Survey of Coastal Emergency Managers Perspectives on NWS Storm Surge Information: Hurricane Forecast Improvement Program/Storm Surge Roadmap

January, 2013

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National Center for Atmospheric Research  
P. O. Box 3000  
Boulder, Colorado  80307-3000  
ISSN Print Edition 2153-2397  
ISSN Electronic Edition 2153-2400
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NCAR/TN-495+STR  
NCAR Technical Note  
Published By: NCAR Library  
January, 2013
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HURRICANE FORECAST IMPROVEMENT PROGRAM/ STORM SURGE ROADMAP

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January 31, 2013
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Special thanks to Jesse Feyen, Jamie Rhome, Jennifer Sprague, Keelin Kuipers, Mary Erikson, Julie Demuth, Crystal Burghardt, Jennifer Boehnert, Taylor Trogdon, and Christina Thomas for their assistance with this research, analysis, and report. We thank Walt Zaleski for supplying contact information for emergency managers for the survey. We thank the Coastal Services Center’s Coastal Storms Program for their support. We also thank the numerous others who contributed to Storm Surge team conference calls and the respondents and participants in our research. This work was carried out in part with funding under award numbers NA06OAR4310119 and NA06NWS4670013 from the U.S. National Oceanic and Atmospheric Administration, U.S. Department of Commerce.
EXECUTIVE SUMMARY

Purpose

Storm surge is the abnormal rise in sea level accompanying a tropical or extratropical cyclone. The serious threat to life and property posed by storm surge suggests that this threat should be specifically communicated to members of the public so that they can make better proactive and protective decisions. The National Weather Service (NWS) issues a wide array of text and graphical products to communicate the forecasted conditions associated with storm surge. During tropical cyclone situations, the National Hurricane Center (NHC) issues a suite of text and graphical products to communicate the forecast conditions from threatening tropical cyclones. During extratropical cyclones and other weather events resulting in storm surge, such as high astronomical tides, Weather Forecast Offices (WFOs) issue Hurricane Local Statements, Coastal Flood Advisories, Watches, and Warnings, which include detailed, localized information on expected storm surge.

The National Oceanic and Atmospheric Administration/National Ocean Service (NOAA/NOS)-funded project “Assessing Current Storm Surge Information from the Public Perspective” defined two objectives:

1. To explore and assess the public’s awareness and understanding, or lack thereof, concerning storm surge and currently available storm surge information, regardless of the meteorological cause; i.e., “Do they know what storm surge is?”
2. To assess whether the NWS should develop new storm surge informational approaches to improve the communication and decision-making with respect to extratropical and tropical cyclone storm surge risk.

As part of that project, we leveraged resources from the NOAA-funded project “Hurricane Forecast Improvement Project (HFIP) Socio-Economic Impacts Assessment” (HFIP-SEIA) to survey emergency managers’ (EMs’) perspectives on storm surge information. The EM portion of the HFIP-SEIA was designed to assess EMs’ potential need for, uses of, and value for changes
in forecast information that may result from the HFIP effort which allowed for extending the work to assess EM storm surge information perspectives.

**Survey Development, Implementation, and Sample**

Questions for the survey were developed in consultation with the NOAA staff involved in both the Storm Surge Roadmap and HFIP. This work built on prior surveys on the public’s preferences for hurricane information, interviews with stakeholders including emergency managers in hurricane vulnerable areas, and a review of the literature on storm surge communication.

The target population was directors of emergency management programs in counties or parishes that border the coast from North Carolina to Texas, as well as Hawaii and the U.S. Virgin Islands; 114 total contacts were made. The online survey was completed between May and August 2011, with 53 usable responses representing 52 different jurisdictions at a 45.3% completion rate. Using 2010 Census data, the total population of the counties and parishes represented by the emergency managers (EMs) completing the survey was 12,886,649, or 51.4% of the total population (25,053,943) of the 114 counties and parishes or jurisdictions contacted.

Most of the EMs who responded have extensive experience in emergency management. All but two have initiated their response plans for at least one tropical cyclone in the last 10 years. In fact, they average 4.2 activations in the last 10 years. They are well seasoned in hurricane response.

**Results**

EMs listed their major concerns with respect to hurricanes to be storm surge, evacuation issues, then wind and inland flooding. The EMs also deal with uncertainty with respect to surge impacts in their area as new data or models become available. Many of their concerns had to do with a lack of public awareness of storm threats. A number also mentioned special needs or vulnerable populations as a major concern, including disabled, tourists, mobile home residents, nursing home residents, and the elderly. Many of the EMs feel their public does not have an adequate understanding of either surge or the impacts that a small surge implies. Although many feel their
public is well educated about surge, they worry as well about the public being complacent if there hasn’t been a recent event.

And 95% of these coastal emergency managers rate the surge risk in their coastal areas as either above average or extremely high. When asked what portion of the land mass of their jurisdiction was at risk from storm surge, none reported less than one-quarter, and 17% said their entire area was subject to surge.

Coastal areas also tend to be major population areas. When asked what percentage of the population in their jurisdiction is vulnerable to storm surge, in every jurisdiction at least one-quarter of the population was subject to storm surge and in 19% of the cases, the entire population was at risk. Across the sample, EMs indicated that about 52% of the population is vulnerable to storm surge. In every jurisdiction except one, at least one-quarter of the population lived in an official evacuation zone and in 17% of the cases the entire population did. Extrapolating to the population of the 114 counties from the 2010 Census suggests that more than 23 million people are at some risk from cyclone hazards. By these calculations, more than 13 million are at risk from storm surge.

**Storm Surge Forecast Communication**

Respondents were reminded that storm surge information has been removed from the Saffir-Simpson wind scale, and they were then asked the extent to which they agreed with three alternatives on how to communicate storm surge to the public: (1) as information separate from the hurricane wind warning, (2) as a separate storm surge watch, and (3) as a separate storm surge warning (see Figure ES-1). Of the respondents, 76% agree completely that storm surge should be communicated separately, 60% agree completely with issuing a separate storm surge watch, and 68% agree completely with issuing a separate storm surge warning. Overall, these results imply strong positive support from EMs to develop and disseminate storm surge information above and beyond that provided with current hurricane warning products.

Respondents were asked, “If a storm surge watch were to be developed, at what minimum depth of storm surge do you feel it should be issued?” Although 11% thought it should not be issued at all, almost half thought it should be issued at 2 feet or less above ground level and another 30%
felt it should be issued at up to 5 feet above ground level; 79% feel it should be provided at 5 feet or less.

With respect to the format of surge information presentation, support is highest for maps, closely followed by graphics and pictures. Although still considered extremely or somewhat useful by 74% of the EMs, text rated lower than other modes. The significant degree to which each modality is considered useful, however, points to the importance of diverse communication strategies. All of the content considered for communicating storm surge is viewed as useful, with feet above sea level rating lower than other content. Expressing surge as feet above ground level is preferred over sea level.

Some EMs indicated concerns about the ability of forecasters to reliably provide the information desired at the necessary spatial and temporal scales they need for their decision making. Some also voiced concerns regarding the timing of forecasts. Specifically, there was strong concern that they are not getting the surge forecasts before they have to make evacuation decisions.

**Summary**

The respondent EMs are located in areas that are highly vulnerable to hurricane hazards, particularly to storm surge, from North Carolina to Texas, and including Hawaii. These emergency managers:

- Have high levels of concern about the safety of their citizenry, and
Coastal Emergency Manager Survey

- Believe there is a serious lack of understanding of storm surge.

Three-fourths of these EMs think storm surge information should be provided separately from hurricane wind information (i.e., current hurricane warnings). Although most support the issuance of separate surge watches and warnings, support is highest for the latter.

About half of the respondents felt that a surge watch should be issued for 2 feet or less—virtually all the time—with another third saying at something less than 7 feet. Nearly all thought stating surge levels as feet above ground level would be useful. However, about two-thirds also thought stating it in terms of sea level would also be useful. There were, however, a few vocal dissents to changes in the current information approaches.

In summary, the opinions of these EMs indicate that there is a great deal of concern about the surge threat among coastal emergency managers. They support the separation of surge from the Saffir-Simpson scale as well as new ways to convey the potential danger to the public, including the issuance of separate surge watches and warnings, and the expression of surge using feet above ground level. In general, the responding EMs indicated that they would like earlier surge forecasts and more graphics and visual materials to use in their communication with the public.
1. BACKGROUND

Storm surge is defined as an abnormal rise in sea level accompanying a tropical or extratropical cyclone (http://www.nhc.noaa.gov/surge/). The National Weather Service (NWS) currently issues a wide array of text and graphical products to communicate the forecasted conditions associated with storm surge. Although many people associate storm surge only with tropical cyclones, storm surge also occurs from extratropical cyclones. Storm surge is part of “storm tide” as an addition to normal tide levels (Fig. 1). Assessment of needs for storm surge communication must be comprehensive and address storm surge regardless of the meteorological causes.

![Fig. 1-1. Storm surge](http://www.nhc.noaa.gov/surge/)

During tropical cyclone situations, the National Hurricane Center (NHC) issues a suite of text and graphical products to communicate the forecasted conditions from threatening tropical cyclones (TCs). For the purpose of this discussion, TCs include subtropical cyclones, another class of cyclones. These products include information about the position, movement, and characteristics of the TC as well as the threat it poses. The public advisory, forecast discussion, and probabilistic storm surge products include detailed information about the storm surge threat, but this information is combined with all the other TC forecast information. Moreover, the TC
Watches and Warnings issued by NHC currently are based on wind speed criteria only (i.e., for tropical storm- and hurricane-force wind speeds). During tropical cyclone situations, local NWS Weather Forecast Offices (WFOs) also issue detailed Hurricane Local Statements, which include localized information on expected storm surges. Many of these WFOs are also issuing experimental TC Impacts Graphics, which include a graphic detailing expected storm surge impacts. During some TC situations, storm surge can occur at coastal locations outside of the areas covered by NHC-issued TC Watches and Warnings. In these situations, local NWS WFOs issue Coastal Flood Advisories, Watches, and Warnings, which include detailed, localized information on expected storm surge.

During extratropical cyclones (ET) and other weather events resulting in storm surge, such as high astronomical tides, WFOs again issue Coastal Flood Advisories, Watches, and Warnings with detailed, localized information on expected storm surge such as the combinations of onshore winds with high astronomical tides.

The serious threat to life and property posed by storm surge suggests that this threat should be specifically communicated to members of the public so that people can make better proactive and protective decisions. It is important to assess whether the creation of new information approaches specific to storm surge, such as a storm surge warning product, is needed to improve decision making and help to further protect life and property. Ultimately, assessment of storm surge information needs should be directed to members of the general public, emergency managers, and media across coastal areas of the United States and its territories, to include the U.S. Atlantic, Gulf and West coasts; Alaska; the Hawaiian Islands; and U.S. territories in the Pacific Ocean. The current report focuses on research with EMs in TC vulnerable locales. Other associated work is under way with the public, EMs, and broadcasters in TC and ET areas and will reported subsequently.

The National Oceanic and Atmospheric Administration/National Ocean Service (NOAA/NOS)-funded project “Assessing Current Storm Surge Information from the Public Perspective” defined two objectives:
Coastal Emergency Manager Survey

1. To explore and assess the public’s awareness and understanding, or lack thereof, concerning storm surge and currently available storm surge information, regardless of the meteorological cause; i.e., “Do they know what storm surge is?”

2. To assess whether the NWS should develop new storm surge informational approaches to improve the communication and decision-making with respect to extratropical and tropical cyclone storm surge risk.

As part of that project, we leveraged resources from the NOAA-funded project “Hurricane Forecast Improvement Project (HFIP) Socio-Economic Impacts Assessment” (HFIP-SEIA) to survey emergency managers’ (EMs’) perspectives on storm surge information. The EM portion of the HFIP-SEIA was designed to assess EMs’ potential need for, uses of, and value for changes in forecast information that may result from the HFIP effort which allowed for extending the work to assess EM storm surge information perspectives.
2. METHODS

NOAA’s Storm Surge Roadmap is intended to improve the accuracy and communication of storm water levels. One of the tasks associated with the first phase of this multiple-year project is to understand how current surge forecasts are received and used by public and private decision-makers. To this end, relevant storm surge questions were added to the Coastal Emergency Managers Online Survey that had already been planned in support of HFIP.

