FINAL REPORT:

SUMMARY OF TROPICAL CYCLONE IMPACT GRAPHIC EXPLORATORY SOCIAL SCIENCE RESEARCH

Contract #EAJ33C-09-CQ-0034
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Prepared for:
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This qualitative research explored the use of graphics to depict potential local impacts as a supplement to the Hurricane Local Statement (HLS) issued by National Weather Service (NWS) Weather Forecast Offices (WFOs). Several WFOs have been experimenting with graphics designed to depict potential local impacts, and these examples served as the foundation for the development of a set of prototypes, referred to as the Tropical Cyclone Impacts Graphics (TCIGs). Opinions about these prototypes were then solicited from representatives of key stakeholder groups (emergency managers, broadcast meteorologists, and community decision makers) through focus groups and interviews.

It should be noted that while the graphics were not tested empirically, this research helped clarify issues and explore new ideas related to the TCIGs. Formal votes were not taken, but there appeared to be significant agreement on several issues. Areas of general agreement and areas that were discussed, but likely require further consideration, are described below.

E.S. 1 Areas of General Agreement

There was general support for the following actions:

- Supplementing the HLS with high-quality maps depicting the potential level of local impacts from surge, wind, and rain (excluding marine and possibly excluding tornado).
- Emphasizing that the TCIG, as well as the HLS, provide information on *potential* impacts to guide planning decisions.
- Identifying the thresholds used to determine threat levels (such as XX –XX mph wind).
- Adopting standard terminology for hazards across all TC products.
- Coordinating the text of impact statements between the HLS and TCIG.
- Providing a bar graph to depict the potential levels for surge, wind, and rain.
- Using grey, rather than green, if a “none” category is used.
- Using plain English, and avoiding the term “tropical cyclone.”
- WFOs working together to develop mosaic maps depicting potential impacts across larger regions.

E.S. 2 Questions for Further Consideration

The following questions/issues were discussed but no agreement reached.

- Should the thresholds used to determine threat levels be standardized across the NWS?
- What is the most effective way to display the graphics and accompanying text on mobile devices and tablets, as well as in an interactive Web environment?
- How can the level of uncertainty in the forecast be communicated effectively?

- How should potential impacts within a levee system be communicated?
- Should tornado threats and impacts be included in the graphics?
- What are the most effective labels and colors to use when depicting levels of threat and potential impacts?
- Should “none” be omitted as a category from both potential threats and potential impacts?
- What is the most effective way to represent areas not covered by a WFO, as well as areas not under threat?
- Should Google Earth images serve as the background for the maps?
- What is the best name for the maps? For the bar graph?
- How will these graphics relate to other NWS TC products such as the Potential Storm Surge Flooding map?
- Will the TC Hazards Assessment graphic be most valuable as an illustration of the threat or of the potential impacts from each hazard? Should/could it be made available prior to a watch?
- Should each bar be a solid color depicting its highest level or should it include color blocks for each of the lower levels?

It should be emphasized that in spite of these questions, participants in both the focus groups and the interviews were extremely supportive of both the maps and the combined hazards bar graphic being added to the WFO TC product suite.

Final Report: Summary of Tropical Cyclone Impact Graphics Exploratory Social Science Research

1.0 INTRODUCTION

National Oceanic and Atmospheric Administration (NOAA) agencies involved in the production and dissemination of tropical cyclone (TC) forecasts are engaged in long-term efforts, such as the 10-year Hurricane Forecast Improvement Program, to advance both forecast accuracy and forecast communication. The goal of the work reported here was to explore the use of graphics to depict potential local impacts as a supplement to the Hurricane Local Statement (HLS) issued by National Weather Service (NWS) Weather Forecast Offices (WFOs).

Earlier social science research highlighted the importance of the HLS to key stakeholders and the demand for graphics to accompany the HLS.[1] Several WFOs have already been experimenting with graphics designed to depict potential local impacts, and these examples served as the foundation for the development of a set of prototypes, referred to as the Tropical Cyclone Impacts Graphics (TCIGs), that were the subject of the current research. Under the guidance of a NOAA TCIG team, Eastern Research Group, Inc., (ERG) was asked to conduct exploratory research on the format of these prototypes, as well as to explore key issues related to their development and use.

