor's or post-graduate degrees. All emergency personnel and more than three-quarters of resident participants (residents) had lived near the coast in Ocean County or Monmouth County for eight or more years. More than half of the residents indicated that they lived in a flood zone. The only noteworthy difference between the two rounds is that round 1 residents as a group were somewhat younger than those in round 2.

Almost all of round 1 residents and more than half of round 2 residents had experienced the impacts of flooding prior to Hurricane Sandy, either directly or

indirectly through friends and family, most within the last five years. Nearly three-quarters of all residents experienced damage to their homes or businesses during Hurricane Sandy. More than three-quarters of round 1 residents reported that they took action based on the warnings, as did more than half of round 2 residents. Round 2 residents rated their flood risk nearly twice as low as did round 1 residents. Emergency managers were asked about their perceptions of community flood risk with almost three-quarters reporting "extremely high" in contrast to the residents whose perceptions of flood risk were relatively lower.

b. Use of and reactions to emergency briefing packages

This study focused particularly on the use of emergency briefing packages (in PDF format), to determine first how effective they have been, and might be, in motivating public action, and then to make best practice recommendations for future briefings. Participants were asked to consider the timing of the briefings, which products should be included, how the information should be presented, and at which thresholds they should be issued. In round 1, participants were shown two briefing packages (Fig. 2) at the end of the scenario to allow for a focused discussion, specifically with emphasis on what they include and how they could be improved. In round 2, the briefing packages (Fig. 3) were included as part of the scenario.

The briefing packages used in round 1 (Fig. 2) coincided with days T-6 and T-2 (T-*n* refers to the number of days prior to hurricane landfall). A few participants in round 1 were familiar with the briefing packages, including one who "uses it a lot." Another participant noted, "it would have been helpful" and others said they liked it, especially the explanatory material. Some would still have liked more explanation, such as legends. At the package issued at T-6, participants noted there was no mention of the moon or the strength of the storm, which they considered important, due to the effect of the moon on tide level. One person said T-4 is a good time to have it; another would be more interested in receiving it later, issued closer to the arrival of the storm. At the same time, there were critiques of how the information was presented, as indicated by this comment: "'Active Weather Threat' is not going to cut it." Further, it was noted that there was "lots of weather technical jargon." Suggestions included adding "some legends or descriptions of how to read the maps" and reducing the number of prognosis maps, noting that "the public would read the other graphs more easily."

Participants specifically called for more direction within the briefings on actions they should take, noting

TABLE 2. Overview of the contents of the emergency briefing packages shown in round 1 (at the end) and round 2 (during the scenario). Note: The extratropical storm surge graphic was renamed observed and forecast water levels in round 2.

Round 1: Emergency briefing (T-6, T-1)	Round 2: Emergency briefing (T-6, T-4, T-1)
<p>T-6 (11 pages):</p> <ol style="list-style-type: none"> 1. Active weather threat (title page) 2. Purpose of briefing (map/text) 3. Executive summary (text) 4. Current status of Tropical Storm Sandy (cone/text) 5. Where does Sandy go after it is no longer tropical? (tracks/text) 6. Latest forecast for storm system track (surface prognosis map/text) 7. Second surface prognosis map/text 8. Third surface prognosis map/text 9. Note about preceding maps (text) 10. Things to focus on with this storm (text) 11. Questions 	<p>T-6 (8 pages):</p> <ol style="list-style-type: none"> 1. Potentially damaging storm (title page) 2. Summary of weather situation (map/text) 3. What you need to know about this storm (text) 4. Current status of storm (hurricane cone) 5. Possible paths for Sandy (ensemble tracks/text) 6. When will the system reach us? (surface prognosis maps revised—3 total) 7. Note about forecast maps (disclaimer/text) 8. Questions (text) <p>T-4 (9 pages):</p> <ol style="list-style-type: none"> 1. Potentially damaging storm (title page) 2. Summary of weather situation (map/text) 3. What you need to know about this storm (text) 4. Actions you should take now to prepare (text) 5. Current status of Hurricane Sandy (cone/text) 6. Inland flooding threat (5-day precipitation forecast revised/text) 7. Coastal flood levels (observed and forecast water levels revised/text) 8. Note about forecast maps (disclaimer/text) 9. Questions (text)
<p>T-1 (16 pages):</p> <ol style="list-style-type: none"> 1. Very dangerous Hurricane Sandy (title) 2. Purpose of briefing (map/text) 3. Changes from previous briefing (text) 4. Executive summary (text) 5. Current status of Hurricane Sandy (cone/text) 6. Note about preceding maps (text) 7. Terminology (text) 8. Inland flood threat (5-day rainfall graphic/text) 9. Inland flooding tools (hydrograph/text) 10. Coastal flooding tools (extratropical storm surge/text) 11. Things to focus on regarding coastal flooding (text) 12. Personal plea (text) 13. Winds (wind speed/direction graphic/text) 14. Forecast tool information (text/links) 15. Housekeeping (text) 16. Questions (text) 	<p>T-1 (13 pages):</p> <ol style="list-style-type: none"> 1. Very dangerous Hurricane Sandy (title page) 2. Summary of weather situation (map/text) 3. Personal plea (text) 4. Coastal flood risk (text) 5. Current status of hurricane (cone/text) 6. Coastal flood levels (observed and forecast water levels revised/text) 7. Inland (river) flooding threat (5-day precipitation forecast revised/text) 8. Inland (river) flooding tools (hydrograph revised/text) 9. Winds (wind speed/direction forecast revised/text) 10. Important notes from the forecaster (text) 11. Where to find more forecast information (text) 12. Housekeeping notes (text) 13. Questions (text)

that many do not know how to prepare. “[T]he only thing you hear on the news is, ‘Do you have batteries and a flashlight?’ They don’t really tell you what to do. And most people don’t know what to do,” said one participant, who was echoed by others who called for more detailed information on how to prepare: “You get all these warnings; they don’t tell people what to do to prepare for the storm.” Participants also wanted the

briefings to visually convey the level of risk quickly. For instance, one participant referenced the need to put something large and visual on the cover of the briefing to grab people’s attention. “There’s the classic example of the skull and crossbones—you know it’s bad. . . . Let’s just say I saw this sitting somewhere, I would have to actually see the word dangerous . . . I might not just read text, even though it says ‘very dangerous.’” The second

TABLE 3. Characteristics (all values in %) of study's focus group participants.

