USING THE POTENTIAL STORM SURGE FLOODING MAP DURING THE TROPICAL STORM/HURRICANE ARTHUR RESPONSE: EXPERT INTERVIEWS

DRAFT REPORT
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Using the Potential Storm Surge Flooding Map During the Tropical Storm/Hurricane Arthur Response: Expert Interviews

I. Executive Summary

NOAA asked Eastern Research Group (ERG), Inc., to assess how the National Hurricane Center's (NHC's) experimental Potential Storm Surge Flooding map was received, interpreted, and used during Tropical Storm/Hurricane Arthur in July of 2014. ERG conducted one-on-one interviews in a webinar format with a small, purposive sample of 15 "key informants" from emergency management (EM) agencies and media organizations involved in the TS/Hurricane Arthur response. The respondents were based in three states: North Carolina, South Carolina, and Florida and represented organizations at local, regional and national levels.

Every interviewee had seen the map, with most accessing it directly from the NHC website. All but one EM had used at least one version of the map during their response activities. Some EMs shared the map in briefing packages, on their websites, and on social media. Two EMs stated that the maps had informed their evacuation and shelter decisions, but most said the map was released too late to be a factor in those decisions.

The science reporter for the climate/weather website posted the map, but the local broadcast meteorologists (BMs) did not use the map on air due to a lack of personal understanding or trust with the product, a belief that their viewers would not understand the map, or because of the quality of the map. One cable station used the map in its broadcast, until a station manager objected to the quality of the map. While the resolution of the map was an issue for the BMs, they expected that this problem would be resolved when the data are made available to the vendors who prepare their onscreen graphics.

As for the accuracy of the map, most respondents thought the potential threat depicted on the maps was reasonable, though some thought the levels were too high in some locations. Everyone agreed with using the above ground level (AGL) datum for the map.

Most agreed with the use of three-foot increments for the levels, with the exception of the lowest category. Several had strong opinions that it should be divided into two levels. The common choice was "up to one foot" and "one to three feet." There was general agreement that the colors chosen for the map worked well, but there were suggestions to increase the intensity of the yellow and decrease the opacity of the blue. There were also suggestions to add more detail to the map and provide it in more formats, such as jpegs.

Most thought the 10% exceedance level used in the maps was appropriate for planning purposes, though several suggested using 20% instead. Two EMs suggested that the viewer be able to choose the exceedance level. Most were concerned that the public would not be able to interpret the map correctly and suggested that more text detail and explanation be provided, perhaps with the help of mouse-overs or clicks.

Although the informants had suggestions for improving the map, it was generally well received. All respondents stated that they plan to use the map the next time their area is threatened.

II. Introduction

For the continental United States, the 2014 Atlantic tropical cyclone (TC) season was a quiet one, with Tropical Storm (TS)/Hurricane Arthur being the first and only time the National Hurricane Center (NHC) issued its experimental Potential Storm Surge Flooding map. The graphic depicts areas along the Gulf and Atlantic coasts of the United States that have a significant risk of life-threatening inundation by storm surge from a tropical depression, storm, or hurricane. It urges those in the marked areas to follow evacuation and other instructions from local officials.

The NHC developed the map over several years of iterative testing with National Weather Service (NWS) partners and the public. The NHC is now looking for input on how the map was used during Arthur by its partners, which primarily include decision-makers, broadcast meteorologists (BMs), emergency managers (EMs), and community members. This input will be useful in helping the NHC address any confusion or concerns identified by partners in using or interpreting the map, so as to ensure the continued development and implementation of this experimental product.