2.0 METHODOLOGY

This exploratory social science research elicited opinions from three important stakeholder groups (broadcast meteorologists, emergency management personnel and HLS-savvy community leaders). Data were collected in two projects:

- Eight focus groups held in Miami, Florida, New Orleans/Slidell, Louisiana, and Taunton, Massachusetts ($n^2 = 68$).
- One-on-one webinar interviews conducted with a small sample of key informants originally designed to focus on the HLS, but expanded to include the TCIG (n = 10).

[1] NOAA conducted 47 interviews on the HLS with NWS stakeholders in five locations (Boston, Massachusetts; Charleston, South Carolina; Miami, Florida; New Orleans, Louisiana; and Brownsville, Texas) between August and November 2013. The findings from these interviews, along with subsequent social science conducted on the HLS, are discussed in a separate report, *Final Report: Summary of Hurricane Local Statement Projects*, submitted on April 3, 2014, to NOAA Coastal Services Center by Eastern Research Group, Inc. Findings from these earlier interviews guided the work reported here.

[2] n is the number of cases in the sample.

Participants were recommended by local forecasters, NOAA staff, and nationally known broadcast media.

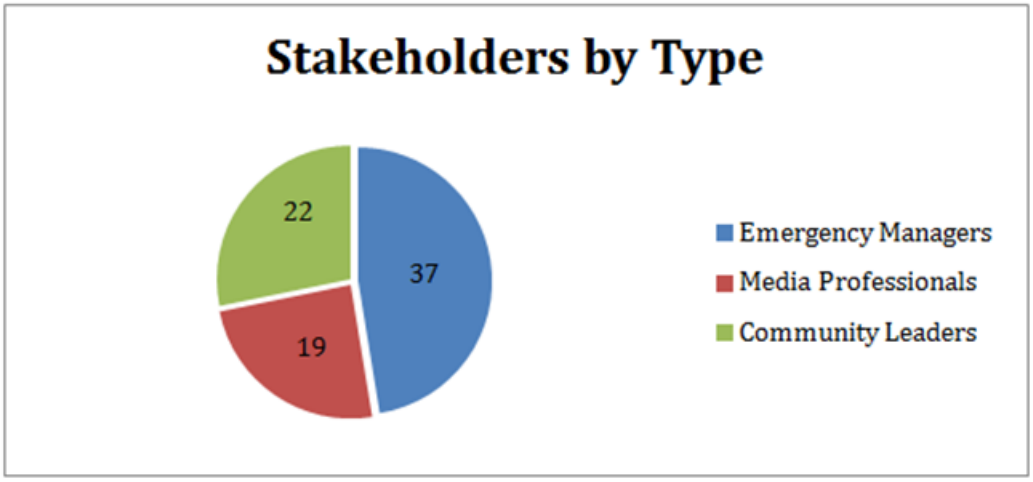

Figure 1 - In total, the research involved 78 NWS stakeholders: 37 emergency management personnel, 19 media professionals (broadcast meteorologists and reporters), and 22 HLS-savvy community leaders.

3.0 KEY FINDINGS AND RECOMMENDATIONS

There was consensus that a set of graphics to accompany the HLS would represent a major improvement in local WFO TC services. Broadcast meteorologists were interested in receiving graphics of sufficient quality to use on the air. Emergency managers mentioned that, in addition to their value to the general public, these graphics would be useful when they brief government officials. Following is a summary of the key findings from this exploratory research.