2.1 Survey Development
Questions for this survey were developed in consultation with the NOAA staff involved in both Storm Surge Roadmap and HFIP. This work built on prior surveys on the public’s preferences for hurricane information (Lazo and Waldman 2011; Lazo et al. 2010), interviews with stakeholders (including EMs) in hurricane vulnerable areas,¹ and a review of the literature on storm surge communication.² The survey was programmed for online implementation by ResearchExec and pilot tested. The final survey consisted of 41 questions, including demographics. (Appendix B includes the complete questionnaire and summary response data.)

2.2 Sample
The target population was directors of emergency management programs in counties or parishes that border the coast from North Carolina to Texas, as well as Hawaii and the U.S. Virgin Islands; 114 total contacts were made. Electronic mail addresses were obtained through directories, phone calls, and websites. An introductory letter was emailed to each address from Jeff Lazo at the National Center for Atmospheric Research (see Appendix A). ResearchExec then sent an email with details for participation. Many initial contacts bounced because of either incorrect email addresses or changes in emergency managers. Phone calls were made to obtain corrections.

2.3 Survey Implementation and Respondents’ Jurisdictions and Characteristics
The survey was designed to provide a better understanding of the hurricane or cyclone-related concerns of coastal emergency managers and how they use NWS forecast products in protective decision-making. To provide review of both text and graphic products, the survey respondents

¹ A separate report is forthcoming on the stakeholders’ interviews.
² A separate report is forthcoming on the on the literature review.
Coastal Emergency Manager Survey

needed to view product examples as they answered the questions. Therefore, this was an online survey administered by ResearchExec.

The survey was completed in two phases between May and August 2011. The first one yielded 37 responses, including two duplicates. The second phase resulted in 18 more completions, for a total of 53 usable responses representing different 52 jurisdictions (one survey was completed by a regional director.) Given that 114 jurisdictions were included in the target population, this resulted in a 45.3% completion rate. Table 2-1 shows the completion rate by state and territory.

<table>
<thead>
<tr>
<th>State</th>
<th>Number of invitations</th>
<th>Number of completes</th>
<th>Completion rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>2</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Florida</td>
<td>36</td>
<td>18</td>
<td>50</td>
</tr>
<tr>
<td>Georgia</td>
<td>6</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Hawaii</td>
<td>3</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Louisiana</td>
<td>19</td>
<td>10</td>
<td>53</td>
</tr>
<tr>
<td>Mississippi</td>
<td>3</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>North Carolina</td>
<td>17</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>South Carolina</td>
<td>6</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>Texas*</td>
<td>24</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>US Virgin Islands</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>117</td>
<td>53</td>
<td>45.3</td>
</tr>
</tbody>
</table>

*Includes one regional emergency management director, one city emergency manager, and one local emergency manager (subcounty).

Using 2010 Census data, the total population of the counties and parishes represented by the emergency managers completing the survey was 12,886,649, or 51.4% of the total population (25,053,943) of the 114 jurisdictions contacted.

Questions on this survey required considerable thought. The elapsed time between starting the survey and finishing it ranged from 13 minutes to more than 23 hours – based on start and end times and dates, it appears that three respondents started the survey on one day and completed the following day. Clearly, many EMs worked on it when they had time between other activities. It is indicative of the importance they placed on the topic that they were so diligent in completing the survey. The median time spent on the survey was 44 minutes. The map in Figure 2-2 depicts the jurisdictional locations of the coastal EMs who were contacted. Surveys were
completed in the counties or parishes depicted as blue. Nonresponse jurisdictions are shown in red.

Although not a random sample, the distribution gives no evidence of systematic geographical differences between those who responded and those who did not. There also did not seem to be a difference in size of jurisdiction with respect to respondents and nonrespondents.

The population size of the jurisdictions of these EMs varied from 4,000 to 4,000,000. The organization of emergency management programs varies a great deal across counties, parishes, and states. In some cases EMs report to county administrators or commissioners, in others to parish presidents, county judges, sheriffs, and public safety directors. Although they have a variety of titles, 49 of 53 respondents are in charge of the emergency management operations in their counties or parishes.

Most of the respondents have extensive experience in emergency management. As illustrated in Figure 2-3, 32% have been working in the field of emergency management for more than 25 years. The average time spent in their current position is more than 12 years.
We searched for other references regarding experience levels of U.S. EMs with very limited results. In one random survey of EMs, participants reported these experience levels: < 10 years, 29%; > 25 years, 18% (Grist 2007). In a recent survey conducted by the National Emergency Management Association, 43% had been working in emergency management 11 years or less and 21% had been in the field for 25 years or more. It would appear that the EMs in our sample might be more experienced than average.

All but two of these EMs have initiated their response plans for at least one tropical storms or cyclone in the last 10 years. In fact, they average 4.2 activations in the last 10 years. They are well seasoned in hurricane response.

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3 Email from Beverly Bell, Senior Policy Analysis, National Emergency Management Association. 10/12/11.
3. RESULTS

3.1 Emergency Manager’s Concerns

Before focusing on storm surge, an open-ended question (Q3) asked the EMs to list their major concerns when a hurricane threatened their jurisdiction. Storm surge was mentioned most often (28 of the 53 respondents), followed by evacuation issues, wind, and inland flooding. Evacuation issues included timing, compliance, and sheltering. Many respondents noted concerns with respect to citizens who do not evacuate when they should. It seems possible that better communication of storm surge hazards could facilitate better evacuation compliance, since evacuations are based upon the storm surge threat. Some statements were:

“Getting citizens to evacuate from surge vulnerable areas…Cat 5 could put storm surge in over 200,000 homes.”

“Storm surge, evacuation compliance, complacency.”

“A large enough storm …would produce a storm surge that could inundate thousands of homes and injure or kill many residents.”

In a later open-ended question (Q15) they were asked if they had any “special concerns with respect to people or areas in your jurisdiction at risk from storm surge.” Some of their concerns had to do with a lack of public awareness.

“Citizens do not adequately understand the risks of surge.”

“They understand that there is a risk but often fail to understand the speed in which a storm surge can strike.”

“…they don’t comprehend their vulnerability to the amount of water that is possible, or the power of that water.”

“Lack of public understanding that surge may impact pre-landfall and reduce or eliminate the ability to evacuate. Lack of understanding and appreciation for the power/weight of

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4 We have not undertaken formal coding of open-ended response, but made every effort to present representative responses and other responses that proved of specific interest.
the water and how it might impact the structural integrity of shelters (homes). Lack of understanding and appreciation for the power/weight of water-driven debris.”

Clearly, the EMs in this sample understand the heavy responsibility they bear to protect their constituencies from hurricane hazards, particularly surge. Their use of, and opinions about, NWS hurricane products related to storm surge should thus provide valuable information to inform the Surge Roadmap Project. A significant number of the EMs also clearly perceive that their citizens do not have an adequate understanding of the threat of storm surge.

The EMs also deal with uncertainty with respect to surge impacts in their area as new data or models become available:

“The newest SLOSH, with the large storm, resulted in additional evacuation areas inland that we don't yet have a way to evaluate....is it 2 inches of surge in the worst of the worst of the worst case scenarios, or is it 2 feet. Our evacuation population is already huge, we do not need to be over-evacuating when the worst possible scenario would result in 2 inches of surge inland.”

Several also mentioned special needs or vulnerable populations as a major concern, including the disabled, tourists, mobile home residents, nursing homes, and the elderly (Lazrus et al. 2012).

In a related question (Q16), we asked, “What do you think your public understands about its storm surge risk?” EM perceptions of their publics will influence how they provide information and what actions they take during an emergency given how they think the public will react.

“I believe they have a vague understanding of the risk. But do they understand the details of what could happen, I would say no.”

“20% understand all risk. 50% of the population understands but sometimes has a difficult time visualizing the risk and damage. 20% don't understand. 10% don't care.”

“Most are educated on the risk associated with storm surge. This office frequently hosts meetings to ensure the public.”
As these quotes suggest, many of the EMs feel their public does not have either an adequate understanding of surge or of the impacts that a small surge implies. Although many believe their public is well educated about surge, they worry about the public being complacent if there hasn’t been a recent event.

3.2 Vulnerability to Surge
Several survey questions delved into how the EMs perceive the vulnerability of their communities. They were asked to “describe your jurisdiction’s risk from surge in each of the following areas: coastal areas, major population areas, major evacuation routes, and inland areas.” The results are reported in Table 3-1.

<table>
<thead>
<tr>
<th>Area</th>
<th>Extremely high (%)</th>
<th>Above average (%)</th>
<th>Average (%)</th>
<th>Below average (%)</th>
<th>Extremely low (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal areas</td>
<td>76</td>
<td>19</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Major population areas</td>
<td>28</td>
<td>30</td>
<td>30</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Evacuation routes</td>
<td>34</td>
<td>28</td>
<td>21</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Inland areas</td>
<td>17</td>
<td>23</td>
<td>32</td>
<td>17</td>
<td>1</td>
</tr>
</tbody>
</table>

The rows in all tables in this report may not add up to 100% because of rounding errors.
Note: n=53 for all tables, graphics, and statistics unless otherwise indicated.

No surprise, 95% of these coastal EMs rate the surge risk in their coastal areas as either above average or extremely high. When asked what portion of the land mass of their jurisdiction was at risk from storm surge, none reported less than one-quarter, and 17% said their entire area was subject to surge.

Coastal areas also tend to be major population areas. When asked what percentage of the population in their jurisdiction is vulnerable to storm surge, in every jurisdiction EMs estimated that at least one-quarter of the population was subject to storm surge; in 19% of the jurisdictions, the entire population was at risk. They were also asked what portion lives in official storm surge zones. As expected, the results were nearly identical – across the 52 jurisdictions, an average of 54% of the population was indicated as living in storm surge zones versus 52% are stated to be vulnerable to storm surge. In every jurisdiction except one, at least one-quarter of the population lived in an official evacuation zone and in 17% of the jurisdictions, the entire population did.
Table 3-2 shows the average percentage of population that the EMs perceived to be at risk from TC hazards. This is extrapolated to the population of the 114 counties from the 2010 census to suggest that more than 23 million people are at some risk from cyclone hazards. By these calculations, more than 13 million are at risk from storm surge. Based on the respondents stated percentages of population vulnerable to surge multiplied by their jurisdictions’ population and then averaged across the whole sample, a somewhat smaller portion of the total population is calculated to be at risk—about 40%. This implies that a larger percentage are at risk in smaller communities than in larger communities, which would be expected if smaller communities are located closer to the shore whereas larger cities may have a significant portion of their population farther from the coast.

It is clear that these EMs have serious responsibilities related to protecting their citizens from the storm surge associated with hurricanes.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Average percent perceived to be at risk</th>
<th>At risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>93.4</td>
<td>23,399,437</td>
</tr>
<tr>
<td>Inland flooding</td>
<td>45.1</td>
<td>11,298,837</td>
</tr>
<tr>
<td>Tornado</td>
<td>90.7</td>
<td>22,720,488</td>
</tr>
<tr>
<td>Surge</td>
<td>52.4</td>
<td>13,117,866</td>
</tr>
</tbody>
</table>

### 3.3 Storm Surge Forecast Communication

The next section of the survey dealt with specific issues related to the communication of storm surge forecasts.

#### 3.3.1 How To Express Surge Information

The EM respondents were reminded that storm surge information has been removed from the Saffir-Simpson wind scale. They were then asked (Q17) the extent to which they agreed with three alternatives on how to communicate storm surge to the public: (1) as information separate from the hurricane wind warning, (2) as a separate storm surge watch, and (3) as a separate storm surge warning. As shown in the Figures 3-1, 3-2, and 3-3, 76% agree completely that storm surge should be communicated separately, 60% agree completely with issuing a separate storm surge watch and 68% agree completely with issuing a separate storm surge warning.
Overall, these results imply strong positive support from EMs to develop and disseminate storm surge information above and beyond that given with current hurricane warning products.

Fig. 3-1. Communicate surge separate from wind information

Fig. 3-2. Issue separate storm surge watch
In the subsequent question, Q18, respondents were asked, “If a storm surge watch were to be developed, at what minimum depth of storm surge do you feel it should be issued?”
Figure 3-4 illustrates that, although 11% thought a watch should not be issued at all, almost half thought it should be issued at 2 feet or less above ground level (phrased in the survey as “up to 2 feet), and another 30% felt it should be issued at up to 5 feet above ground level; 79% believed it should be issued at 5 feet or less. In our 2010 survey of the general public, responses to a parallel question revealed that 57% of the public believed that a surge warning should be issued at 5 feet or less.\textsuperscript{5} The difference between EMs’ and the public’s preferences for a storm surge warning likely corresponds with differences in perception of the physical threat associated with these surge levels. It may be important to supply the public with additional information on the meaning and impacts of different depths of storm surge that might be provided in future surge warnings to prompt the behavioral responses that EMs desire.