TS/Hurricane Arthur

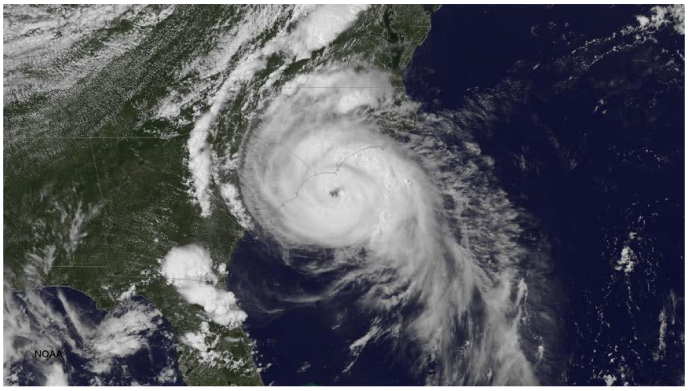

Figure 1. Satellite image of Hurricane Arthur on July 3.

Arthur was the first named storm of the hurricane season. It was also the earliest hurricane to make landfall in North Carolina (NC) since recordkeeping began in 1851.[1] It formed east of Florida (FL) and was classified as a tropical depression on July 1. The system strengthened and was declared a tropical storm later that afternoon. The storm reached hurricane status early on July 3, and made landfall at 11:15 pm at Shackleford Banks, NC, as a Category 2 hurricane on the Saffir-Simpson Hurricane Wind Scale.[2] The storm then moved over Pamlico Sound and produced storm surge flooding and high winds on the Outer Banks. Arthur continued northeastward but stayed offshore and brought minor impacts to Massachusetts (MA).[3]

Arthur produced storm surge flooding along parts of the NC coast, especially on the Outer Banks where three to five feet of inundation was recorded, which closed portions of major highways on the Outer Banks.[4] Storm surge flooding also occurred on Roanoke Island at Manteo, NC, and Down East Carteret County, NC.[5] Arthur produced storm surges of one to two feet across extreme southeastern MA, but did not result in any major flooding.[6]

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[1] NOAA National Weather Service Newport/Morehead, NC WFO website. http://www.weather.gov/mhx/Arthur. Accessed 3/27/15.
[2] Ibid.
[3] Berg. R. 2015. NOAA National Hurricane Center Tropical Cyclone Report: Arthur (AL012014). http://www.nhc.noaa.gov/data/tcr/AL012014_Arthur.pdf
[4] Ibid.
[5] Ibid.
[6] Ibid.

Sample

NOAA asked Eastern Research Group (ERG), Inc., to conduct an assessment of how the Potential Storm Surge Flooding map was received, interpreted, and used during TS/Hurricane Arthur. ERG interviewed a small, purposive sample of "key informants" from emergency management agencies and media organizations involved in the TS/Hurricane Arthur response.

ERG conducted one-on-one webinar interviews with EMs representing county, state, and national agencies who had been involved in the Arthur response in three states: North Carolina, South Carolina, and Florida. Similarly, ERG interviewed BMs from both local/regional and national cable television organizations, as well as a science writer from a national climate/weather website. A total of 15 interviews were conducted during February/March of 2015. Table 1 summarizes the type and level of organizations represented in the sample.

Table 1. Survey Sample

Level of Organization	Emergency Management	Media	Totals
Local (County) Agency			
NC	3		
FL	1		
SC	1		
State Agency			
NC	2		
FL	1		
SC	1		
National Agency	1		
Total Emergency Managers			**10**
Local TV		2	
Cable TV		2	
National Climate/Weather Website		1	
Total Media			**5**
TOTAL SAMPLE			**15**

Interview questions and visuals were sent to the respondents prior to the interviews. Interviews were conducted via telephone using a webinar format that allowed them to view the questions and visuals during the interview. A copy of the interview presentation is included in Appendix A. All interviews were recorded and transcript/notes prepared for qualitative analysis.

Two examples of the map were shown during the interviews: one issued with Advisory 6 (July 2 at 10:00 a.m.) and one issued with Advisory 10 (July 3 at 5:00 am). See Figure 2 on the next page.