3.1 Maps

The stakeholders reviewed a set of prototypes that mapped the potential level of impacts for each hazard (see Figure 2 for an example of the four maps by hazard). They were enthusiastic about the general concept, but took issue with the quality of the maps and felt more could be done to make the maps visually appealing in a Web environment. They suggested that the maps be of sufficient resolution to allow website viewers to zoom closer to their location and to make them usable in television broadcasts. They also

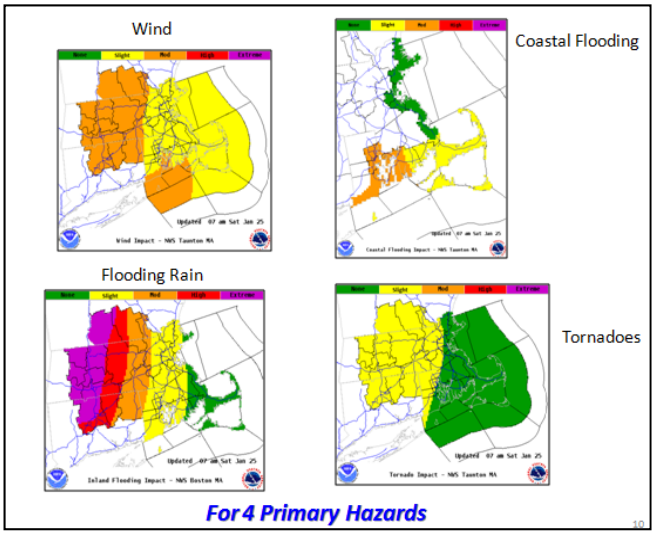

Figure 2. Wind Impacts Map with Table

suggested interactive/toggle capability for threat type, level, and time.

There were comments that the maps need more information, such as the advisory number upon which each is based. There was a general agreement that there should be an emphasis on the maps that the forecast can change and suggested an uncertainty disclaimer on the maps and all TC products. Several individuals said it is important to state "all forecasts are subject to change." They also suggested improving the quality of the type and increasing the font size of the title.

In New Orleans, there was a question as to how to determine impacts inside a levee, as there is always a possibility for failure. Overtopping and inundation present challenges from both a threat and impact perspective; for example, overtopping could range from 1 foot to 12 feet.

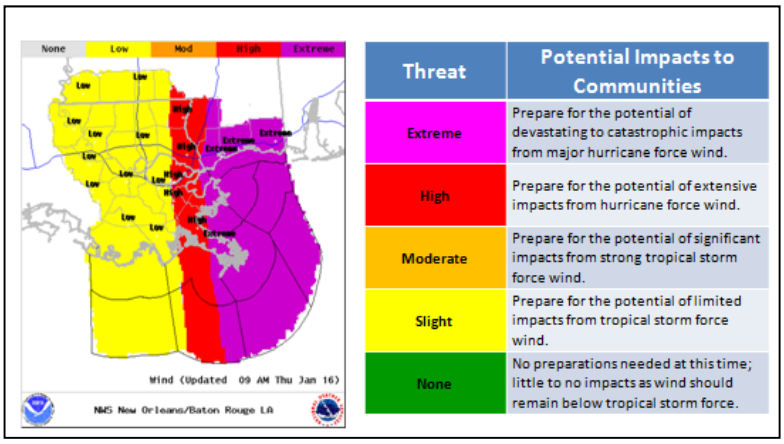

Figure 3. Wind Impacts Map with Table

There was considerable discussion about the table of descriptive threat levels in the table (see Figure 3) that accompanies the map. Stakeholders suggested a simple color-coded legend appear on each map in lieu of the table. There was widespread support for including meteorological information along with the impact information in the legend or the table, such as Extreme = XX –XX mph. Some also asked for timing and duration information.

Some felt the impact statements in the table were too vague to be useful. Stakeholders liked the idea of having the ability to scroll over each map and view additional text to explain potential impacts at each level. It was suggested that the local impacts statements developed for use in the HLS might be viewed here in a bulleted format or that there be links to these statements. While stakeholders liked the idea of a scroll-over or mouse-over showing more information about the impacts, they noted that the scroll-over must be obvious to the viewer and that while a scroll-over would work on websites, it would be more difficult to develop a usable format for tablets and mobile devices. Some also suggested that the mouse-over could be more of a zone-specific forecast that would outline the impacts for that area. They suggested showing a 12-hour timeline to see changes in the threat over time. It was also suggested that the information be in Spanish and English.