### 3.3.2 Options for Receiving Surge Information

The next set of questions (Q19) asked, “How useful in your decision making would each of the following options be for receiving information about a potential storm surge threat?” The options covered two areas: mode presentation:

- Text explanations of potential depths of storm surge
- Graphics and pictures showing potential storm surge damage
- Information on the Internet about storm surge forecasts
- Maps showing where storm surge flooding could occur

and information content:

- Statements of the probability of different depths of storm surge
- Expected surge depth explained in terms of feet above ground level
- Expected surge depth explained in terms of feet above sea level
- Storm surge watch and warning separate from hurricane warnings.

The extent to which each option was felt to be useful is presented in Tables 3-3 and 3-4.

\textsuperscript{5} Report forthcoming on public survey.
<table>
<thead>
<tr>
<th>Option</th>
<th>Extremely useful</th>
<th>Very useful</th>
<th>Somewhat useful</th>
<th>Not very useful</th>
<th>Not at all useful</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maps</td>
<td>76%</td>
<td>19%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Graphics and pictures</td>
<td>68%</td>
<td>19%</td>
<td>6%</td>
<td>2%</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>Internet</td>
<td>49%</td>
<td>23%</td>
<td>23%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Text</td>
<td>44%</td>
<td>30%</td>
<td>15%</td>
<td>6%</td>
<td>2%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Support is highest for maps, closely followed by graphics and pictures. Although still considered extremely or somewhat useful by 74% of the EMs, text rated lower than other modes. The significant degree to which each modality is considered useful, however, points to the importance of diverse communication strategies.

<table>
<thead>
<tr>
<th>Option</th>
<th>Extremely useful</th>
<th>Very useful</th>
<th>Somewhat useful</th>
<th>Not very useful</th>
<th>Not at all useful</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of different depths</td>
<td>47%</td>
<td>36%</td>
<td>13%</td>
<td>0%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Feet above ground level</td>
<td>64%</td>
<td>26%</td>
<td>4%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Feet above sea level</td>
<td>44%</td>
<td>21%</td>
<td>23%</td>
<td>11%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Separate surge watch and warning</td>
<td>57%</td>
<td>21%</td>
<td>9%</td>
<td>8%</td>
<td>6%</td>
<td>0%</td>
</tr>
</tbody>
</table>

All of the content considered for communicating storm surge is considered useful, with feet above sea level rating lower that the other content. Expressing surge as feet above ground level is preferred over sea level. On a scale of 1 to 5 with 1 being “Not At All Useful” and 5 being “Extremely Useful”, the mean ratings for “feet above ground level” and “feet above sea level” were 4.5 and 3.9, respectively. Based on a simple t-test, feet above ground level is considered significantly more useful than feet above sea level ($t = 2.61$, $pr. = 0.118$, $d.f. = 52$). Similar to previous findings, there is strong support for the issuance of storm surge watches and warnings (88% indicating that this would be very or extremely useful).

They were also given the opportunity to express any additional thoughts about the communication of storm surge risks. It is important to note that although there was strong
support for new storm surge information approaches, several dissents or specific concerns were voiced.

“Surge maps are sufficient as the current science is not specific enough to depict how much water will be in any given location by street.”

“Do not confuse the public with another set of watches and warnings for surge … could lead people to play meteorologist and decide how to respond appropriately based on one or the other.”

“I completely disagree with the concept of expressing water over ground elevations. It is unrealistic to believe that there would be a map that could predict this unless they have something that they have not shown us…I feel it will lead people to false hope and potentially cost lives.”

This suggests that some EMs have concerns about the ability of forecasters to reliably provide the information desired at the necessary spatial and temporal scales they need for their decision making. Several called for specific ways of showing storm surge and its potential effects.

“Graphical explanations are always better than tables. Localized overhead photo maps are always better than topo maps. Get interactive educational tools in the hands of children in elementary school so they can educate their families.”

“[We need] tools or products (pictures, animation) that model depth along the coast line and which contain recognizable landmarks.”

“Consider providing educational materials describing the different levels of potential impact/damage based on structure type, i.e., a 2-foot surge may have the potential to create significant damage to a ground level mobile home, minimal damage to a wood structure, no damage to a masonry structure or structure built on stilts.”

### 3.3.3 Timing of Forecasts

Numerous comments were made throughout the survey about the timing of forecasts, including:
Coastal Emergency Manager Survey

“Releasing storm surge forecasts 2 days before landfall is practically useless. Evacuations would have been initiated by that time. There are private services out there that are already providing this information. The NWS doesn’t seem to recognize the reality of modern day 24 hour a day media coverage of these events.”

“The NWS needs to issue storm surge predictions way earlier. I think they are afraid they will be wrong, but by the time they issue the official forecast, it is largely irrelevant.”

There appear to be some serious concerns regarding the timing of forecasts. Specifically, there was strong concern that they are not getting the surge forecasts before they have to make evacuation decisions.
4. SUMMARY

This project resulted in highly relevant information from a sample of coastal EMs who are highly experienced in terms of both tenure in emergency management and experience in hurricane response. They are located in areas that are highly vulnerable to hurricane hazards, particularly to storm surge, from North Carolina to Texas, and including Hawaii. These EMs:

- Have high levels of concern about the safety of their citizenry, and
- Believe there is a serious lack of understanding of storm surge.

Three-fourths of these EMs think storm surge information should be issued separately from hurricane wind information (i.e., current hurricane warnings). Although most support separate surge watches and warnings, support is highest for the latter. When they were grouped together in a subsequent question, however, 78% were in favor of their issuance.

About half of the respondents felt that a surge watch should be issued for 2 feet or less—virtually all the time—with another third saying at something less than 7 feet. Nearly all thought stating surge levels as feet above ground level would be useful. About two-thirds, however, also thought stating it in terms of sea level would also be useful. But there were a few vocal dissents to these changes.

In summary, the opinions of these EMs indicate that there is a great deal of concern about the surge threat among coastal EMs. They support the separation of surge from the Saffir-Simpson scale as well as new ways to convey the potential danger to the public, including the issuance of separate surge watches and warnings, and the expression of surge using feet above ground level. In general, the respondent EMs indicated that they would like earlier surge forecasts and more graphics and visual materials to use in their communication with the public.
REFERENCES


Appendix A. Introductory Letter Emailed to Emergency Managers

April 26, 2011

Dear Selected Emergency Manager:

You will soon receive an email inviting you to participate in a very important survey about your use of hurricane warnings and forecasts and about storm surge information. This research may be used to provide guidance to NOAA and the National Weather Service on the Hurricane Forecast Improvement Program and the Surge Roadmap Project.

The survey is being conducted to inform these National Weather Service projects on how emergency managers use hurricane forecast information in decision making and what preferences they have for that information.

You have been chosen to be included in a select sample of county or parish emergency management directors/coordinators from Hawaii, the US Virgin Islands and the continental US coastline from North Carolina to Texas.

In this Internet-based survey you will be asked to provide information about how you receive, use and evaluate current hurricane forecast products. You will also be shown examples and asked to assess the relative importance of several new or proposed initiatives such as the Hazards Impact Graphic.

The survey should take you about 25 minutes to complete. Completing this survey is voluntary. The information you provide us that can be identified with you will remain confidential. We will analyze your responses together with all other respondents, so please respond as honestly as you can.

While this is an opportunity for your voice to be heard, all of your responses will remain confidential.

The project is directed by Dr. Jeff Lazo (National Corporation for Atmospheric Research) and Dr. Betty Morrow (SocResearch Miami). The Internet survey will be administered by ResearchExec, a professional Internet survey administration company.

Please watch for a future email from us explaining how you will log in to complete the survey.

Do not hesitate to call or email Jeff (303-497-2857 – lazo@ucar.edu) or Betty (305-385-5953 betty@bmorrow.com) if you have questions or concerns.

Jeffrey K. Lazo
lazo@ucar.edu
Appendix B. Survey Codebook (Not Including Open-Ended Responses)
Hurricane Forecast Improvement Socio-Economic Impacts Assessment and Storm Surge Projects
Coastal Emergency Managers Survey
To be implemented: May 2011

INTRODUCTION

Important information about this survey. Please read!

This survey is being conducted to inform two National Weather Service (NWS) projects – the Hurricane Forecast Improvement Project and the Storm Surge Study.

YOU HAVE BEEN CHOSEN AS PART OF THE EMERGENCY MANAGEMENT SAMPLE AND YOUR RESPONSES ARE VERY IMPORTANT. We are interested in 1) how you use hurricane forecast information in your decision making; and 2) your preferences for that information.

The survey should take you about 25 minutes to complete. Your responses will remain confidential. We will analyze your responses together with all other respondents, thus preserving confidentiality, so please respond as honestly as you can.

If you don’t know an answer, please indicate “Don’t Know”.

Completing this survey is voluntary. By clicking on the “Agree and Continue” button below you are indicating that you have read this and agree to participate in this survey.

If you do not want to continue, please click that you “Do Not Wish to Continue” and you will be exited from the survey.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY!

[“Agree and continue” button – required to click on this to continue – if not, they will exit the survey. “Exit” button will take them to a Thank You screen and end data collection]
Coastal Emergency Manager Survey

HURRICANE EXPERIENCE AND CONCERNS
1.) Has your jurisdiction initiated response plans anytime in the last 10 years (2001-2010) in reaction to a tropical storm or hurricane threat?

<table>
<thead>
<tr>
<th>Q1</th>
<th>Yes</th>
<th>No</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>n</th>
<th># missing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51</td>
<td>1</td>
<td>1</td>
<td>1.02</td>
<td>1</td>
<td>0.20</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>96.2%</td>
<td>1.9%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.) Please provide the names of Hurricanes or Tropical Storms for which your jurisdiction initiated response plans during the years of 2001 to 2010.

2b: If others, please enter additional information in the text box.
OPEN-ENDED RESPONSE

3.) What are your major concerns in the event a hurricane threatens your jurisdiction? If no major concerns, please write in “none.”
OPEN-ENDED RESPONSE

4.) In your opinion, what percentage of the population in your jurisdiction is vulnerable to the following hazards potentially associated with a hurricane?

<table>
<thead>
<tr>
<th>Q4</th>
<th>None (0%)</th>
<th>One-Fourth (25%)</th>
<th>Half (50%)</th>
<th>Three-Fourths (75%)</th>
<th>All (100%)</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>n</th>
<th># missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind (Q4a)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>2 (3.8%)</td>
<td>10 (18.9%)</td>
<td>41 (77.4%)</td>
<td>0 (0.0%)</td>
<td>4.74</td>
<td>5</td>
<td>0.52</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>Inland Flooding (Q4b)</td>
<td>2 (3.8%)</td>
<td>24 (45.3%)</td>
<td>11 (20.8%)</td>
<td>8 (15.1%)</td>
<td>6 (11.3%)</td>
<td>2 (3.8%)</td>
<td>2.84</td>
<td>2</td>
<td>1.23</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>Tornadoes (Q4c)</td>
<td>0 (0.0%)</td>
<td>4 (7.5%)</td>
<td>2 (3.8%)</td>
<td>3 (5.7%)</td>
<td>42 (79.2%)</td>
<td>2 (3.8%)</td>
<td>4.63</td>
<td>5</td>
<td>1.25</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>Storm Surge (Q4d)</td>
<td>0 (0.0%)</td>
<td>25 (47.2%)</td>
<td>6 (11.3%)</td>
<td>12 (22.6%)</td>
<td>10 (18.9%)</td>
<td>0 (0.0%)</td>
<td>3.13</td>
<td>3</td>
<td>1.21</td>
<td>53</td>
<td>0</td>
</tr>
</tbody>
</table>
Coastal Emergency Manager Survey

HURRICANE FORECAST IMPROVEMENT PROGRAM (HFIP)

Building on several post-Katrina assessments and other studies, the National Weather Service has developed several research goals for improving hurricane forecasts.

Think now about how you would use potential improvements in forecast information in your role as an emergency manager.

For each of the HFIP goals presented over the next 4 survey pages, please indicate how much you agree or disagree with each of the statements about that “specific” goal.

Q5-8 (HFIP Research Goals) randomize order of presentation – keep the response categories (from the table below) in same order.