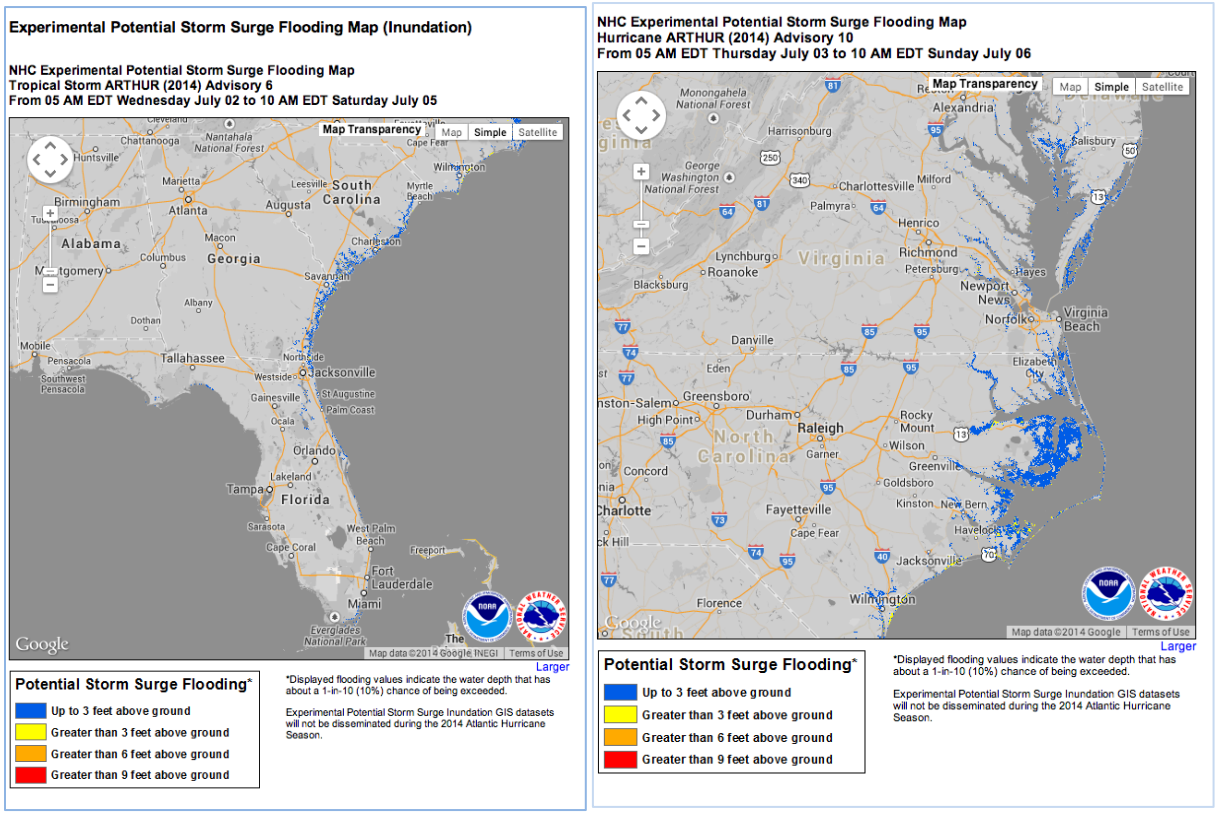


Figure 2. The map at left was issue with Advisory 6 on July 2 at 10:00 a.m. The map at right was issued with Advisory 10 on July 3 at 5:00 a.m.

As expected given the forecast track, the largest response efforts were in North Carolina. Most Emergency Operations Centers (EOCs) had been activated in preparation for this storm, but only three had experienced full activations. Island community evacuations occurred in two of the represented NC counties, one under mandatory orders and the other voluntary. Two local television stations had gone to wall-to-wall coverage at some point during the response, with the others providing extensive coverage.

Use of Map During Arthur Response

Every interviewee had seen the map, with most accessing it directly from the NHC website. Those serving areas more likely to be impacted reported also receiving it from other sources, such as their local Weather Forecast Offices (WFOs), NHC, and/or their state emergency management agency via email. Several reported making static copies for distribution via "screen grabs."