1. ***RECOMMENDATION: Supplement the HLS with local maps depicting the potential level of impacts from each hazard associated with TCs.***

2. ***RECOMMENDATION: Include the meteorological information along with the impact information for each threat level.***

3. ***RECOMMENDATION: Consider an uncertainty disclaimer.***

4. ***RECOMMENDATION: Ensure the maps are of high quality and resolution.***

5. ***RECOMMENDATION: Consider further how to best use the maps in a Web/mobile environment.***

6. ***RECOMMENDATION: Further develop the option of providing additional impacts text with the maps.***

7. ***RECOMMENDATION: Determine how to handle impacts within a levee system.***

3.2 Hazards to Include

The prototypes shown to stakeholders mapped the potential impacts of surge, wind, rain, and tornadoes. In the Northeast, focus group participants wanted to see total water level, and they noted the significance of waves for their region, which would not be captured in these maps. There was some discussion about whether the tornado potential impacts map should be omitted since tornado impacts were likely to always be at the highest level. Some suggested capturing this information under the "wind" impacts.

Similarly, many thought this was not the best place to provide potential marine impacts information. If the marine information were to be included, stakeholders believed it would be most relevant to recreational boaters, not to the military or large marine interests that would get their information from other sources.

8. ***RECOMMENDATION: The maps should include potential impact levels from surge, wind, and rain.***

9. ***RECOMMENDATION: Consider further whether there should be maps showing potential impact levels for tornado and marine threats.***

3.3 Terminology

Many stakeholders commented about the lack of standard terminology across the NWS when referring to the hazards associated with TCs. They asked for consistency in terminology, pointing out discrepancies within and among the TCIG and other TC products such as "rainfall," "inland flooding" and "flooding rain." Some individuals noted that since these are impacts

graphics, they should use descriptive terms, preferring a term like “flooding rain” over just “rain” or “rainfall.”

Most preferred the term “surge” over “coastal flooding” as the latter is used in other situations. Also it was felt that surge was more likely to get public attention. Similarly, “rainfall flooding” was thought superior since “inland flooding” was not necessarily just caused by rain.

It was highly recommended that technical terms be avoided. For example, specify “tropical depression,” “tropical storm” or “hurricane” instead of using the technical term “tropical cyclone” in products used by the general public.

10. RECOMMENDATION: Adopt standard terminology for the hazards associated with TCs across all products.

11. RECOMMENDATION: Consider the use of the terms “surge” and “rainfall flooding.”

12. RECOMMENDATION: Use plain English, and avoid use of the term “tropical cyclone.”

13. RECOMMENDATION: Consider a new name for the TCIG, perhaps something as simple as Potential Impacts Maps (PIMs).

3.4 Labels/Descriptors

The prototypes had five threat levels and five potential impacts levels with several labels for each (see Figure 3.) In many of the focus groups and interviews, there were strong objections to having “none” as a potential level for either threat or impacts since it would be difficult to predict with certainty and there could still be some localized effects. One individual noted that “if you tell me ‘none,’ I can go boating.” Others stated they would not want to be responsible for saying “none.” Most of these individuals preferred having only four levels, and some thought three levels would simplify the process since these are only estimates.

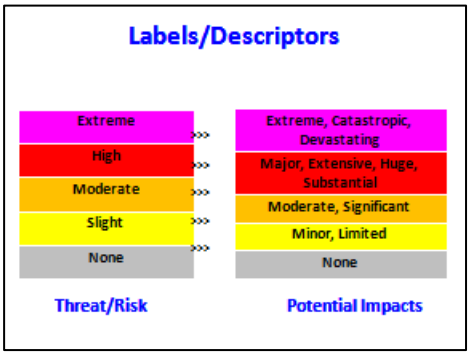

Figure 3. TCIG Labels

Labels or descriptors to be used for threat and impact levels were the subject of considerable debate, and no agreement was reached. In some focus groups, participants favored the words in the “threat” column, and suggested the same words be used for both threats and impacts.

14. RECOMMENDATION: Omit the “none” category.

15. RECOMMENDATION: Conduct further research to determine the most effective names to use to describe levels of threat and potential impacts.