5.) HFIP Research Goal: Reduce average track error in the hurricane forecast by 50% for Days 1 through 5.

<table>
<thead>
<tr>
<th>Q5</th>
<th>Disagree Completely</th>
<th>Disagree Somewhat</th>
<th>Neutral</th>
<th>Agree Somewhat</th>
<th>Agree Completely</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>n</th>
<th># missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>This would improve your ability to make decisions when a hurricane threatened. (Q5a)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>44</td>
<td>1</td>
<td>4.85</td>
<td>5</td>
<td>0.76</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>15.1%</td>
<td>83.0%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would be useful in communicating with the public. (Q5b)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>41</td>
<td>1</td>
<td>4.73</td>
<td>5</td>
<td>0.86</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>0.0%</td>
<td>0.0%</td>
<td>5.7%</td>
<td>15.1%</td>
<td>77.4%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would improve the safety in your jurisdiction. (Q5c)</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>11</td>
<td>34</td>
<td>1</td>
<td>4.52</td>
<td>5</td>
<td>0.95</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>0.0%</td>
<td>0.0%</td>
<td>13.2%</td>
<td>20.8%</td>
<td>64.2%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would result in changes in your hurricane response plans. (Q5d)</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>20</td>
<td>17</td>
<td>1</td>
<td>3.85</td>
<td>4</td>
<td>1.25</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>5.7%</td>
<td>7.5%</td>
<td>15.1%</td>
<td>37.7%</td>
<td>32.1%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would be an important improvement in hurricane forecasting capabilities. (Q5e)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>44</td>
<td>1</td>
<td>4.85</td>
<td>5</td>
<td>0.76</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>15.1%</td>
<td>83.0%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.) HFIP Research Goal: Increase ability to forecast rapid intensity changes during a storm’s final few days before landfall. Rapid intensity change is defined as an increase or decrease of at least two categories on the Saffir-Simpson Hurricane Wind Scale in 24 hours.

<table>
<thead>
<tr>
<th>Q6</th>
<th>Disagree Completely</th>
<th>Disagree Somewhat</th>
<th>Neutral</th>
<th>Agree Somewhat</th>
<th>Agree Completely</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>n</th>
<th># missing</th>
</tr>
</thead>
</table>
| This would improve your ability to make decisions when a hurricane threatened. (Q6a) | 0.0%  
0 | 0.0%  
0 | 0.0%  
0 | 0.0%  
0 | 0.0%  
0 | 0.0%  
0 | 1.9%  
1 | 13.2%  
11 | 84.9%  
40 | 19%  
1 | 4.87  
4.75 | 5 | 5 | 0.75 | 53 | 0 |
| This would be useful in communicating with the public. (Q6b)         | 0.0%  
0 | 0.0%  
0 | 1.9%  
1 | 20.8%  
11 | 75.5%  
40 | 19%  
1 | 4.75  
4.77 | 5 | 5 | 0.81 | 53 | 0 |
| This would improve the safety in your jurisdiction. (Q6c)            | 0.0%  
0 | 0.0%  
0 | 3.8%  
2 | 15.1%  
8 | 79.2%  
42 | 19%  
1 | 4.77  
4.10 | 5 | 4 | 0.83 | 53 | 0 |
| This would result in changes in your hurricane response plans. (Q6d)  | 5.7%  
3 | 3.8%  
2 | 5.7%  
3 | 43.4%  
23 | 39.6%  
21 | 19%  
1 | 4.10  
4.94 | 4 | 5 | 1.20 | 53 | 0 |
| This would be an important improvement in hurricane forecasting capabilities. (Q6e) | 0.0%  
0 | 0.0%  
0 | 0.0%  
0 | 5.7%  
3 | 92.5%  
49 | 19%  
1 | 4.94  
4.94 | 5 | 5 | 0.72 | 53 | 0 |
Coastal Emergency Manager Survey

7.) HFIP Research Goal: Reduce average intensity error by 50% for Days 1 through 5.

<table>
<thead>
<tr>
<th>Q7</th>
<th>Disagree Completely</th>
<th>Disagree Somewhat</th>
<th>Neutral</th>
<th>Agree Somewhat</th>
<th>Agree Completely</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>n</th>
<th># missing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would improve your ability to make decisions when a hurricane threatened. (Q7a)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>12</td>
<td>38</td>
<td>1</td>
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<td>5</td>
<td>0.84</td>
<td>53</td>
<td>0</td>
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<tr>
<td></td>
<td>0.0%</td>
<td>0.0%</td>
<td>3.8%</td>
<td>22.6%</td>
<td>71.7%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would be useful in communicating with the public. (Q7b)</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>8</td>
<td>35</td>
<td>1</td>
<td>4.50</td>
<td>5</td>
<td>0.99</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.0%</td>
<td>0.0%</td>
<td>17.0%</td>
<td>15.1%</td>
<td>66.0%</td>
<td>1.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This would improve the safety in your jurisdiction. (Q7c)</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>11</td>
<td>33</td>
<td>1</td>
<td>4.48</td>
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<td>0.97</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.0%</td>
<td>0.0%</td>
<td>15.1%</td>
<td>20.8%</td>
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<tr>
<td>This would result in changes in your hurricane response plans. (Q7d)</td>
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<tr>
<td>This would be an important improvement in hurricane forecasting capabilities. (Q7e)</td>
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8.) HFIP Research Goal: Extend the lead time for hurricane forecasts out to Day 7.

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<th>Neutral</th>
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<th>Agree Completely</th>
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<th>Median</th>
<th>SD</th>
<th>n</th>
<th># missing</th>
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<tr>
<td>This would improve your ability to make decisions when a hurricane threatened. (Q8a)</td>
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<td>This would be useful in communicating with the public. (Q8b)</td>
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<td>This would improve the safety in your jurisdiction. (Q8c)</td>
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<td>This would result in changes in your hurricane response plans. (Q8d)</td>
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<td>22</td>
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</tbody>
</table>
9.) While all of the goals are important, it is necessary to set priorities. Please rank the four research goals from 1 for most important to 4 for least important in helping you meet your objectives as an emergency manager.
Place a number "1" in the box next to the goal that is most important in helping you meet your objectives. Place the number "2" for the second most important goal. Place the number "3" for the third most important goal. And lastly, place the number "4" in the box next to your least important goal.

___ Reduce average track error in the hurricane forecast by 50% for Days 1 through 5.
___ Reduce average intensity error by 50% for Days 1 through 5.
___ Increase ability to forecast rapid intensity changes during a storm’s final few days before landfall. Rapid intensity change is defined as an increase or decrease of at least two categories on the Saffir-Simpson Hurricane Wind Scale in 24 hours
___ Extend the lead time for hurricane forecasts out to Day 7.

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<tr>
<th>Q9</th>
<th>Most Important</th>
<th>2nd Most Important</th>
<th>3rd Most Important</th>
<th>Least Important</th>
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<th>Median</th>
<th>SD</th>
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<td>0.89</td>
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<td>81.1%</td>
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</table>

10.) Please provide any thoughts or comments you have about the Hurricane Forecast Improvement Program.
OPEN-ENDED RESPONSE
STORM SURGE
In this section we are specifically interested in risks associated with storm surge.

11.) How would you describe your jurisdiction’s risk from surge in each of the following areas?

<table>
<thead>
<tr>
<th>Q11</th>
<th>Extremely Low</th>
<th>Below Average</th>
<th>Average</th>
<th>Above Average</th>
<th>Extremely High</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
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<td>5</td>
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<tr>
<td>Coastal areas (Q11a)</td>
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<td>0</td>
<td>3</td>
<td>10</td>
<td>40</td>
<td>4.70</td>
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<td>75.5%</td>
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<td>Major population areas (Q11b)</td>
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<td>16</td>
<td>16</td>
<td>15</td>
<td>3.74</td>
<td>4</td>
<td>1.04</td>
<td>53</td>
<td>0</td>
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<td></td>
<td>1.9%</td>
<td>9.4%</td>
<td>30.2%</td>
<td>30.2%</td>
<td>28.3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major evacuation routes (Q11c)</td>
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<td>6</td>
<td>11</td>
<td>15</td>
<td>18</td>
<td>3.74</td>
<td>4</td>
<td>1.21</td>
<td>53</td>
<td>0</td>
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<td>11.3%</td>
<td>20.8%</td>
<td>28.3%</td>
<td>34.0%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inland areas (Q11d)</td>
<td>6</td>
<td>9</td>
<td>17</td>
<td>12</td>
<td>9</td>
<td>3.17</td>
<td>3</td>
<td>1.24</td>
<td>53</td>
<td>0</td>
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<td></td>
<td>11.3%</td>
<td>17.0%</td>
<td>32.1%</td>
<td>22.6%</td>
<td>17.0%</td>
<td></td>
<td></td>
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</table>

12.) What portion of the land mass in your jurisdiction is at risk from storm surge?

<table>
<thead>
<tr>
<th>Q12</th>
<th>None (0%)</th>
<th>One-Fourth (25%)</th>
<th>Half (50%)</th>
<th>Three- Fourths (75%)</th>
<th>All (100%)</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>n</th>
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<td>3.15</td>
<td>3</td>
<td>1.17</td>
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<td></td>
<td>0.0%</td>
<td>43.4%</td>
<td>15.1%</td>
<td>24.5%</td>
<td>17.0%</td>
<td>0.0%</td>
<td></td>
<td></td>
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</table>

13.) What is the current population estimate for your jurisdiction?
OPEN-ENDED RESPONSE
Coastal Emergency Manager Survey

14.) What portion of your population lives in official storm surge zones?

<table>
<thead>
<tr>
<th>Q14</th>
<th>None (0%)</th>
<th>One-Fourth (25%)</th>
<th>Half (50%)</th>
<th>Three-Fourths (75%)</th>
<th>All (100%)</th>
<th>Don't Know</th>
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<th>Median</th>
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<td>3</td>
<td>1.26</td>
<td>53</td>
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</tbody>
</table>

15.) Are there special concerns with respect to people or areas in your jurisdiction at risk from storm surge? If no special concerns, please write in “none.”

OPEN-ENDED RESPONSE

16.) What do you think your public understands about its storm surge risk?

OPEN-ENDED RESPONSE
17.) The Saffir-Simpson Scale and current hurricane warnings are based on wind speeds. The National Hurricane Center has removed storm surge information from the Saffir-Simpson Scale since often there is not a direct correlation between wind and surge. This has led to an investigation of how surge information should be communicated. Below are some suggestions. Please indicate how much you agree or disagree with each of these options.

<table>
<thead>
<tr>
<th>Q17</th>
<th>Disagree Completely</th>
<th>Disagree Somewhat</th>
<th>Neutral</th>
<th>Agree Somewhat</th>
<th>Agree Completely</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
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<td></td>
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<td>issue storm surge information separate from wind information (Q17a)</td>
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<td>5</td>
<td>1.41</td>
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<td>0%</td>
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<td>issue a separate storm surge WARNING (Q17b)</td>
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<td>6</td>
<td>36</td>
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<td>issue a separate storm surge WATCH (Q17c)</td>
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<td>9</td>
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</table>

18.) If a storm surge watch were to be developed, at what minimum depth of storm surge do feel it should be issued?

<table>
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<tr>
<th>Q18</th>
<th>They should not issue separate storm surge information</th>
<th>Up to 2 feet above ground level</th>
<th>Up to 5 feet above ground level</th>
<th>Up to 7 feet above ground level</th>
<th>8 feet to 15 feet above ground level</th>
<th>More than 15 feet above ground level</th>
<th>Mean</th>
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</table>
19.) How useful in your decision making would each of the following options be for receiving information about a potential storm surge threat?

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<th>Q19</th>
<th>Not At All Useful</th>
<th>Not Very Useful</th>
<th>Somewhat Useful</th>
<th>Very Useful</th>
<th>Extremely Useful</th>
<th>Don't Know</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
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<td>Graphics and pictures showing potential storm surge damage (Q19b)</td>
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20.) What would be most useful or important to you and your jurisdiction to improve the communication to your stakeholders and public about storm surge risks?

OPEN-ENDED RESPONSE

21.) Please provide any additional thoughts or comments about ways to improve the communication of storm surge risk.

OPEN-ENDED RESPONSE

**COMMUNICATING FORECAST INFORMATION**

22.) How important are each of the following sources of hurricane forecast information for your decision making?

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## Coastal Emergency Manager Survey

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Coastal Emergency Manager Survey

23.) Do you use any other sources for hurricane forecast information?
   _____ No
   _____ Yes.
   If yes, please list/explain.
   **OPEN-ENDED RESPONSE**

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24.) How important are each of the following methods for communicating your agency's hurricane information and decisions to stakeholders and citizens in your jurisdiction?