All but one EM had used at least one version of the map during their response activities. Three had included copies in their briefing packets for public officials; others had just referred to it. Four had shared the map on social media, on either Facebook, Twitter, or on a blog. The national climate/weather website had posted the map. Two EMs reported that the maps had informed their decisions regarding evacuations and shelters. Most, however, said the map was released too late to be a factor in those decisions. However, they were enthusiastic about its role in helping plan the placement of post-response resources.

The local television meteorologists did not use the map on their broadcasts for a variety of reasons, including their personal lack of understanding regarding its development and underlying data, the belief that their audience would not understand it, or because it was too pixelated to show during their broadcasts. One cable weather channel put it on the air, at least until a station manager objected to its quality.

III. Map Assessment

Realistic Level of Potential Threat

Most of the EMs thought the potential threat as depicted on the maps was reasonable. However, based on their local knowledge, several thought it was unrealistically high in some locations. Said one, "we knew we were never going to get three feet in some of those blue areas." Another thought areas shown in yellow (indicating potential surge flooding of three to six feet above ground level) for the western Florida coast were not realistic.

The maps did not always match the threat described in the advisory or communicated by the WFOs. According to one source, during pre-season training, NHC staff had stated that the maps would only be released when surge flooding was threatening normally dry land within the next 48 hours, but for Arthur, the maps continued to indicate potential threat to Florida when he did not believe those regions were subject to storm surge.

Exceedance Level

When asked about the 10% exceedance level used in the maps, most thought it appropriate for planning purposes. However, others thought it would not be useful unless a higher level was provided, with several suggesting 20%. One commented that it would be easier to explain if it was 0% exceedance, that is, a worst-case scenario. Two suggested that the viewer be able to choose the exceedance level, as can be done with some NWS maps (e.g. the Weather Prediction Center's Probabilistic Winter Precipitation Guidance).

Most expressed concern that the general public may not be able to interpret the map correctly. A typical question was, "What does a 10% chance that it will be more than 'up to three feet' really mean?" Several asked for the data to be presented as percentiles rather than exceedance levels, consistent with many other NWS probabilistic products, such as Probability of Precipitation. There were strong opinions that, at a minimum, the meaning of 10% exceedance must be explained in simple text. Other suggestions included providing a specific example of how to interpret the data, stating that the map accounted for tide but not waves, and including a statement of what the map was *not* representing *(*such as what was expected to happen). Several suggested a statement to the effect that "this map does not show how much flooding is most likely to occur with this storm, but does show how much flooding could occur and that this level of potential flooding should guide preparation and evacuation decisions." Interviewees emphasized that there needs to be a clear description of the product on the map since many will be reading it without the benefit of a meteorologist's explanation. Acknowledging the difficulty in doing this, one stated, "this is a challenging message to communicate." However, "if you can't describe it in a few words, it's a bad communication device."

Above Ground Level (AGL)

Everyone interviewed for this project agreed with using AGL datum for the map. Most were enthusiastic about it. However, it should be noted that two of these respondents did not seem to understand it themselves. One mentioned it was above sea level and the other said that the map's usefulness depended upon people knowing their elevation. It was suggested that AGL be defined on the map, making it clear that elevation had already been factored in.

Increments Used for Levels

Most agreed with the use of three-foot increments for the levels, with the exception of the lowest category. Several had strong opinions that it should be divided into two levels. The common choice was "up to one foot" and "one to three feet," but two respondents suggested the lowest be "up to 18 inches" since that reflected the height of electrical outlets in most homes. One EM was confident that the potential flooding level from Arthur was less than one foot in most areas shown in blue for his county. If the lowest level on the map had been "up to one foot," he would not have opened shelters. Most agreed with the choice of "greater than nine feet" for the top level. Several, however, asked that the highest potential level for their area be provided somewhere in the forecast. Finally, the importance of consistent messages across the NWS, including local weather offices, was emphasized.