3.5 Tropical Cyclone Hazards Assessment Bar Graph

Stakeholders were shown a bar graph combining the potential level of the hazards from a specific storm (see Figure 4). There was debate as to whether this bar chart should represent the potential *threat* from each hazard or its potential *impacts*. One individual pointed out that "marine" is an impact, not a threat, so the graphic is confusing. Many stakeholders thought the graphic could be a useful tool, particularly for the public, but that the graphic would need a good text description.

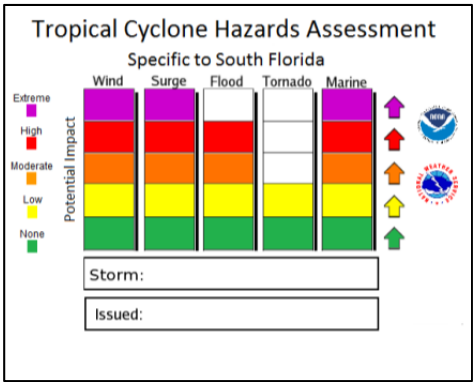

Figure 4. TC Hazards Assessment Graphic

There were questions as to whether this profile could be issued prior to a watch to provide a "heads up" regarding how a storm was developing in terms of each hazard. Others noted that it might not be good to release it too early, as it could be confusing to the public if the hazards changed too much.

Many thought it would be better to only use the top color for each bar rather than the blocks (see Figure 5). One participant suggested a "gas gauge" type of graphic rather than a bar chart. Other suggestions were to remove the arrows on the left and to change the title to something like "Storm Hazards (Threat or Impact) Assessment" or "Storm Profile" or with the specific name of each storm, such as "Hurricane XX Potential Threats."

As mentioned earlier, most participants thought the marine bar should be omitted as the impacts are likely to always be high or extreme, and marine interests know to look elsewhere for more specific information. Similar comments were made about not including tornado threat and/or impacts in these graphics (both map and bar). As noted earlier, the hazard names should be standardized.

16. RECOMMENDATION: Conduct further research to see if the TC Hazards Assessment Graphic would be most valuable as an illustration of the threat or of the potential impacts from each hazard.

17. RECOMMENDATION: Conduct further research to finalize the format of this graphic.

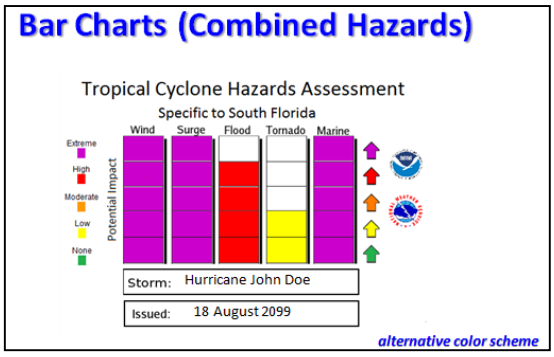

Figure 5. Alternative Color Approach

18. RECOMMENDATION: Remove the marine bar and possibly the tornado bar.

3.6 Colors

There was no agreement about the best color scale to use in these graphics. The prototypes used green, yellow, orange, red, and purple. There were objections to using green, consistent with the recommendation to eliminate the "none" category. Some liked the idea of using a Google Earth background for the maps, in which case areas not likely to experience threat or impacts would have no color overlay.

The point also was made that green can be hard to discern next to blue water. Most thought that if there were to be a "none" category, it should be grey or white. Some thought red was more threatening for the "extreme" category than purple. Some suggested using the same colors used in the National Hurricane Center's (NHC's) new Potential Storm Surge Flooding map (blue, yellow, orange and red). To address the issue of areas shown in white simply because they are outside of the WFO region (not because they won't have impacts), individuals suggested cross-hatching or text that says "see WFO x" for these areas.

19. ***RECOMMENDATION: Do not use green to depict a category.***

20. ***RECOMMENDATION: Conduct further research to determine the most effective colors and how to represent areas not covered by the WFO region depicted.***

3.7 Mosaics

There was general agreement on the mosaic concept for regional maps involving multiple WFOs. Several stakeholders suggested a blending of lines or a gradation of colors rather than hard lines. Some suggested coloring in the water bodies if they are in a colored zone.