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# Coastal Emergency Manager Survey

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25.) Have you signed up to use the services of any media outlet to send messages to smart phones during an event (such as Notify! at the Weather Channel)?

___ No
___ Yes
___ Don’t Know

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26.) What, if any, special issues or challenges do you have in using hurricane forecast and warning information in your jurisdiction?  
OPEN-ENDED RESPONSE

Q27-30 randomize order
27.) What, if anything, do you think could be done to improve communication for decision making between you as an emergency manager and the National Hurricane Center or your local Weather Forecast Office?  
OPEN-ENDED RESPONSE

28.) What, if anything, do you think could be done to improve communication for decision making between you as an emergency manager and broadcast media – that is the local and national television and radio and other communication media?  
OPEN-ENDED RESPONSE

29.) What, if anything, do you think could be done to improve communication for decision making between you as an emergency manager and the public?  
OPEN-ENDED RESPONSE

30.) What, if anything, do you think could be done to improve communication for decision making between you as an emergency manager and other stakeholders (please indicate what stakeholders you are thinking of)?  
OPEN-ENDED RESPONSE
ASSESSMENT OF CURRENT NWS PRODUCTS

For each of the following NWS products, we'll be asking you to indicate how often you do, or would, use this product for decision making when a hurricane threatens your jurisdiction. Then, if you do use, or would use the product, you'll be asked to give your assessment from 1 for Very Negative to 5 for Very Positive on the attributes listed.

For products a-h below ask Q31, Q32, and Q33
If the answer is 2 or higher – ask the following two questions – otherwise skip to next product
Randomize order of presentation of a-h

c. Saffir-Simpson Wind Scale (revised to not include surge) – See example. http://www.nhc.noaa.gov/sshws.shtml
d. Track Forecast Cone – See example. http://www.nhc.noaa.gov/aboutnhcgraphics.shtml#WATCHWARN

31.) Please indicate how often you do, or would, use this product for decision making when a hurricane threatens your jurisdiction.

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<th>Use Half the Time</th>
<th>Usually Use</th>
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If the answer is 2 or higher – ask the following two questions – otherwise skip to next product

32.) What is your perception of this product with respect to the following qualities or characteristics?

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### Coastal Emergency Manager Survey

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33.) Please provide any comments or suggestions you have for improvement of this product.
OPEN-ENDED RESPONSE

JURISDICTION AND POSITION
34.) What is the official name of your agency?
OPEN-ENDED RESPONSE

35.) What counties or parishes are within the jurisdiction of your agency?
OPEN-ENDED RESPONSE

36.) What major cities are located within the jurisdiction of your agency?
OPEN-ENDED RESPONSE

37.) What is your official title?
OPEN-ENDED RESPONSE

38.) Who do you report to, i.e. who is your “boss”?
OPEN-ENDED RESPONSE
How long have you been in your current position?

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39.) How long have you been in emergency management?

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A. We will also be interested in contacting broadcast media (TV, Radio, Internet) in your jurisdiction to ask them about their opinions on the communication of hurricane forecast and warning information. Can you please provide us with the names and email addresses of media people in your area that we could survey?

OPEN-ENDED RESPONSE

B. Is there anything further you’d like to say regarding NWS hurricane products or about this survey?

OPEN-ENDED RESPONSE

COMPLETION
We greatly appreciate the time you took to complete this survey. Thank you!
Please click the FINISH button below to record your responses.
SCREEN
Thank you for your consideration.
Please click the FINISH button below to be exited from the survey.
Appendix C. Screen Shots of NWS Products
FOR STORM INFORMATION SPECIFIC TO YOUR AREA...INCLUDING POSSIBLE INLAND WATCHES AND WARNINGS...PLEASE MONITOR PRODUCTS ISSUED BY YOUR LOCAL WEATHER OFFICE.

AT 1000 PM CDT...0100Z...THE CENTER OF HURRICANE IKE WAS LOCATED NEAR LATITUDE 26.3 NORTH...LONGITUDE 90.4 WEST OR ABOUT 445 MILES...715 KM...EAST-SOUTHEAST OF CORPUS CHRISTI TEXAS AND ABOUT 340 MILES...545 KM...SOUTHEAST OF GALVESTON TEXAS.

IKE IS MOVING TOWARD THE WEST-NORTHWEST AT 12 MPH...19 KM/HR... AND THIS GENERAL MOTION IS EXPECTED TO CONTINUE FOR THE NEXT 24 HOURS...WITH A TURN TO THE NORTHWEST EXPECTED TO BEGIN LATE FRIDAY. ON THE FORECAST TRACK...THE CENTER OF IKE WILL BE VERY NEAR THE UPPER TEXAS COAST BY LATE FRIDAY. HOWEVEr...BECAUSE IKE IS A VERY LARGE TROPICAL CYCLONE...WEATHER WILL DETERIORATE ALONG THE COASTLINE EARLY ON FRIDAY...LONG BEFORE THE CENTER REACHES THE COAST.

DATA FROM BOTH NOAA AND AIR FORCE HURRICANE HUNTER AIRCRAFT INDICATE THAT MAXIMUM SUSTAINED WINDS REMAIN NEAR 100 MPH...160 KM/HR...WITH HIGHER GUSTS. IKE IS A CATEGORY TWO HURRICANE ON THE Saffir-Simpson Scale. SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS OR SO...AND IKE COULD BECOME A MAJOR HURRICANE BEFORE REACHING THE COAST.

THE AIRCRAFT DATA INDICATE THAT IKE REMAINS A LARGE CYCLONE. HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 115 MILES...185 KM...FROM THE CENTER...AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 245 MILES...395 KM.

THE ESTIMATED MINIMUM CENTRAL PRESSURE BASED ON AIRCRAFT DATA IS 956 MB...31.23 INCHES.

COASTAL STORM SURGE FLOODING OF UP TO 20 FEET ABOVE NORMAL TIDE LEVELS...ALONG WITH LARGE AND DANGEROUS BATTERING WAVES...CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER OF IKE MAKES LANDFALL...EXTENDING A GREATER THAN USUAL DISTANCE FROM THE CENTER DUE TO THE LARGE SIZE OF THE CYCLONE. STORM SURGE FLOODING OF UP TO 25 FEET COULD OCCUR AT THE HEADS OF BAYS. COASTAL STORM SURGE FLOODING OF 6 TO 8 FEET ABOVE NORMAL TIDE LEVELS...ALONG WITH LARGE AND DANGEROUS WAVES...CAN BE EXPECTED WITHIN THE TROPICAL STORM WARNING AREA ALONG THE NORTHERN GULF COAST. ABOVE NORMAL TIDES IN THE EASTERN GULF OF MEXICO SHOULD GRADUALLY SUBSIDE OVER THE NEXT DAY OR SO.

IKE IS EXPECTED TO PRODUCE RAINFALL AMOUNTS OF 5 TO 10 INCHES ALONG THE MIDDLE AND UPPER TEXAS COAST AND OVER PORTIONS OF SOUTHWESTERN LOUISIANA...WITH ISOLATED MAXIMUM AMOUNTS OF 15 INCHES POSSIBLE.

ISOLATED TORNADOES ARE POSSIBLE ON FRIDAY OVER PORTIONS OF SOUTHWESTERN LOUISIANA AND SOUTHEASTERN TEXAS.

REPEATING THE 1000 PM CDT POSITION...26.3 N...90.4 W. MOVEMENT TOWARD...WEST-NORTHWEST NEAR 12 MPH. MAXIMUM SUSTAINED WINDS...100 MPH. MINIMUM CENTRAL PRESSURE...956 MB.

AN INTERMEDIATE ADVISORY WILL BE ISSUED BY THE NATIONAL HURRICANE CENTER AT 1000 AM CDT FOLLOWED BY THE NEXT COMPLETE ADVISORY AT 400 AM CDT.

** FORECASTER BEARS/BERG

NHC
Three types of tropical cyclone wind speed probability values are created for each forecast/advisory package, but not all of these values are distributed or placed on the Internet. For each probability value, the event in question is a sustained (one-minute average) surface (10 m) wind speed of at least a particular threshold value (34 kt, 39 mph, 50 kt, 55 mph, or 64 kt, 74 mph) at a specific location.

**Cumulative** – These values tell you the overall probability the event will occur sometime during the specified cumulative forecast period (0-6 hours, 0-12, 0-18, etc.) at each specific point. These values are provided in both the text and graphical formats. In the text product, the numbers are in parentheses. The graphical products depict only cumulative values. The text product is transmitted to users via normal NWS dissemination methods. The graphic is available on the Internet from the National Hurricane Center and the Central Pacific Hurricane Center.

**Individual** – These values tell you the probability the event will start sometime during the specified individual forecast period (0-6 hours, 0-12, 12-18, etc.) at each specific point. These periods are individual, since nothing that occurs before or after the specified period affects the probability. These values are provided only in the text NHC product. They are the values outside of the parentheses (cumulative values are in the parentheses). The term “individual” also makes a clear distinction from the cumulative period values for users.

Graphics for Atlantic tropical cyclones are normally issued every six hours at 5:00 AM EDT, 11:00 AM EDT, 5:00 PM EDT, and 11:00 PM EDT (or 4:00 AM EST, 10:00 AM EST, 4:00 PM EST, and 10:00 PM EST). Graphics for Eastern Pacific tropical cyclones are normally issued every six hours at 2:00 AM PDT, 8:00 AM PDT, 2:00 PM PDT, and 8:00 PM PDT (or 1:00 AM PST, 7:00 AM PST, 1:00 PM PST, and 7:00 PM PST).

Special graphics may be issued at any time due to significant changes in warnings or in the cyclone.

**Note:** A more detailed description of these probability products is also available.

**Tropical Cyclone Surface Wind Field**
Example - Tropical Cyclone Wind Speed Probabilities

000
FORTIS KNHC 212039
FWSTI
HURRICANE BILL WIND SPEED PROBABILITIES NUMBER 26
NWS NATIONAL HURRICANE CENTER NVOC FL AL212039
2100 UTC FRI AUG AUG 2009
AT 2100Z THE CENTER OF HURRICANE BILL WAS LOCATED NEAR LATITUDE 20.4
NORTH...LONGITUDE 68.4 WEST WITH MAXIMUM SUSTAINED WINDS NEAR 90 KTS
...155 MPH...165 KPH.
2 INDICATES COORDINATE UNIVERSAL TIME (GREENWICH)
ATLANTIC STANDARD TIME (AST)...SUBTRACT 4 HOURS FROM 2 TIME
EASTERN DAYLIGHT TIME (EDT)...SUBTRACT 4 HOURS FROM 2 TIME
CENTRAL DAYLIGHT TIME (CDT)...SUBTRACT 5 HOURS FROM 2 TIME

I. MAXIMUM WIND SPEED (INTENSITY) PROBABILITY TABLE

CHANGES THAT THE MAXIMUM SUSTAINED (1-MINUTE AVERAGE) WIND SPEED OF
THE TROPICAL CYCLONE WILL BE WITHIN ANY OF THE FOLLOWING CATEGORIES
AT EACH OFFICIAL FORECAST TIME DURING THE NEXT 5 DAYS.
PROBABILITIES ARE GIVEN IN PERCENT. X INDICATES PROBABILITIES LESS
THAN 1 PERCENT.