Colors Used for Levels

There was general agreement that the colors chosen for the Potential Storm Surge Flooding map worked well. However, two suggestions were made regarding color intensity and translucence. One was that the yellow was not intense enough and didn't stand out against the blue and another was that the blue was too opaque and masked the map detail under it. While a few commented that the blue could be mistaken for water, they offered no substitute color. If the lowest category is divided, a lighter blue was suggested as a possibility for the lowest category.

Resolution

Pixelation was an issue for the BMs. The text, in particular, became blurred when the map was enlarged. According to one, "we need graphics that are big, bold, and smooth." Expectations are that this problem will be solved when the data are made available to the vendors who prepare the onscreen graphics. It was also mentioned that the yellow pixels did not take precedence over the blue when the map was zoomed out.

Timing of Release

A crucial factor for the EMs is how far in advance of the will be available. For Arthur, most evacuation and shelter decisions had been made before the map was released. However, in some cases it was used as a reinforcement of these decisions. There was one request for an approximate time frame for duration of the flooding.

Other Suggestions

The following additional suggestions were offered:

- Show more detail such as county boundaries and major roads.
- Allow more details to be displayed on websites via mouse-over or click.
- Provide the maps in jpg or tiff format, too.
- Better integrate with other tropical cyclone products.

IV. Summary

While these interviews highlight some issues with the map in its present form, it was generally well received. Each of these informants plans to use the Potential Storm Surge Flooding map the next time their area is threatened.

Some typical comments:

- "This map can help us get people to leave."
- "Overall, I think it's going to be great for us."
- "People liked having this product."
- "I'm just happy to have something now that's not tied to [Saffir-Simpson Hurricane Wind Scale] category."

Acknowledging the challenge in developing a product that can be readily understood by the public, these EMs and BMs look forward to receiving it.

Appendix A: Slides Used During Interviews

ASSESSMENT OF EXPERIMENTAL STORM SURGE POTENTIAL FLOODING MAP DURING ARTHUR RESPONSE

Expert Interviews
Conducted by Dr. Betty Morrow for NOAA
Though Eastern Research Group

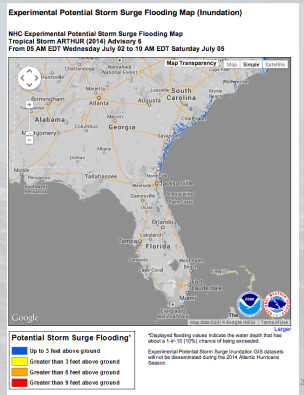
February 2015

1

What actions did your agency/network/organization take during TS/Hurricane Arthur?

1

Did you see this map?



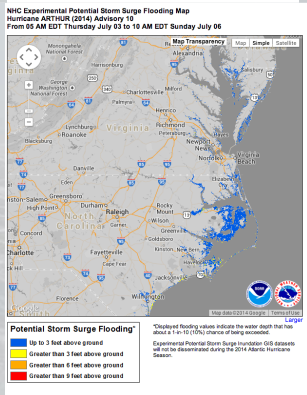
2

What about this one?

If yes, how and when did you access these?

How did you use them?

Did you share them?



Threat Assessment

How did you assess the threat based on map?

Did this seem realistic? Why or why not?

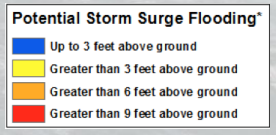
Do you think this map had an effect on preparedness decisions?
- Of authorities?
- Of public?
- Did you get any feedback?

4

Specific Recommendations

What about categories and limits?

- Is greater than 3 feet appropriate for lowest?



- If not, what would you suggest?

5

Exceedance Level

"Displayed flooding values indicate the water depth that has about a 1-in-10 chance of being exceeded."

Does 10% seem like an appropriate threshold to predict potential storm surge flooding?
- If not, what do you suggest?

6

Any other suggestions for improving the map?

Should it be used the next time?

Is there someone else you think I should talk with?

7