	Residents 1 <i>N</i> = 18	Residents 2 <i>N</i> = 21	Emergency managers <i>N</i> = 7
Age			
30–39	33	0	14
40–49	11	5	14
50–59	6	43	71
60–69	17	19	
70+	6	24	
NA	28	10	
Gender			
Male	28	43	86
Female	50	52	14
NA	22	5	
Education			
High school	17	5	29
Associate of arts	0	10	0
Bachelor of the arts	22	29	43
Postgraduate	44	43	29
NA	17	14	
Years living in coastal area			
Fewer than 8	17	10	0
8 or more	61	86	100
NA	22	5	0
Years in Monmouth/Ocean County			
Fewer than 8	17	10	0
8 or more	61	62	100
NA	22	29	0
Flood experience			
Yes	89	57	
No	11	43	
Timing of flood experience			
Within last 5 years	78	48	
More than 5 years ago	11	10	
NA	11	43	
Damage from Hurricane Sandy			
Yes	72	71	
No	28	29	
Responded to warnings			
Yes	67	57	
No	17	24	
NA	17	19	
Response taken			
Evacuated	39	33	
Secured objects (stayed)	28	14	
NA	33	52	
Perception of flood risk			EM (community risk)
Extremely high	17	14	71
Somewhat high	56	24	29
Very little or no risk	28	57	0
NA	0	5	0

briefing package, shown on day T-2, included a personal plea (Fig. 4) from the MIC of the WFO.² The plea

²The research team worked closely with the MIC, who provided the briefing packages and reviewed the changes implemented for round 2.

exhorted readers to please evacuate when told and to consult with those who had been through previous extreme storms when deciding whether to leave or ride out the storm. Participants responded almost uniformly positively to the plea, noting that it was effective in triggering attention, with the caveat that it could be improved by being shortened.

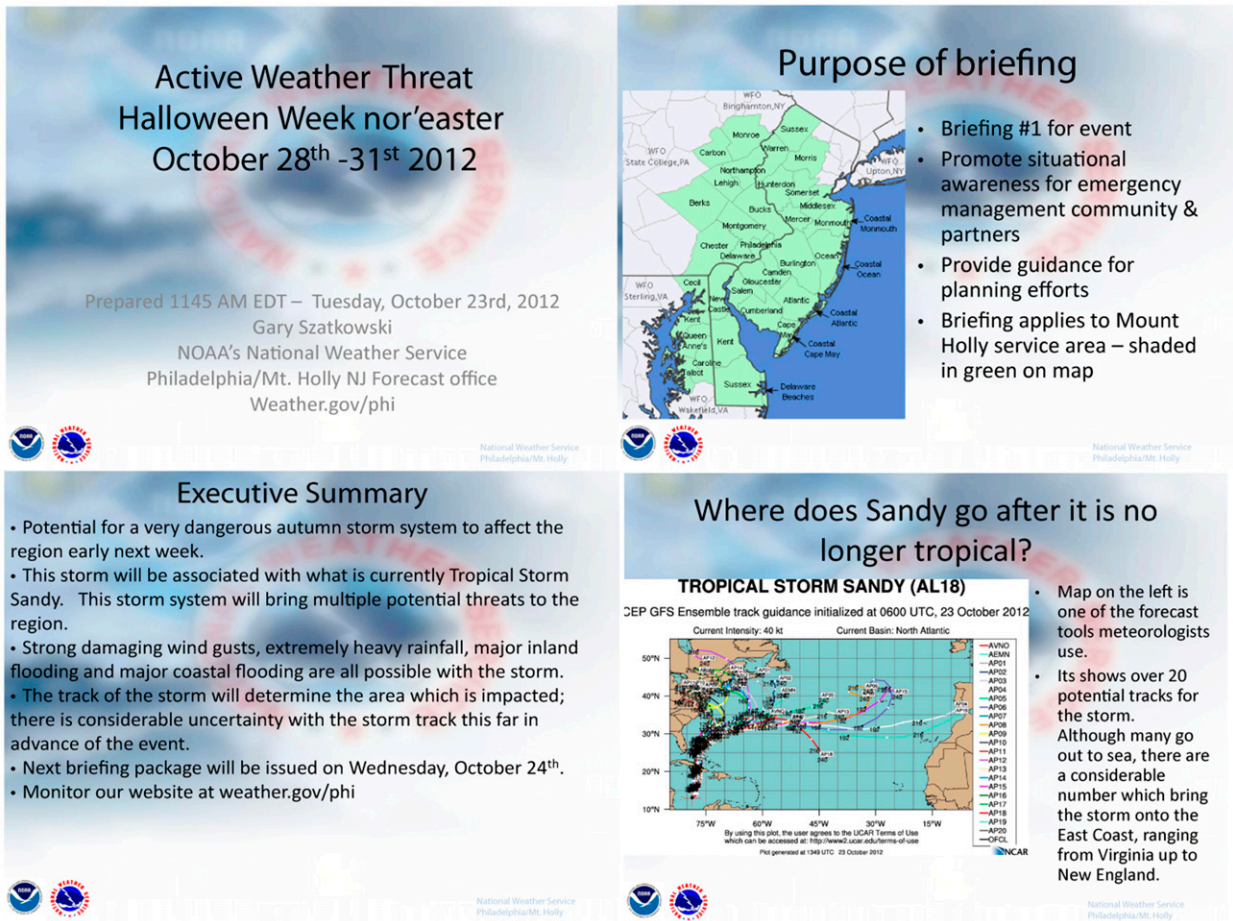


FIG. 2. Screenshots of some of the slides of the original emergency briefing package used in round 1.