--- MAXIMUM WIND SPEED (INTENSITY) PROBABILITIES ---

VALID TIME 06Z SAT 18Z SAT 06Z SUN 18Z SUN 18Z MON 18Z TUE 18Z WED
FORECAST HOUR 12 24 36 48 72 96 120
--- --- --- --- --- --- --- ---

HUR CAT 1 4 13 45 39 12 11 7
HUR CAT 2 54 35 27 14 5 2 1
HUR CAT 3 67 40 11 3 1 0 0
HUR CAT 4 7 4 2 2 1 0 0
HUR CAT 5 1 0 0 0 0 0 0
--- --- --- --- --- --- --- ---

PCT MAX WIND 100KT 100KT 85KT 75KT 50KT 45KT 58KT
--- --- --- --- --- --- --- ---

II. WIND SPEED PROBABILITY TABLE FOR SPECIFIC LOCATIONS

CHANGES OF SUSTAINED (1-MINUTE AVERAGE) WIND SPEEDS OF AT LEAST
...34 Kt (39 MPH...63 Kmph)...34 Kt (50 MPH...93 Kmph)...34 Kt (74 MPH...119 Kmph)
FOR LOCATIONS AND TIME PERIODS DURING THE NEXT 5 DAYS
PROBABILITIES FOR LOCATIONS ARE GIVEN AS IP(CP) WHERE
IP IS THE PROBABILITY OF THE EVENT BEGINNING DURING
AN INDIVIDUAL TIME PERIOD (INDEPENDENT PROBABILITY)
(CP) IS THE PROBABILITY OF THE EVENT OCCURRING BETWEEN
18Z FRI AND THE FORECAST HOUR (CONOLATIVE PROBABILITY)
PROBABILITIES ARE GIVEN IN PERCENT
X INDICATES PROBABILITIES LESS THAN 1 PERCENT
PROBABILITIES FOR 34 KT AND 50 KT ARE SHOWN AT A GIVEN LOCATION WHEN
THE 5-DAY CONOLATIVE PROBABILITY IS AT LEAST 3 PERCENT.
Coastal Emergency Manager Survey

PROBABILITIES ARE GIVEN IN PERCENT
X INDICATES PROBABILITIES LESS THAN 1 PERCENT.
PROBABILITIES FOR 34 KT AND 50 KT ARE SHOWN AT A GIVEN LOCATION WHEN
THE 5-DAY CUMULATIVE PROBABILITY IS AT LEAST 3 PERCENT.
PROBABILITIES FOR 64 KT ARE SHOWN WHEN THE 5-DAY CUMULATIVE
PROBABILITY IS AT LEAST 1 PERCENT.

- - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -

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Coastal Emergency Manager Survey

National Hurricane Center

The Saffir-Simpson Hurricane Wind Scale

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 categorization based on the hurricane's intensity at the indicated time. The scale—the originally developed by wind engineer Herbert Saffir and meteorologist Bob Simpson—has been an excellent tool for alerting the public about the possible impacts of various intensity hurricanes. The scale provides examples of the type of damage and impacts in the United States associated with winds of the indicated intensity. In general, damage increases by about a factor of four for every category increase. The maximum sustained surface wind speed (peak 1-minute wind at the standard mobile (10-m) elevation above ground level) of winds between 15 m (40 ft) over undamaged exposure associated with the cyclogenesis is the determining factor in the scale. (Note that sustained winds can be stronger in hilly or mountainous terrain—such as over the Appalachians or over much of Puerto Rico—compared with that experienced over flat terrain.) The historical examples provided in each of the categories correspond with the observed or estimated maximum wind speeds from the hurricane experienced at the location indicated. These do not necessarily correspond with the peak intensity reached by the system during its lifetime. It is also important to note that peak 1-minute winds in hurricanes are balanced to diminish to one category within a short distance, perhaps a kilometer (~half a mile) of the coastline.

For example, Hurricane Wilma made landfall in 2005 in southwest Florida as a Category 3 hurricane. Even though this hurricane only took four hours to traverse the peninsula, the winds experienced by most Miami-Dade, Broward, and Palm Beach County communities were Category 1 to Category 2 conditions. However, exceptions to this generalization are certainly possible.

The scale does not address the potential for other hurricane-related impacts, such as storm surge, rainfall-induced floods, and tornadoes. It should also be noted that these wind-caused damage general descriptions are to some degree dependent upon the local building codes in effect and how well and how long they have been enforced. For example, building codes enacted during the 1980s in Florida, North Carolina, and South Carolina are likely to reduce the damage to newer structures from that described below. However, for a long time to come, the majority of the building stock in existence on the coast will not have been built to higher code. Hurricane wind damage is also very dependent upon other factors, such as duration of high winds, change of wind direction, and age of structures.

Earlier versions of this scale—known as the Saffir-Simpson Hurricane Scale—incorporated central pressure and storm surge as components of the categories. The central pressures used during the 1970s and 1980s as a proxy for the winds as accurate wind speed (as measured from aircraft reconnaissance) were not routinely available for hurricanes until 1990. Storm surge was also quantified by category in the earliest published versions of the scale dating back to 1972. However, hurricane size (extent of hurricane-force winds), local bathymetry (depth of near-shore waters), topography, the hurricane's forward speed, and angle to the coast also affect the surge that is produced. For example, the very large Hurricane Ike (with hurricane-force winds extending as much as 125 mi from the center) in 2008 made landfall in Texas as a Category 2 hurricane and had peak storm surge values of about 20 ft. In contrast, tiny Hurricane Charley (with hurricane-force winds extending at most 25 mi from the center) struck Florida in 2004 as a Category 4 hurricane and produced a peak storm surge of only about 7 ft. These storm surge values were substantially outside of the ranges suggested in the original scale. Thus, to help reduce public confusion about the impacts associated with the various hurricane categories as well as to provide a more scientifically defensible scale, the storm surge ranges, flooding impact and central pressure statements are being removed from the scale and only peak winds are employed in this revised version, the Saffir-Simpson Hurricane Wind Scale. (The impact statements below were derived from recommendations graciously provided by experts—Bruce Harper, Forrest Masters, Mark Powell, Tim Marshall, Tim Reinhardt, and Peter Vicker.)

The Saffir-Simpson Hurricane Wind Scale

<table>
<thead>
<tr>
<th>Category</th>
<th>Wind Speed</th>
<th>Damages</th>
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<tbody>
<tr>
<td>Category 1</td>
<td>74-95 mph, 64-82 kt, or 119-153 km/hr</td>
<td>Very dangerous winds will produce some damage. People, livestock, and pet structures may be damaged, and injury may occur.</td>
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<tr>
<td>Category 2</td>
<td>96-110 mph, 83-95 kt, or 179-226 km/hr</td>
<td>Significant damage to buildings will occur and widely known hazardous areas will be at risk of structural failure. Some areas of urban damage will occur.</td>
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<tr>
<td>Category 3</td>
<td>111-130 mph, 96-105 kt, or 185-220 km/hr</td>
<td>Extreme structural damage will occur to most buildings and many hazardous areas will be affected. Damage to urban areas will be extensive.</td>
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<tr>
<td>Category 4</td>
<td>131-155 mph, 106-115 kt, or 226-279 km/hr</td>
<td>Complete destruction of most buildings and hazardous areas. Major damage to urban areas will occur.</td>
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<tr>
<td>Category 5</td>
<td>Over 155 mph, Over 115 kt, or Over 279 km/hr</td>
<td>Total destruction of buildings and hazardous areas. Major damage to urban areas will occur at greatest extent.</td>
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Coastal Emergency Manager Survey

Category One Hurricane (Sustained winds 74-95 mph, 64-82 kt, or 119-153 km/hr)

Very dangerous winds will produce some damage

People, livestock, and pets struck by flying or falling debris could be injured or killed. Older (mainly pre-1994 construction) mobile homes could be destroyed, especially if they are not anchored properly as they tend to shift or roll off their foundations. Narrow mobile homes that are anchored properly can sustain damage involving the removal of shingles or metal roof coverings, and loss of vinyl siding, as well as damage to carports, sunrooms, or lanais. Some poorly constructed frame homes can experience major damage, involving loss of the roof covering and damage to gable ends as well as the removal of porch coverings and awnings. Unprotected windows may break if struck by flying debris. Masonry chimneys can be toppled. Well-constructed frame homes could have damage to roof shingles, vinyl siding, soffit panels, and gutters. Failure of aluminum, screened-in, swimming pool enclosures can occur. Some apartment buildings and shopping center roof coverings could be partially removed. Industrial buildings can lose roof and siding especially from windward corners, rakes, and soffits. Failure to overhead doors and unprotected windows will be common. Windows in high-rise buildings can be broken by flying debris. Falling and broken glass will pose a significant danger even after the storm. There will be occasional damage to commercial signage, fences, and canopies. Large branches of trees will snap and shallow-rooted trees can be toppled. Extensive damage to power lines and poles will likely result in power outages that could last a few to several days. Hurricane Dolly (2003) is an example of a hurricane that brought Category 1 winds and impacts to South Padre Island, Texas.

Category Two Hurricane (Sustained winds 96-110 mph, 83-95 kt, or 154-177 km/hr)

Extremely dangerous winds will cause extensive damage

There is a substantial risk of injury or death to people, livestock, and pets due to flying and falling debris. Older (mainly pre-1994 construction) mobile homes have a very high chance of being destroyed and the flying debris generated can shred nearby mobile homes. Narrow mobile homes can also be destroyed. Poorly constructed frame homes have a high chance of having their roof structures removed especially if they are not anchored properly. Unprotected windows will have a high probability of being blown out by flying debris. Well-constructed frame homes could sustain major roof and siding damage. Failure of aluminum, screened-in, swimming pool enclosures will be common. There will be a substantial percentage of roof and siding damage to apartment buildings and industrial buildings. Unreinforced masonry walls can collapse. Windows in high-rise buildings can be broken by flying debris. Falling and broken glass will pose a significant danger even after the storm. Commercial signage, fences, and canopies will be damaged and partially destroyed. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Extensive damage to power lines is expected with outages that could last from several days to weeks. Potable water could become scarce as filtration systems begin to fail. Hurricane Frances (2004) is an example of a hurricane that brought Category 2 winds and impacts to coastal portions of Port St. Lucie, Florida with Category 1 conditions experienced elsewhere in the city.

Category Three Hurricane (Sustained winds 111-130 mph, 99-113 kt, or 178-209 km/hr)

Catastrophic damage will occur

There is a high risk of injury or death to people, livestock, and pets due to flying and falling debris. Nearly all older (pre-1994) mobile homes will be destroyed. Most newer mobile homes will sustain severe damage with potential for complete roof failure and wall collapse. Poorly constructed frame homes can be destroyed by the removal of the roof and exterior walls. Unprotected windows will be broken by flying debris. Well-built frame homes can experience major damage involving the removal of roof, siding and damage to apartment buildings and industrial buildings. Isolated structural damage to wood or steel framing can occur. Complete failure of older metal buildings is possible, and older unreinforced masonry buildings can collapse. Numerous windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm. Most commercial signage, fences, and canopies will be destroyed. Many trees will be snapped or uprooted, blocking numerous roads. Extensive damage to power lines is expected with outages that could last from several days to weeks. Shortage of potable water will be unavailable for several days to a few weeks after the storm passes. Hurricane Ivan (2004) is an example of a hurricane that brought Category 3 winds and impacts to coastal portions of Gulf Shores, Alabama with Category 2 conditions experienced elsewhere in the city.

Category Four Hurricane (Sustained winds 131-155 mph, 114-135 kt, or 210-240 km/hr)

Catastrophic damage will occur

There is a very high risk of injury or death to people, livestock, and pets due to flying and falling debris. Nearly all older (pre-1994) mobile homes will be destroyed. A high percentage of newer mobile homes also will be destroyed. Poorly constructed homes can sustain complete collapse of all walls as well as the loss of the roof structure. Well-built homes also can sustain severe damage with loss of most of the roof structure and some exterior walls. Extensive damage to roof coverings, windows, and doors will occur. Large amounts of windborne debris will be lofted into the air. Windborne debris damage will break most unprotected windows and penetrate some protected windows. There will be a high percentage of structural damage to the top floors of apartment buildings. Steel frames in older industrial buildings can collapse. There will be a high percentage of collapse to older unreinforced masonry buildings. Most windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm. Extensive damage to commercial signage, fences, and canopies will be destroyed. Many trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Short-term water shortages will increase human suffering. Most of the area will be uninhabitable for weeks or months. Hurricane Charley (2004) is an example of a hurricane that brought Category 4 winds and impacts to coastal portions of Punta Gorda, Florida with Category 3 conditions experienced elsewhere in the city.
Coastal Emergency Manager Survey

Category Five Hurricane (Sustained winds greater than 155 mph, greater than 135 kt, or greater than 249 kph).

Catastrophic damage will occur.

People, livestock, and pets are at very high risk of injury or death from flying or falling debris, even if indoors in mobile homes or frame homes. Almost complete destruction of all mobile homes will occur, regardless of age or construction. A high percentage of frame homes will be destroyed with total roof failure and wall collapse. Extensive damage to roof covers, windows, and doors will occur. Large amounts of windborne debris will be lofted into the air. Windborne debris damage will occur to nearly all unprotected windows and many protected windows. Significant damage to wood roof commercial buildings will occur due to loss of roof sheathing. Complete collapse of many older metal buildings can occur. Most unreinforced masonry walls will fall which can lead to the collapse of the buildings. A high percentage of industrial buildings and low-rise apartment buildings will be destroyed. Nearly all windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm. Nearly all commercial signage, fences, and canopies will be destroyed. Nearly all trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Long-term water shortages will increase human suffering. Most of the area will be uninhabitable for weeks or months.