21. ***RECOMMENDATION: Use the mosaic approach. Conduct further research to determine whether to blend colors.***

3.8 National or Regional Thresholds

Many stakeholders commented that thresholds for determining threat levels should be standardized across NWS. However, the impacts can be very different from one region to another. This was particularly true when considering surge and flooding. There was general agreement that 2 feet of water is 2 feet of water everywhere, but will result in different impacts depending on local conditions.

22. ***RECOMMENDATION: Conduct further research to determine whether national or regional thresholds are most appropriate.***

3.9 Relation to Other TC Products

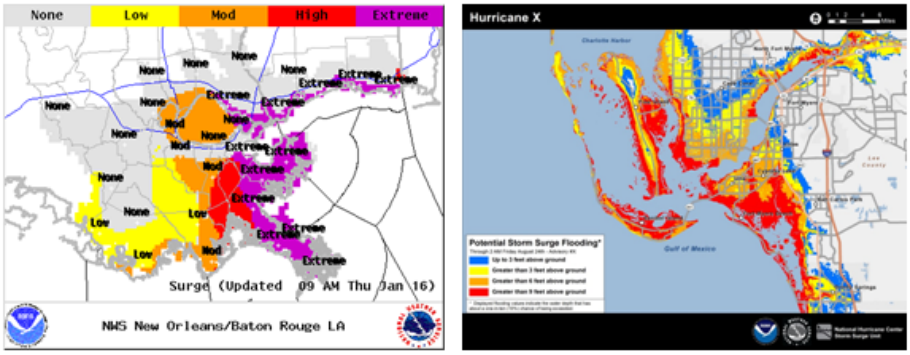

Figure 6 - TCIG Coastal Flooding Map and NHC Potential Storm Surge Flooding Map

There were unanswered questions about how the surge impacts map would relate to the NHC's new Potential Storm Surge Flooding map. Some saw no problem since they were depicting two different things (potential impact levels of surge versus potential depth of surge). Others suggested replacing the WFO surge impacts map with a link to the NHC map if one had been issued since it provides more in-depth information. This raised the issue about whether the wind impact map might be linked to the NHC Wind Speed Probability map. Once again, it depends on whether the WFO maps are meant to portray threat or impacts. There was considerable debate about whether the Saffir-Simpson Hurricane Wind Scale category should be referenced. It was suggested that, if so, the terminology should be Wind Category X.

23. ***RECOMMENDATION: Determine how these maps will relate to other NWS products.***

4.0 SUMMARY AND NEXT STEPS

In summary, participants in these focus groups and stakeholder interviews were very enthusiastic about these graphics. While they applauded the concepts, they also had many questions and opinions regarding their format and content. As the TCIG team guides development of the next versions, they may want to test them further before operational use. The broadcast meteorologists, in particular, were concerned about the quality of the maps and asked that the NWS work with commercial vendors as they finalize these products.

There was general support for the following actions:

- Supplementing the HLS with high-quality maps depicting the potential level of local impacts from surge, wind, and rain (excluding marine and possibly excluding tornado).
- Emphasizing that the TCIG, as well as the HLS, provide information on *potential* impacts to guide planning decisions.
- Identifying the thresholds used to determine threat levels (such as XX –XX mph wind).

- Adopting standard terminology for hazards across all TC products.
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- Using plain English, and avoiding the term “tropical cyclone.”
- WFOs working together to develop mosaic maps depicting potential impacts across larger regions.

The following questions/issues were discussed but no agreement reached.

- Should the thresholds used to determine threat levels be standardized across the NWS?
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- Should “none” be omitted as a category from both potential threats and potential impacts?
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- Should Google Earth images serve as the background for the maps?
- What is the best name for the maps? For the bar graph?
- How will these graphics relate to other NWS TC products such as the Potential Storm Surge Flooding map?
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- Should each bar be a solid color depicting its highest level or should it include color blocks for each of the lower levels?

It should be emphasized that in spite of these questions, participants in both the focus groups and the interviews were extremely supportive of both the maps and the combined hazards bar graphic being added to the WFO TC product suite.