c. Revisions to the emergency briefing packages

The second round of briefing packages, part of which is shown in Fig. 3, reflected changes based on the recommendations from the first round of focus groups. The briefing packages were revised to enhance visual clarity, to reduce the length of the briefings, and to prioritize action steps. They were designed with the most critical information up front, allowing for later information to be considered if desired, without losing key understanding. The revised briefings attempted to notify the user in the first two to three pages of the most critical information so that if they read no further, they would have the basic knowledge they needed to proceed. Detailed storm and meteorological information was still included for emergency managers and for those who seek fuller understanding of storm dynamics and anticipated impacts but were moved to the end of the package. Orange and red colors were used to call out text that indicates a watch-level (orange) or warning-level (red) threat or concern. The revised

briefing for day T-2 retained the original personal plea, which had registered as highly motivational among participants.

d. Use of and reaction to the extratropical surge forecast

Though study participants provided feedback on a range of products, several of which were revised and reevaluated during round 2 (including surface prognosis maps, wind speed and wind direction maps, and others), we focus specifically here on the extratropical surge forecast graphic because it provides point-specific water-level information that participants identified as having high potential for influencing decision-making. This product was shown on its own as part of the scenario and it was included in the briefing package. The extratropical surge forecast was shown in the scenario first at T-4 (Fig. 5) and again at T-2 (Fig. 6) in both rounds 1 and 2. When first shown in round 1, few of the participants said they were aware of the

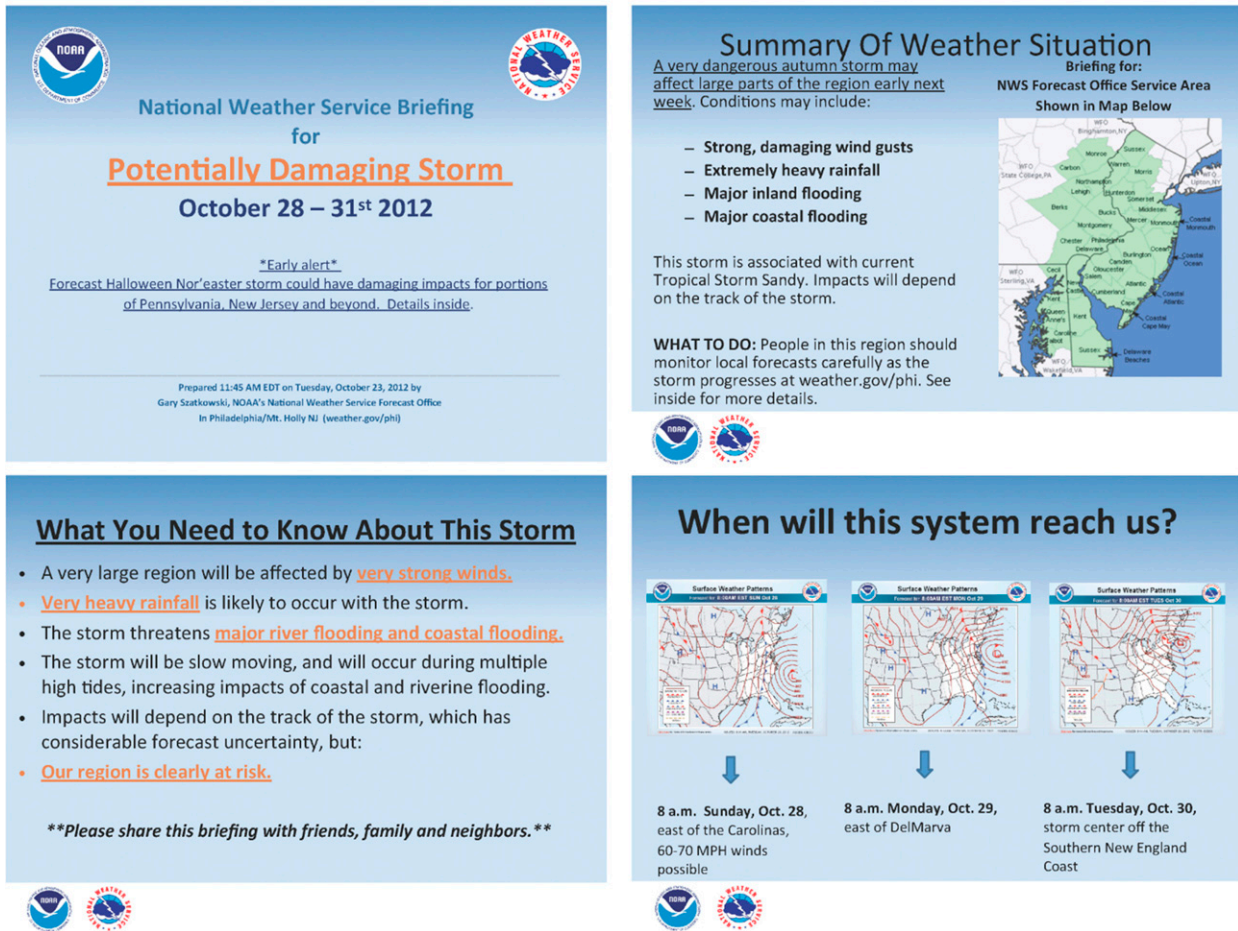


FIG. 3. Screenshots of some of the slides included in the revised emergency briefing package in round 2, T-6.

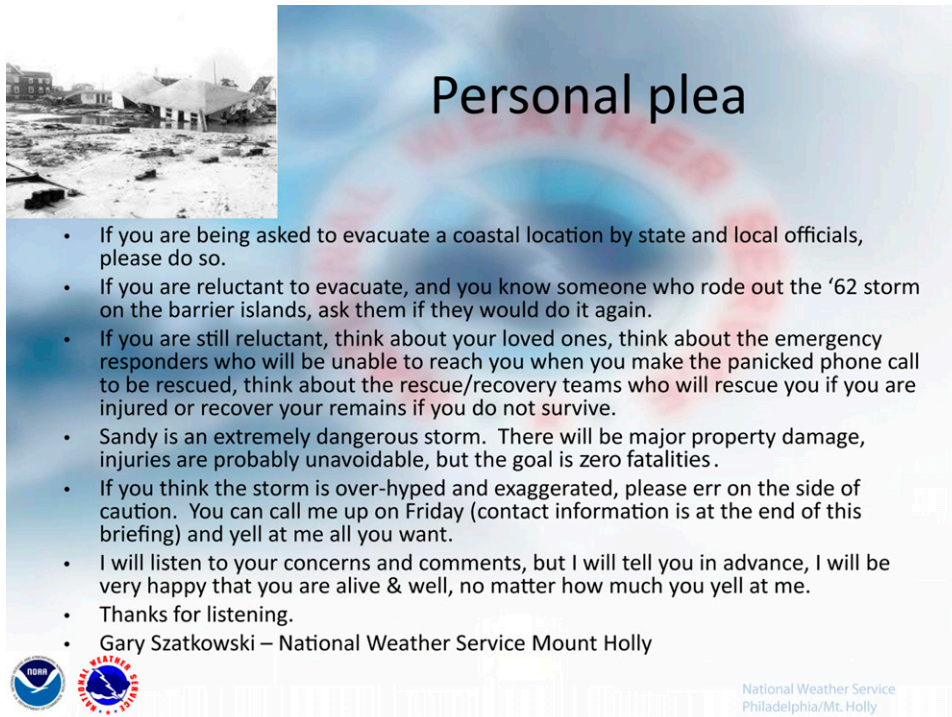
product; only about one-third had seen it before. Similarly, about one-third said they would not use it. In fact, it had to be explained by the facilitator. Once this was done, participants made comments such as “I would not have known that before that,” there are “no explanations for the layman,” and it is “not clear.” Once the graphic was better understood, participants began to analyze it with respect to where they lived. One participant noted, “Leeward and windward side makes a difference. South wind means a definite flood.” Another said, “a spike Sunday would be troubling.” Even following that discussion, comments centered on how difficult it was to interpret, with one making a creative and interesting analogy: “Most people don’t know what that means. It could be the Energizer Bunny,”³ referring to the image that came

³ The Energizer Bunny is a familiar advertising trademark for a national brand of battery.

to that individual’s mind given the small “×” markings and up-and-down waves on the graphics.



When presented with a version of the graphic two scenario-days later, which showed significantly higher forecast water levels, participants focused much of the discussion on the changes from the previous one. “This changes my thought,” said one; another, more bluntly said: “That’s a ‘holy [\$\$@#!]’ for me.” Several called for more specific information. “The reference point is 2–3 feet above normal,” asserted one, “99% of people don’t know what normal is and how to translate that into 11 feet,” noting that 11 feet is high anywhere on the New Jersey shore. Others were very concerned about 11- or 12-ft-high waves. “Obviously this is worse than the prediction of the T-4 map,” said one person, and another person countered, “Who cuts these maps out . . . and compares them? Nobody. Write it down, tell people, and not in science terms, what it means to where you live.”

Not surprisingly, the focus group of emergency managers had seen and used these products. One described



Personal plea

- If you are being asked to evacuate a coastal location by state and local officials, please do so.
- If you are reluctant to evacuate, and you know someone who rode out the '62 storm on the barrier islands, ask them if they would do it again.
- If you are still reluctant, think about your loved ones, think about the emergency responders who will be unable to reach you when you make the panicked phone call to be rescued, think about the rescue/recovery teams who will rescue you if you are injured or recover your remains if you do not survive.
- Sandy is an extremely dangerous storm. There will be major property damage, injuries are probably unavoidable, but the goal is zero fatalities.
- If you think the storm is over-hyped and exaggerated, please err on the side of caution. You can call me up on Friday (contact information is at the end of this briefing) and yell at me all you want.
- I will listen to your concerns and comments, but I will tell you in advance, I will be very happy that you are alive & well, no matter how much you yell at me.
- Thanks for listening.
- Gary Szatkowski – National Weather Service Mount Holly

National Weather Service
Philadelphia/Mt. Holly

FIG. 4. The personal plea included in the emergency briefing packages.

how wind forecasts helped them understand how much water will “pile up” and for how long, noting that winds from the north and northeast will cause floods, which interestingly contradicts a statement made by a resident

about southern winds causing flooding. At the same time, there was general acknowledgment that residents, particularly those who are new to the area, have no idea what is going on under such circumstances.

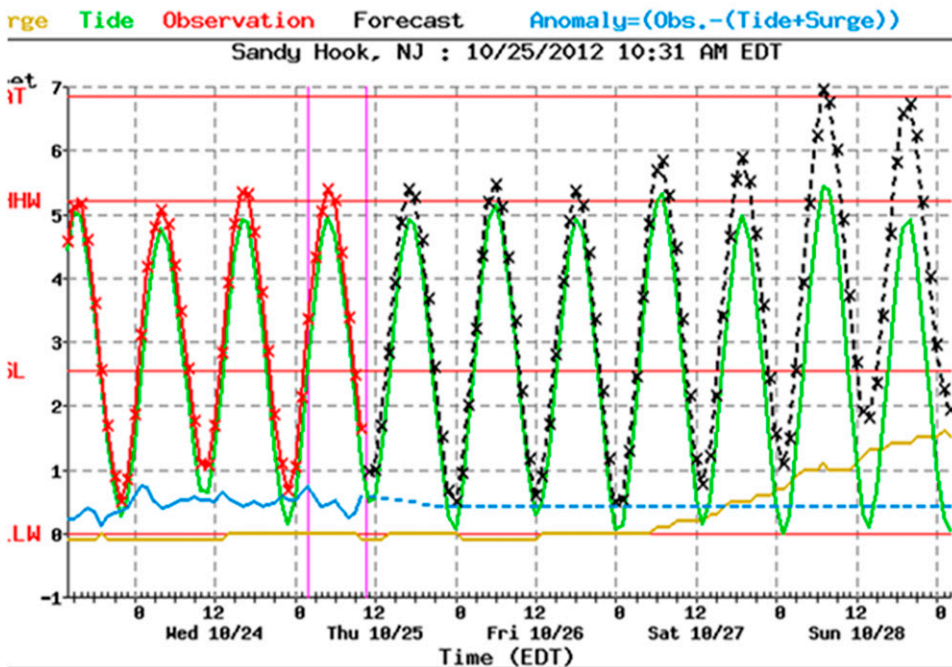


FIG. 5. Extratropical storm surge graphic shown to focus group participants at T-4 in round 1.

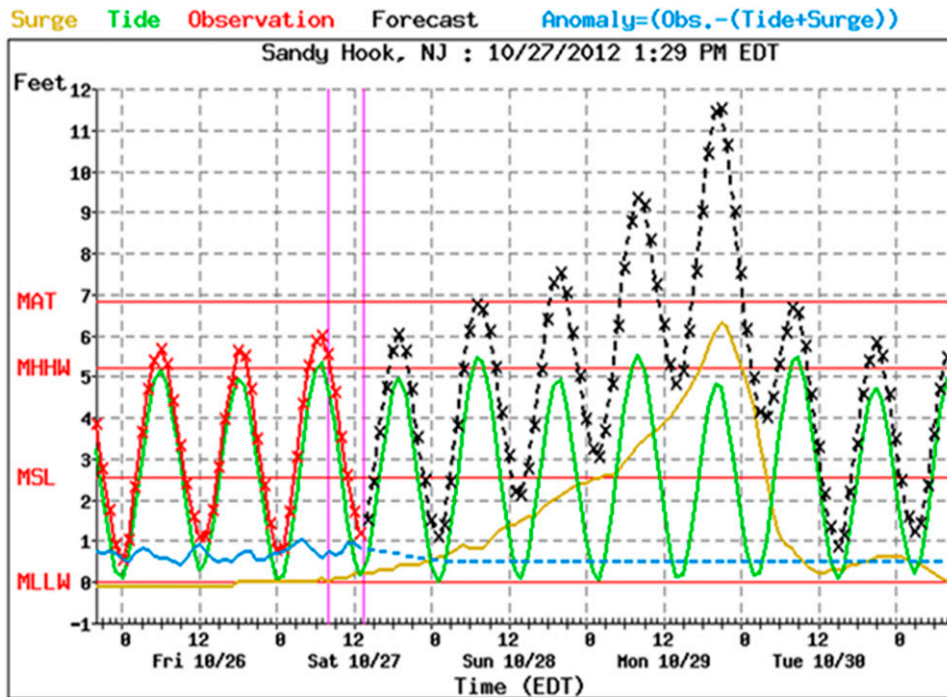


FIG. 6. Extratropical storm surge graphic shown to focus group participants at T-2 in round 1.

e. Revisions to the extratropical surge forecast

The extratropical surge forecast graphic was redesigned to address some of the difficulties participants had understanding it and to incorporate suggestions that were feasible, according to NOAA/NWS partners. The results of this redesign are shown in Fig. 7. As can be seen, the title has been changed to make it more intuitive for the layperson, the small \times marks on the lines have been removed, the legend expanded and relocated, and the water levels on the y axis defined. Additionally, shading was added to differentiate between the observed and forecast water levels. A statement explaining that flooding can be expected at or above the level of maximum astronomical tide (MAT) was added to overcome the feedback from round 1 that residents lacked knowledge about the levels at which water impacts their communities. When shown this new version of the product in round 2, participants' reactions indicated much less confusion than seen in round 1. While this may be partly due to the fact that just under half of the participants had seen it before, and a few had used it before, the discussion was much more focused on the information it was conveying rather than on trying to interpret it. The graph shown at T-2 evoked some laughter as participants grasped the severity and immediacy of the storm. "It looks really nasty," said one participant; "Now it's really scary. The other [earlier version] said 7 feet and

now they're saying 12." Several participants noted that this product would be useful in the future—"We learned what 12 feet [of tidal surge] looks like"—and so will pay attention but, like the emergency managers in round 1, wondered if people new to the area would understand what it means.

f. Timing

Participants also provided feedback about when they would like to receive briefings. The lead time prior to storm landfall when the emergency briefing packages were found to be most useful varied slightly between the round 1 and round 2 focus groups, with the round 1 focus group preferring the briefings five days before the storm and the round 2 focus group preferring the briefing four days before the storm (Fig. 8). Emergency managers' preference for the timing of the briefing package was much different from residents, with the most use occurring seven and three days before the storm event, respectively. The different roles in an extreme weather event would explain this difference; emergency managers need information well in advance in order to make plans and to start outreach in the community, while residents want the information four to five days in advance—any earlier and they do not feel the forecast is sufficiently certain, while any later most residents are planning for or already taking action and are less engaged in looking for information.

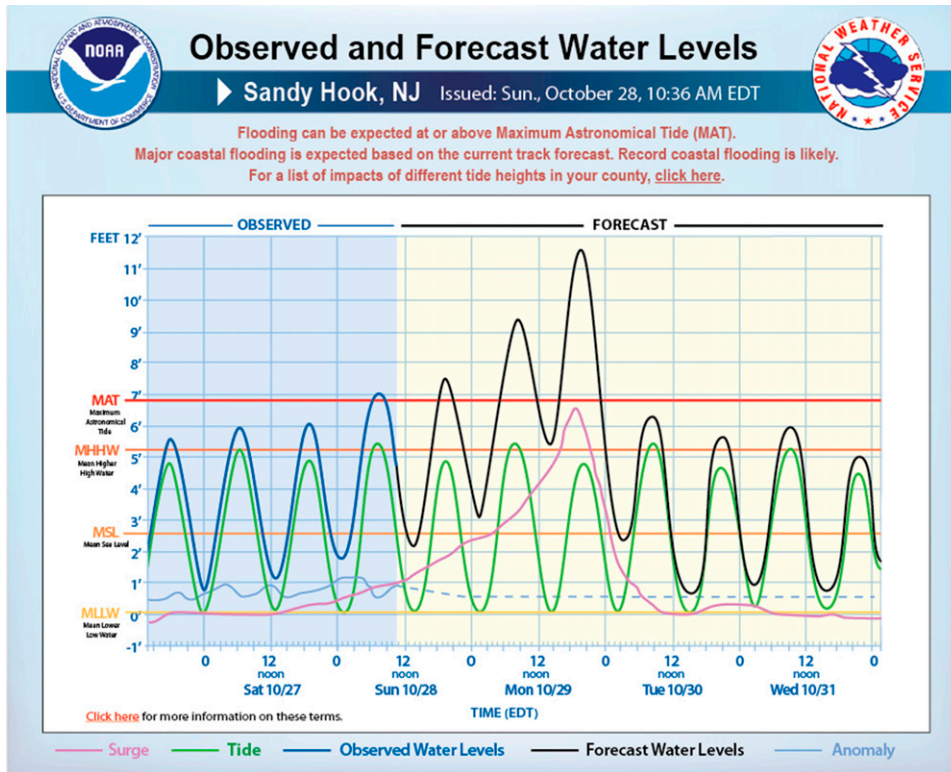


FIG. 7. Revised extratropical surge forecast map used in round 2 with the name observed and forecast water levels.

g. *The value of the briefing package*

Both residents and emergency managers liked the emergency briefing packages and saw their utility for disseminating extreme weather and preparation information. In response to a slide that had an NWS forecast product accompanied by brief explanatory text, one resident stated, “If I was going to the NWS website, I would just be staring at this graphic, and I’d have to learn how to interpret it from staring at it, where this [briefing package] at least has some explanatory info right next to it in the package, so that’s a big bonus for me.”

In addition to explaining the products succinctly, the action-oriented nature of the briefing packages was a key element cited by residents for motivating action: “if you gave me this now, I would think I’d pay more attention to it, because it at least tells you, ‘well time to go again, it’s time to pack up and go again.’” However, some expressed concern about the frequency of updates, recognizing the changing nature of storm development: “I think this is great to have as a tool if it’s coming close enough to you, but like this is just static; a storm is fluid.”

Participants also noted that the briefings provide a regional perspective, and often, local information is also required. For instance, one participant indicated the

need for interactive tools in the briefing to find local conditions and forecasts: “If there was a link to a town-by-town or county-by-county map that would be very [helpful]. Both my mother and I are in a situation where we are more affected by creeks and things flooding so really getting a micro view is more helpful.”

Similarly, some participants indicated that during Hurricane Sandy, they did not know whether the forecasted impacts applied to their communities unless their town name was specifically noted: “One of the things that caught my attention. About T-4 on *The Weather Channel*, they were interviewing hundreds of meteorologists. One of them [the meteorologists] said, ‘I see this storm going in Manasquan inlet.’ I live in Manasquan inlet. That got my attention. That was the only time I heard it.” This sentiment was echoed by others: “We never heard anything Seaside Heights-related until the storm was like here. It was like, ‘It’s gonna hit Atlantic City, it’s going to hit Atlantic City,’ and then Atlantic City got . . . meh . . . a little,” and continuing, “You hear Seaside Heights, you hear Sandy Hook, but you live in Lavalette—it’s like, ‘Maybe it won’t hit me.’”

Participants provided insight into the factors that motivate them to take action. Specifically, they discussed the need to prioritize the risks in order to determine

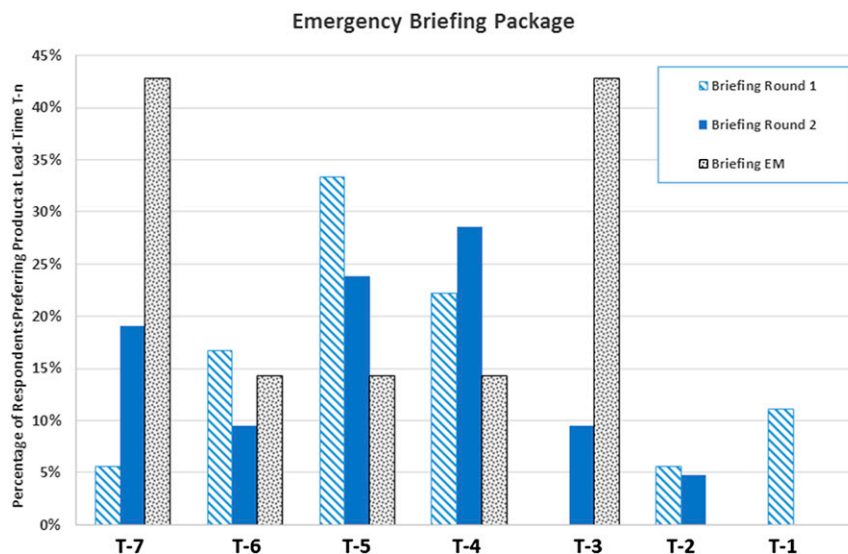


FIG. 8. Frequency of use of the emergency briefing package over the course of the scenario leading up to storm landfall.

appropriate actions. For instance, one participant noted: “It would be nice if there was a prioritization of what should I be more concerned about, the wind damage or the water or the water then the wind because like I said they couldn’t move all their boats, you have limited resources especially in government and where should those resources be applied?” Participants also stressed the need for information about which actions to take. The emphasis mentioned earlier about batteries and flashlights is not enough, as noted, “Most people don’t know what to do. . . . They don’t know [to] put your lawn furniture away, secure things down.”

Relating the storm events to previous events was also specifically mentioned as an effective tool for helping people to understand and plan for their risk. In response to the briefing language, one participant suggested: “When you talk about record coastal flooding . . . if you would’ve said, this will be the highest recorded tidal surge of the history of the NY–NJ area, I think you really would’ve nailed it.”

Similarly, another point of emphasis from participants was the need to translate meteorological details into statements of visible and meaningful impacts. As one participant said, “It’s not [that] the vocabulary is too difficult to understand, it’s that I don’t have a picture in my brain of what that speed of wind . . . implications are.” Others echoed this sentiment: “The person who is writing this understands that 75 mph that’s going to do damage . . . you have to translate that: Your roof can blow off, secure things.” And “Again, I need a translation—like, knowing the inches of flood level doesn’t help me out as much as if you said, ‘This could cause the tide to come in this far.’”

Keeping messages short and to the point emerged as the best way to convey the forecast and actions needed in the briefing packages. As one participant stated, “The graphic should explain itself . . . and if it doesn’t, then just a few words to explain it. So, if the graphic needs a textbook to explain what it is, it’s a failed graphic.” This point was echoed throughout the focus groups: “I think graphics always speak louder than words, and you need a minimum amount of text to explain the graphics.” One participant praised the briefing for its brevity: “It’s bold, it’s short, not too much you have to read.”

Emergency managers had distinct needs for the emergency briefings. They appreciated the wide range of information the briefings offered and were generally were appreciative of more—rather than less—information for their own planning while also expressing concern that too much information might be problematic for the residents they need to motivate.

One emergency manager noted, “I personally like these because it gives you every aspect to look at, even closer in. It gives you the wind. It gives you the rain. It gives you the coastal impacts. All the stuff that we see—the surge statements, the coastal surf warning statements, and all that stuff—so it’s good. There is a point where you have to worry about desensitizing people, where it starts to become spam.” Another emergency manager noted concern about disseminating the briefing packages to the public, “This is okay for us ‘cause we can disseminate what we have to do. So, more information for us is good. But I don’t know, not necessarily a lot of information for the public is a good thing. Somewhere somebody’s got to figure out what they need to know.”

4. Discussion and conclusions

This study examined a range of NOAA/NWS forecast products to understand how the public uses and interprets them and to understand the ways these products motivate action. Of the suite of tools studied, the extratropical surge graphic and the emergency briefing package stand out as holding high value for residents in coastal flood-prone areas.

The extratropical storm surge product conveys critical information about observed and forecast water levels—information that was valued by participants. However, the current presentation of that information was insufficient for most participants in terms of conveying understandable information and for motivating action. Modifications to labels and legends and design revisions to this product can help to more clearly convey the expected water levels, and to familiarize residents with the levels that will lead to significant impacts.

Further, study results provide evidence that emergency briefing packages can be an effective dissemination tool for communicating risk to the general public. When first implemented, this tool was primarily used by NWS offices for communication with emergency managers. However, the combination of graphics and explanatory text makes the briefings appealing to the public. In addition, briefings put all the information in one place and can be pushed to residents, instead of residents' having to search out each product related to the storm. Briefings also allow forecasters to establish a personal tone and sense of urgency about an event, and it can allow forecasters to prioritize information, risks, and impacts in a way that other products often do not.

The findings here suggest that effective messaging in briefings requires considering several factors in the briefing design, including the structure of the package, the information included, and the source and channels of dissemination of the briefings. To address those considerations in order, the study results indicate that briefings should be concise and action oriented, with anticipated impacts and short, concise action statements up front. Forecasters can consider the use of color in text to emphasize differing levels of risk and anticipated impact. Formatting the briefings so that key information is located up front allows readers to scan the early pages of the briefing and identify whether it applies to them and which actions they should take next. To remain effective to emergency managers, the packages must retain the full breadth of meteorological information, which can be delivered later in the package for more highly motivated users, both residential and emergency managers alike.

How much information to include and how to present it are also important. Participants wanted clear descriptions of any essential technical information and favored simple, clear graphics to convey critical storm information. Residential participants prioritized information on how to respond over lengthy meteorological descriptions. To the extent feasible, information clarifying the local areas of impact is desired. When warranted, personal appeals about the extent of the risk may be effective in distinguishing extraordinary events with impacts that are anticipated to be unusually severe.

Locality mattered—both in terms of having information specific for a locale and in having that information come from a local, known source. While participants identified NOAA as a trusted source of information and appreciated the briefings as a concise source of NOAA data, they also indicated a desire to receive information from local municipal officials and emergency managers in order to be certain that storm impacts were locally relevant. Having municipal emergency managers distribute the briefings to residents (via social media, e-mail lists, or website postings) may be a mechanism for helping residents to understand the local applicability of the briefing information and reinforce the importance of the information.

Last, briefings must be disseminated at the right time and in the right quantity and frequency. As noted, residential participants emphasized a need for briefings four to five days in advance, in order to plan their preparations. Emergency managers desired as much lead time as possible, as much as seven days or more. While the participants did not establish a firm threshold for what qualifies as an event worthy of an emergency briefing, they did acknowledge that issuing too many briefings in response to routine threats would diminish the likelihood that they would consult the briefings. A suitable frequency with which to issue weather hazard briefings needs to be determined. Although this may emerge in time through the continuing evolution of the NWS service model as described by the Weather-Ready Nation (WRN) initiative (<http://www.nws.noaa.gov/com/weatherreadynation/about.html>), it requires explicit attention, particularly as the timing will likely vary with characteristics of impending events.

Findings of this study suggest that the products discussed here have utility for providing important information about impending severe weather. Yet, the findings also indicate that the products are often unknown, not fully understood, or both. The revisions that resulted from the focus group sessions, undertaken in consultation with NWS partners, were reported by residents to be influential in motivating action. In addition, the timing at which they are issued makes a

difference to both residents and emergency managers with respect to their ability to take appropriate preparatory actions. Given the experiences of the participants in the focus groups (both residents and emergency managers), the revised products, including those that were included in the full scenarios but not discussed here, should be tested in different locations and different circumstances to evaluate their anticipated impact on motivating action.

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REFERENCES

- Department of Commerce, 2016: FY 2016 annual performance plan/FY 2014 annual performance report. 63 pp. [Available online at <http://www.osec.doc.gov/bmi/budget/FY16APPRs/DOC%20APPR.pdf>.]
- Dillon, R. L., C. H. Tinsley, and M. Cronin, 2011: Why near-miss events can decrease an individual's protective responses to hurricanes. *Risk Anal.*, **31**, 440–449, doi:10.1111/j.1539-6924.2010.01506.x.
- Fjord, L., 2007: Disasters, race, and disability: [Un]seen through the political lens on Katrina. *J. Race Policy*, **3**, 46–66.
- Laska, S., and B. H. Morrow, 2006: Social vulnerabilities and Hurricane Katrina: An unnatural disaster in New Orleans. *Mar. Technol. Soc. J.*, **40**, 16–26, doi:10.4031/002533206787353123.
- Meyer, R. J., E. J. Baker, K. Broad, J. Czajkowski, and B. Orlove, 2014: The dynamics of hurricane risk perception: Real-time evidence from the 2012 Atlantic Hurricane season. *Bull. Amer. Meteor. Soc.*, **95**, 1389–1404, doi:10.1175/BAMS-D-12-00218.1.
- Mileti, D. S., and J. H. Sorenson, 1990: Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. Oak Ridge National Laboratory Rep. ORNL-6609, 145 pp. [Available online at http://www.cires.org.mx/docs_info/CIRES_003.pdf.]
- Morrow, B. H., J. K. Lazo, J. Rhome, and J. Feyen, 2015: Improving storm surge risk communication: Stakeholder perspectives. *Bull. Amer. Meteor. Soc.*, **96**, 35–48, doi:10.1175/BAMS-D-13-00197.1.
- Parker, D. J., and J. W. Handmer, 1998: The role of unofficial flood warning systems. *J. Contingencies Crisis Manage.*, **6**, 45–60, doi:10.1111/1468-5973.00067.
- Perry, R. W., M. K. Lindell, and M. R. Greene, 1981: *Evacuation Planning in Emergency Management*. Battelle Human Affairs Research Centers Series, Lexington Books, 199 pp.
- QRS International, 2012: NVivo qualitative data analysis software, version 10. QSR International Pty Ltd.
- Renne, J., T. Sanchez, P. Jenkins, and R. Peterson, 2009: Challenge of evacuating the carless in five major U.S. cities: Identifying the key issues. *Transp. Res. Rec.*, **2119**, 36–44, doi:10.3141/2119-05.
- Richards, L., 1999: *Using NVivo in Qualitative Research*. Advances in Experimental Medicine and Biology, Sage Publications, 240 pp.
- Sharma, U., and A. Patt, 2012: Disaster warning response: The effects of different types of personal experience. *Nat. Hazards*, **60**, 409–423, doi:10.1007/s11069-011-0023-2.
- Tobin, G. A., and B. E. Montz, 1997: *Natural Hazards: Explanation and Integration*. Guilford Press, 388 pp.
- Tufte, E. R., 2001: *The Visual Display of Quantitative Information*. 2nd ed. Graphics Press, 197 pp.
- Zaalberg, R., C. Midden, A. Meijnders, and T. McCalley, 2009: Prevention, adaptation, and threat denial: Flooding experiences in the Netherlands. *Risk Anal.*, **29**, 1759–1778, doi:10.1111/j.1539-6924.2009.01316.x.