Hurricane Charley (2004) is an example of a hurricane that brought Category 4 winds and impacts to coastal portions of Punta Gorda, Florida with Category 3 conditions experienced elsewhere in the city.


Return to Saffir-Simpson Hurricane Wind Scale main page
Tropical Cyclone Track Forecast Cone and Watches/Warnings

This graphic shows an approximate representation of coastal areas under a hurricane warning (red), hurricane watch (pink), tropical storm warning (blue) and tropical storm watch (yellow). The orange circle indicates the current position of the center of the tropical cyclone. The black line and dots show the National Hurricane Center (NHC) forecast track of the center at the times indicated. The dot indicating the forecast center location will be black if the cyclone is forecast to be tropical and will be white with a black outline if the cyclone is forecast to be extratropical. If only an L is displayed, then the system is forecast to be a remnant low. The letter inside the dot indicates the NHC’s forecast intensity for that time:

D: Tropical Depression – wind speed less than 39 MPH
S: Tropical Storm – wind speed between 39 MPH and 73 MPH
H: Hurricane – wind speed between 74 MPH and 110 MPH
M: Major Hurricane – wind speed greater than 110 MPH

NHHC tropical cyclone forecast tracks can be in error. This forecast uncertainty is conveyed by the track forecast "cone": the solid white and stippled white areas in this graphic. The solid white area depicts the track forecast uncertainty for days 1 - 3 of the forecast, while the stippled area depicts the uncertainty on days 4 - 5. Historical data indicate that the entire 5-day path of the center of the tropical cyclone will remain within the cone about 60-70% of the time. To form the cone, a set of imaginary circles is placed along the forecast track at the 12, 24, 36, 48, 72, and 120 h positions, where the size of each circle is set so that it encloses 67% of the previous five years official forecast errors. The cone is then formed by smoothly connecting the area swept out by the set of circles.

There is also uncertainty in the NHHC intensity forecasts. The Maximum 1-minute Wind Speed Probability Table described below provides intensity forecast and uncertainty information.

It is also important to realize that a tropical cyclone is not a point. Their effects can span many hundreds of miles from the center. The area experiencing hurricane force (one-minute average wind speeds of at least 74 mph) and tropical storm force (one-minute average wind speeds of 39-73 mph) winds can extend well beyond the white areas shown enclosing the most likely track area of the center. The distribution of hurricane and tropical storm force winds in this tropical cyclone can be seen in the Cumulative Wind History Graphic described below.

Considering the combined forecast uncertainties in track, intensity, and size, the chances that any particular location will experience winds of 34 kt (tropical storm force), 50 kt, or 64 kt (hurricane force) from this tropical cyclone are presented in graphical form and in tabular form for selected locations and forecast positions.

Graphics for Atlantic tropical cyclones are normally issued every six hours at 5:00 AM EDT, 11:00 AM EDT, 5:00 PM EDT, and 11:00 PM EDT (or 4:00 AM EST, 10:00 AM EST, 4:00 PM EST, and 10:00 PM EST).

Graphics for Eastern Pacific tropical cyclones are normally issued every six hours at 2:00 AM PDT, 8:00 AM PDT, 2:00 PM PDT, and 8:00 PM PDT (or 1:00 AM PST, 7:00 AM PST, 1:00 PM PST, and 7:00 PM PST).

The graphics will also be updated when intermediate public advisories are issued, and special graphics may be issued at any time due to significant changes in warnings or in the cyclone.

Note: A detailed definition of the NHHC track forecast cone is also available.
**Graphical Tropical Weather Outlook**

The graphical Tropical Weather Outlook (TWO) is a web display that the National Hurricane Center (NHC) began testing during the 2007 hurricane season. The Graphical TWO is intended to be a visual companion product to the text TWO. The NHC produces a graphical TWO four times daily in both the Atlantic and Pacific basins.

The graphical TWO is usually available shortly after the text TWO has been issued, but occasionally there might be a slight delay for the updated graphic to appear on the NHC website. For this reason, users are reminded that the text TWO may show updated information a few minutes prior to the graphical TWO.

For the Atlantic basin, the Graphical TWO is issued from June 1 to November 30 at 2:00 AM, 8:00 AM, 2:00 PM, and 8:00 PM EDT. For the Eastern Pacific basin, the Graphical TWO is issued from May 16 to November 30 at 5:00 AM, 11:00 AM, 5:00 PM, and 11:00 PM PDT. During Standard Time, the graphic is issued one hour earlier than the times indicated above.

A special TWO may be issued at any time when important changes in areas of disturbed weather over tropical or subtropical waters need to be conveyed before the next scheduled release of the TWO.

**Note:** A more complete description of the Graphical Tropical Weather Outlook can be found here.

### Tropical Cyclone Storm Surge Probabilities (2 - 25 feet)

<table>
<thead>
<tr>
<th>Tropical Cyclone Storm Surge Probabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of Storm Surge &gt; 2 feet (NOAA-1955) at individual locations</td>
</tr>
<tr>
<td>Hurricane Earl (2010) Advisory 15</td>
</tr>
<tr>
<td>For the 77 hours from 06 AM EDT Wed Sep 01 to 10 AM EDT Sat Sep 04</td>
</tr>
</tbody>
</table>
Coastal Emergency Manager Survey

Tropical Cyclone Storm Surge Probabilities (2 - 25 feet)

Tropical Cyclone Storm Surge Probabilities

Chance of Storm Surge >= 2 feet (NGVD=+129) at individual locations

Hurricane Earl (2010) Advisory 20

For the 77 hours from 06 AM EDT Wed Sep 01 to 10 AM EDT Sat Sep 04

Select Level | Probability of Surge >= 2 feet
---------+------------------

Legend

- 5% - 10%<br> - 10% - 20%<br> - 20% - 30%<br> - 30% - 40%<br> - 40% - 50%<br> - 50% - 60%<br> - 60% - 70%<br> - 70% - 80%<br> - 80% - 90%<br> - 90% - 100%

The Tropical Cyclone Storm Surge Probabilities product consists of a graphic and GFS2 data for creating the graphic for the Gulf of Mexico and Atlantic coastal areas of the continental United States. This product is intended to provide users with information which enhances their ability to make preparedness decisions specific to their own situations.

The graphic shows probabilities, in percent, of storm surge exceeding various thresholds. In 2009, the range of thresholds was expanded and include data at 1-foot intervals. A minimum value of 2 feet and a maximum value of 25 feet will be available.

This storm surge graphic is based upon an ensemble of Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model runs using the National Hurricane Center (NHC) official advisory and accounts for track, size, and intensity errors based on historical errors. Additional information on the SLOSH model can be found at http://www.nhc.noaa.gov/surge_slosh.shtml.

The emergency management community is the primary target audience. However, this product will also be widely used by other federal, state, and local government agencies, the media, maritime interests, and the general public.

The product is available on the NHC website whenever a hurricane watch or hurricane warning is in effect for any portion of the Gulf of Mexico and Atlantic coasts of the continental United States. Updates to the product are produced about one hour after the issuance of routine NHC tropical cyclone advisories at 05:00 AM EDT, 11:00 AM EDT, 5:00 PM EDT, and 11:00 PM EDT (or 04:00 AM EST, 10:00 AM EST, 4:00 PM EST, and 10:00 PM EST).

Note: Read a more complete description of the Storm Surge Probabilities (2 - 25 feet).

Tropical Cyclone Storm Surge Probabilities (exceedance)

National Weather Service - Since 1770

NCAR Societal Impacts Program
The product is available on the NHC website whenever a hurricane watch or hurricane warning is in effect for any portion of the Gulf or Atlantic coasts of the continental United States. Updates to the product are produced about one hour after the issuance of routine NHC tropical cyclone advisories at 5:00 AM EDT, 11:00 AM EDT, 5:00 PM EDT, and 1:00 PM EDT (or 4:00 AM EST, 10:00 AM EST, 4:00 PM EST, and 10:00 PM EST).

Note: Read a more complete description of the Storm Surge Probabilities (2 - 25 feet).

Tropical Cyclone Storm Surge Probabilities (exceedance)

The Probabilistic Tropical Cyclone Storm Surge Exceedance products consist of a graphic and GRIB2 data for creating the graphic for the Gulf of Mexico and Atlantic coastal areas. The exceedance products show storm surge height in feet, above normal tide levels, such that there is an N percent chance of exceeding it, where N ranges from 10 to 80 in intervals of 10 percent. The 10 percent exceedance height, for example, is the storm surge height, above normal tide levels, such that there is a 10 percent chance of exceeding it.

The storm surge graphics are based upon an ensemble of Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model runs using the National Hurricane Center (NHC) official advisory and account for track, size, and intensity uncertainty from historical errors. Additional information on the SLOSH model can be found at http://www.nhc.noaa.gov/surge/surge.shtml.

The emergency management community is the primary target audience. However, this product will also be widely used by other federal, state, and local government agencies; the media; maritime interests; and the general public.

The product is available on the NWS Hydrological Data Laboratory (HDL) website whenever a hurricane watch or hurricane warning is in effect for any portion of the Gulf or Atlantic coasts of the continental United States. Updates to the product are produced about one hour after the issuance of routine NHC tropical cyclone advisories at 5:00 AM EDT, 11:00 AM EDT, 5:00 PM EDT, and 1:00 PM EDT (or 4:00 AM EST, 10:00 AM EST, 4:00 PM EST, and 10:00 PM EST).

Note: You may also read the full description for the Probabilistic Storm Surge Exceedance product at NHC’s web page.
HURRICANE LOCAL STATEMENTS

Local NWS forecast offices (WFOs) produce local statements to keep the media, local decision makers, and the public current on present and anticipated storm effects in their area. The hurricane local statements contain essential hurricane or tropical storm information in a condensed form, but expand on the storm's potential effects on the local area and on any actions declared by local emergency managers.

Local weather statements generally present the following:

- A lead statement
- A sentence detailing the counties, parishes, or cities covered by the statement
- Watches and/or warnings in effect and the counties or parishes to which they apply
- Recommended precautionary actions and the times they should be completed
- Storm surge and storm tide information, including the times that various heights are expected, present heights, and their locations
- Present winds and the expected time of onset of tropical storm or hurricane-force winds
- Tornado, flood, flash flood, rip current, beach erosion, and inland high wind potential
- The time of the next statement
- Information on the probability of hurricane or tropical storm conditions may also be included. An example section of a hurricane local statement is provided below.

ZCSC HURRICANE STATEMENT
TTAA05 KFLL 241537
FL045-064-075-085-241537-
HURRICANE LOCAL STATEMENT...UPDATED TO ADD STORM SURGE INFORMATION FOR KEYS NATIONAL WEATHER SERVICE MIAMI FL 1220 PM EDT THU SEP 24 1998

...HURRICANE WATCH IS IN EFFECT FOR THE FLORIDA KEYS INCLUDING THE KEYS...FORT MYERS...FT LAUDERDALE...AND NAPLES...

...FLOOD WATCH IN EFFECT FOR SOUTH FLORIDA TONIGHT THROUGH SATURDAY...

...HIGH WIND WARNINGS IN EFFECT FOR INLAND SECTIONS OF THE SOUTH FLORIDA LATE TODAY AND TONIGHT...

...MANDATORY EVACUATION OF THE FLORIDA KEYS...THIS STATEMENT RECOMMENDS ACTIONS TO BE TAKEN BY RESIDENTS OF DADE...BROWARD...PALM BEACH...COLLIER...MONROE...GLADES... AND HENDRY COUNTIES OF SOUTH FLORIDA IN PREPARATION FOR HURRICANE GEORGE...

A HURRICANE WARNING IS IN EFFECT FOR MONROE...COLLIER...DADE... AND BROWARD COUNTIES INCLUDING THE FLORIDA KEYS. A HURRICANE WARNING MEANS THAT HURRICANE CONDITIONS...SUSTAINED WINDS OF AT LEAST 74 MPH...ARE EXPECTED TO OCCUR WITHIN THE WARNED AREA WITHIN 24 HOURS.

INLAND HIGH WIND WARNINGS ARE IN EFFECT FOR THE INLAND SECTIONS OF BROWARD...DADE...AND COLLIER COUNTIES. HIGH WIND WARNINGS MEAN SUSTAINED WINDS OF 40 MPH OR GREATER ARE EXPECTED TO LAST ONE HOUR OR LONGER...OR WINDS OF 58 MPH OR GREATER ARE EXPECTED TO OCCUR FOR ANY DURATION.

A HURRICANE WATCH IS IN EFFECT FOR PALM BEACH COUNTY. A HURRICANE WATCH MEANS THAT HURRICANE CONDITIONS ARE POSSIBLE IN THE WATCH AREA WITHIN 36 HOURS.

A LAKE WIND ADVISORY IS IN EFFECT FOR LAKE OKEECHOBEE TONIGHT AND FRIDAY. A LAKE WIND ADVISORY MEANS SUSTAINED WINDS OF 25 MPH OR MORE ARE EXPECTED ACROSS LAKE OKEECHOBEE FOR ONE HOUR OR LONGER.

THE OUTERMOST RAIN BANDS ASSOCIATED WITH GEORGE WILL BE MOVING INTO THE KEYS LATE THIS AFTERNOON AND INTO THE
Coastal Emergency Manager Survey

A HURRICANE WARNING IS IN EFFECT FOR MONROE, COLLIER, DADE, AND BROWARD COUNTIES INCLUDING THE FLORIDA KEYS. A HURRICANE WARNING MEANS THAT HURRICANE CONDITIONS...SUSTAINED WINDS OF AT LEAST 74 MPH...ARE EXPECTED TO OCCUR WITHIN THE WARNING AREA WITHIN 24 HOURS.

INLAND HIGH WIND WARNINGS ARE IN EFFECT FOR THE INLAND SECTIONS OF BROWARD, DADE, AND COLLIER COUNTIES. HIGH WIND WARNINGS MEAN SUSTAINED WINDS OF 40 MPH OR GREATER ARE EXPECTED TO LAST ONE HOUR OR MORE...OR WINDS OF 28 MPH OR GREATER ARE EXPECTED TO OCCUR FOR ANY DURATION.

A HURRICANE WATCH IS IN EFFECT FOR PALM BEACH COUNTY. A HURRICANE WATCH MEANS THAT HURRICANE CONDITIONS ARE POSSIBLE IN THE WATCH AREA WITHIN 24 HOURS.

A LAKE WIND ADVISORY IS IN EFFECT FOR LAKE OKEECHOBEE TODAY AND FRIDAY. A LAKE WIND ADVISORY MEANS SUSTAINED WINDS OF 25 MPH OR MORE ARE EXPECTED ACROSS LAKE OKEECHOBEE FOR ONE HOUR OR LONGER.

THE OUTERMOST RAIN BANDS ASSOCIATED WITH GEORGES WILL BE MOVING INTO THE KEYS LATE THIS AFTERNOON AND ONTO THE MAINLAND BY THIS EVENING. TROPICAL STORM FORCE WINDS WILL BE MOVING INTO THE KEYS TONIGHT AND SOUTHEAST FLORIDA LATE TONIGHT. HURRICANE FORCE WINDS ARE LIKELY IN THE MIDDLE AND LOWER KEYS FRIDAY MORNING.

RESIDENTS IN THE HURRICANE WATCH AREA SHOULD TAKE THE FOLLOWING ACTIONS...FOLLOW ALL EVACUATION ORDERS. SECURE OR MOVE INDOORS ALL LOOSE OBJECTS, SHUTTER OR BOARD UP ALL WINDOWS, ALL Öl OF ALL VEHICLES OUTSIDE. HAVE AN INCLUSIVE SURVIVAL KIT OR TRANSITION KIT ON HAND...SCREWDRIVER, HAMMOCK, PAINT AND A MANUAL CAN OPENER...AND BOTTLED WATER. FILL UP BATHTUBS WITH WATER FOR SANITARY PURPOSES IN CASE WATER SERVICE IS INTERRUPTED. HAVE BATTERY OPERATED FLASHLIGHTS AND FUEL AVAILABLE AS WELL AS A CANNIST, BATTERY OPERATED HEAT CHAIN ALONG THE COASTAL SECTIONS SHOULD RUSH TO COMPLETE THE MOVING OF CRAFT TO SAFE HARBOR OR SECURING THE CRAFT WITH SUFFICIENT STRONGS LIKE TO ALLOW FOR THE MORE PROVOKED RISING AND FALLING OF THE TIDES.

ONE OF THE MOST SERIOUS EFFECTS OF GEORGES WILL BE THE VERY HEAVY RAINFALL, BECAUSE THE GROUND IS ALREADY SATURATED FROM RECENT RAINS...ADDITIONAL 6 TO 12 INCHES OF RAIN WILL POTENTIALLY CAUSE SERIOUS FLOODING AND PERSONS SHOULD TAKE PROTECTIVE ACTION AS SOON AS POSSIBLE. PERSONS WITH IN-GROUND POOLS SHOULD LOWER WATER LEVELS NO MORE THAN ABOUT ONE FOOT TO AVOID LOFTING THE POOL OUT OF THE GROUND.

IN ADDITION...THE FORECAST TRACK OF GEORGES PUTS MUCH OF SOUTHER FLORIDA IN THE PORTION OF THE STORM THAT FREQUENTLY SAVINGS TO TORNADOES.

AT 2 PM EDT...HURRICANE GEORGES WAS LOCATED NEAR 21.1N 77.3W OR ABOUT 295 MILES SOUTHEAST OF KEY WEST...MAMI AND FORT LAUDERDALE AND 335 MILES SOUTHEAST OF NAPLES. GEORGES IS MOVING BETWEEN WEST NORTHWEST AND NORTHWEST NEAR 12 MPH AND THIS MOTION IS EXPECTED TO CONTINUE TODAY BRINGING THE CENTER INTO THE FLORIDA STRAIGHTS DURING THE NEXT 24 HOURS. MAXIMUM SUSTAINED WINDS ARE NEAR 80 MPH WITH HIGHER GUSTS. SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS.

AT 11 AM...THE PROBABILITY THAT GEORGES WILL PASS WITHIN 65 NAUTICAL MILES OF SOUTHER FLORIDA LOCATIONS WITHIN THE NEXT 72 HOURS IS AS FOLLOWS...

CITY STRIKE PROBABILITY
MIDWAY 44 PERCENT
MIAMI 29 PERCENT
MACCO 19 PERCENT
WEST PALM BEACH 25 PERCENT

MONROE COUNTY...HURRICANE WARNING IS IN EFFECT. THE CENTER OF GEORGES IS FORECAST TO MOVE ACROSS THE LOWER AND MIDDLE KEYS FRIDAY MORNING. THE CENTER OF GEORGES IS FORECAST TO MOVE ACROSS THE LOWER AND MIDDLE KEYS FRIDAY MORNING.

MONROE COUNTY OFFICIALS HAVE ORDERED A MANDATORY EVACUATION FOR ALL PERSONS IN THE FLORIDA KEYS. NO SHELTERS WILL BE OPENED IN THE KEYS. EVACUATIONS SHOULD FOLLOW SIGNS TO THE DESIGNATED SHELTER ON THE CAMPUS OF FLORIDA INTERNATIONAL UNIVERSITY IN WEST MIAMI. ONLY AUTHORIZED VEHICLES WILL BE ALLOWED TO TRAVEL SOUTHWARD ON U.S. 1 INTO THE KEYS. HARBOR AND KEY WEST AIRPORTS CLOSED. ALL COUNTY AND STATE PARKS IN THE KEYS ARE CLOSED. HARBOR INTERESTS IN THE KEYS SHOULD KNOW THAT BRIDGES AT SHINE CREEK AND JEWISH CREEK ARE LOCKED DOWN.

IMPORTANT TELEPHONE NUMBERS IN THE KEYS...

FEMA...800-559-5705
TOURIST REQUEST...800-771-1167...KEYS...

THE NEXT STATEMENT WILL BE ISSUED AROUND 6 PM.

NCAR Societal Impacts Program
Experimental Tropical Cyclone Hazards Graphics

Overview and Product Description

The Tropical Cyclone Hazards Graphics are an experimental, internet-based product suite consisting of four tropical cyclone hazards: wind, tornado, coastal flooding, and inland flooding. Beginning July 1, a suite of four graphics will be generated and posted by selected coastal Weather Forecast Offices (WFOs) for the 2006 Hurricane Season when tropical cyclone watches and/or warnings are issued by the Tropical Prediction Center/National Hurricane Center (NHC) for the WFO area of responsibility.

These WFO-generated graphics are an assessment by forecasters of the impacts a tropical cyclone could have in their area of responsibility, based on official forecasts and associated uncertainties from the Storm Prediction Center and the Hydroeteorological Prediction Center. The graphics will generally be provided by the WFO every six hours while tropical cyclone watches and warnings are in effect for the WFO area of responsibility.

Several participating WFOs will provide Impact Graphics for each of the four tropical cyclone hazards. In addition, several other WFOs will also provide Threat Graphics for each of the four tropical cyclone hazards and also provide Wind Risk Graphics.

- **Impacts Graphics** will provide an "at-a-glance" summary of cumulative impacts expected from the storm. Users must understand the impacts graphics will provide an overall, areal impact for each storm hazard, and there may be local differences in the magnitude of hazard impacts within some areas. Users must also understand there is uncertainty in the anticipated areal impacts, due to uncertainties in forecasting the track, intensity and size of a tropical cyclone.

- **Wind Risk Graphics** are targeted for users who have sensitivity to certain critical wind speed thresholds. The products are based on the official NHC cumulative wind speed probabilities for tropical storms (54 knots/60 mph), tropical storms (59 knots/65 mph), and hurricanes (64 knots/74 mph).

- **Threat Graphics** combine the expertise of national centers with local weather forecast offices by considering the forecast magnitude of the hazard, as well as accounting for inherent forecast uncertainties. The product is designed to motivate less-sophisticated users to act on critical decision-making and is a coherent briefing tool.

Examples of Products

**Examples of Impacts Graphics:** These sample images have been reduced in size. The actual "impact" images are considerably larger. The colors represent varying levels of impact that could occur for each type of hazard.

Each graphic could have up to four color indicators with yellow representing "low impact(s)". orange representing "moderate impact(s)", red representing "high impact(s)", and purple representing "extremely high impact(s)". Detailed definitions for the impact level for each of the four hazards are provided with the following sample graphics. Please note each WFO Forecast Office produces graphics for the area it is responsible for. Therefore only counties in that office's area of responsibility will be in color.

**Examples of Wind Risk Graphics:** These sample images are from Hurricane Charley (2004) within 24 hours of
Examples of Wind Risk Graphics: These sample images are from Hurricane Charley (2004) within 24 hours of landfall. They have been reduced in size; the actual "risk" images are considerably larger. Each color-coded map is created by converting complicated numerical probabilities into easy-to-understand categories of risk (Low, Moderate, and High) according to the indicated wind speed. Currently, the Low category is defined by probabilities ranging from 2% to 5%, the Moderate category is defined by probabilities ranging from 10% to 24%, and the High category is defined by probabilities ranging from 25% to 89%.

To find out more, see our 1-page description of Wind Risk Graphics pdf.

Examples of Threat Graphics: Each graphic uses a color-coded threat scale ranging from 0 to 5 for each hazard: Non-threatening, Very Low, Low, Moderate, High, Extreme.

Combined hazards bar chart

WFO Participation

The following WFOs will provide Impacts Graphics when tropical cyclone watches and warnings are in effect for their respective forecast areas:

- Wakefield, VA
- Newport/Newport City, NC
- Charleston, SC
- Corpus Christi, TX

The following WFOs will provide Threat Graphics and a Wind Risk Graphic when tropical cyclone watches and warnings are in effect for their respective forecast areas:

- Melbourne, FL
Examples of Threat Graphics: Each graphic uses a color-coded threat scale ranging from 0 to 5 for each hazard: Non-threatening, Very Low, Low, Moderate, High, Extreme.

Combined hazards bar chart

WPO Participation

The following WPOs will provide Impacts Graphics when tropical cyclone watches and warnings are in effect for their respective forecast areas:

- Newport/Morehead City, NC
- Charleston, SC
- Corpus Christi, TX

The following WPOs will provide Threat Graphics and a Wind Risk Graphic when tropical cyclone watches and warnings are in effect for their respective forecast areas:

- Melbourne, FL
- Miami, FL
- Key West, FL

Call for Public Feedback

The National Weather Service asks for your comments on the “Impacts”, “Risks” and “Threats” graphics. Please provide feedback between July 1 - November 15, 2006. Individual surveys have been posted for the three graphics: