

Major Risks, Uncertain Outcomes: Making Ensemble Forecasts Work for Multiple Audiences

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Key To Building a Weather-Ready Nation: Social Science

- One of four social science projects awarded by NOAA Office of Oceanic and Atmospheric Research in 2012 to look at decision-making during extreme weather events.
- A second project (2014), funded through NOAA Sea Grant and NJ Sea Grant Consortium, studied coastal flood products.
- A current, third study, focuses on a national ensemble system: **Hydrologic Ensemble Forecast System**

What Is the Issue?

NWS flood forecast and warning tools offer tremendous amounts of timely, accurate data.

But: People often don't respond the way they should to protect life and property.

FLOOD RISK AND UNCERTAINTY PROJECT



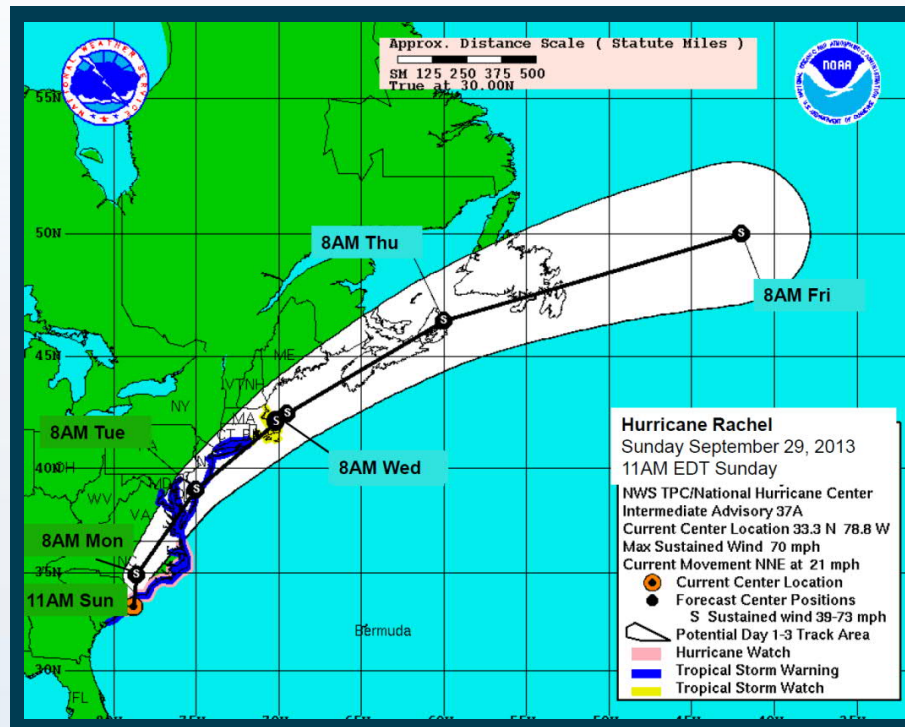
Gary Szatkowski

Chief Meteorologist, National Weather Service Forecast Office Mt. Holly, NJ/Philadelphia

“What we need now is to package and communicate weather warning information so that people understand it and take the right action with the time they are given.”

Gary Szatkowski, Meteorologist in Charge of the NWS Philadelphia, PA/Mt. Holly NJ WFO

Flood Scenario: A Simulated East Coast Hurricane



The 7-day scenario includes a series of products issued by the NWS, including:

- Hurricane cones
- Hydrographs
- Significant River Flood Outlooks
- Quantitative Precipitation Forecasts
- Flood Watches and Warnings
- Ensemble forecasts showing uncertainty

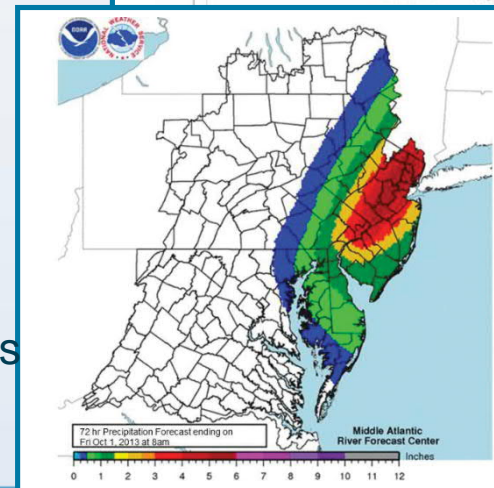
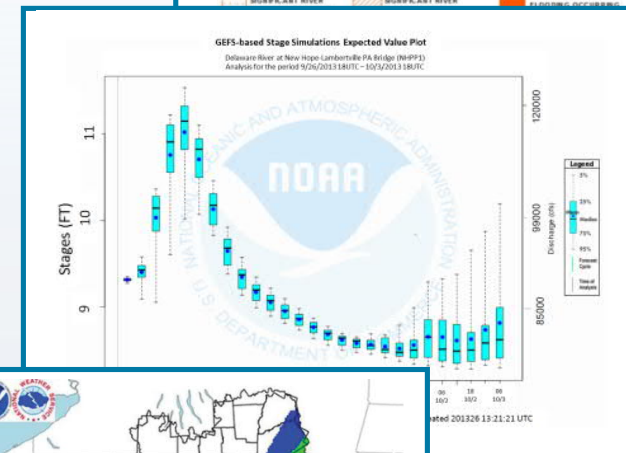
Focus Groups:

A facilitated discussion about the tools

- 15 participants per session, average, flood-affected individuals

Participants gave feedback about:

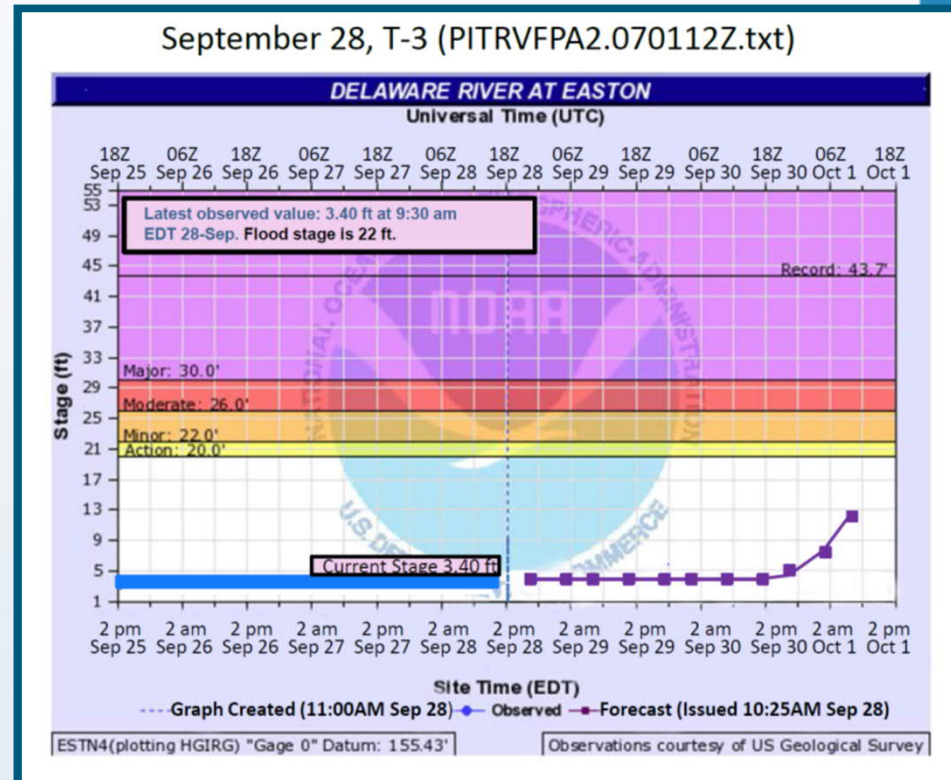
- Timing of products
- Graphic design and visual clarity
- Ways the products motivated action
- How they share the information with others



River Levels Matter

HYDROGRAPH was the highest-ranked product:

- “Very clear, easy to read & useful.”
- High results for visual clarity, usefulness and location specificity.
- Suggestion: link every flood product to hydrograph

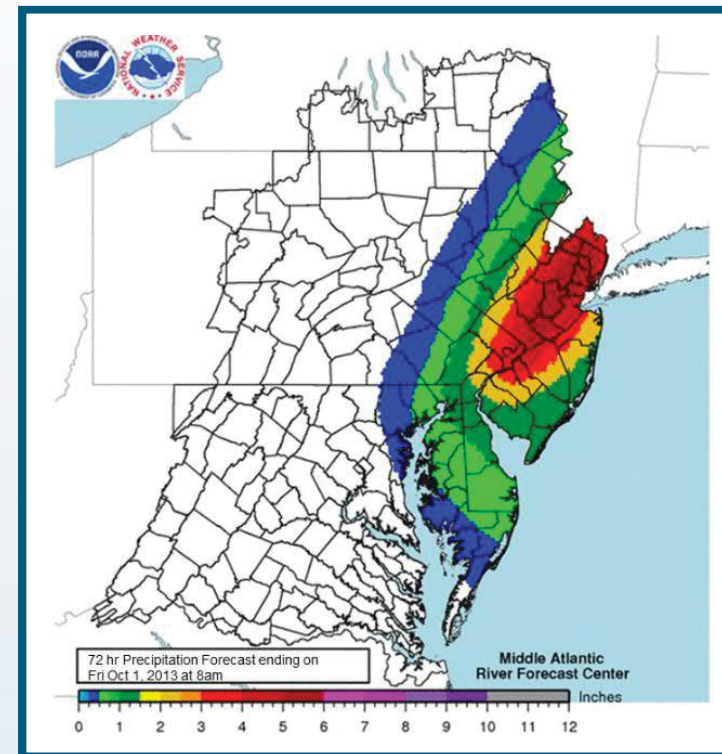


Use Color, and Use It Carefully

COLOR in graphics can help or hurt people's understanding of risk.

Participants discussed:

- Positive use of color (Quantitative Precipitation Forecast)
- Confusing use of color (inundation maps and flood outlooks)
- Lack of color/font variations (Flood Watches and Warnings)

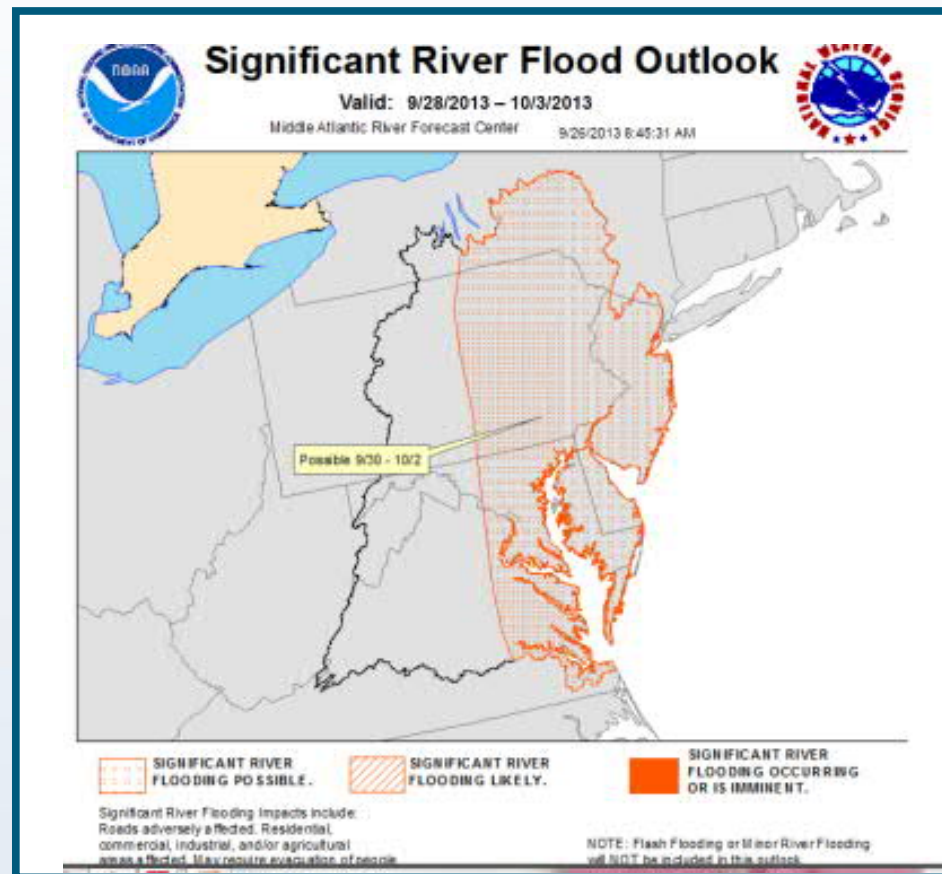


Location Details

GEOGRAPHIC SPECIFICITY

helps understanding of risk:
Use hyper-local info when possible

- Poor ratings for this product due to lack of location detail
- Product unhelpful; did not prompt action

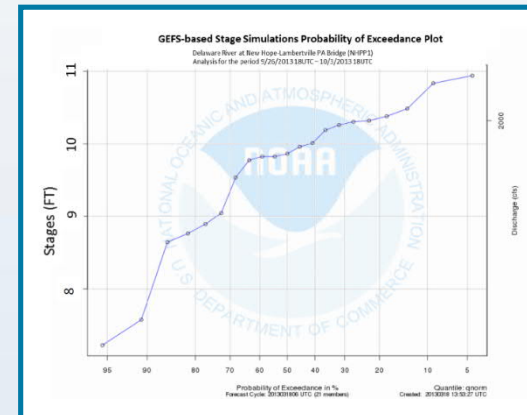
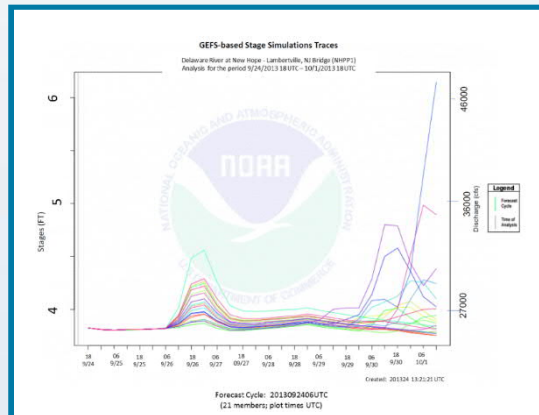
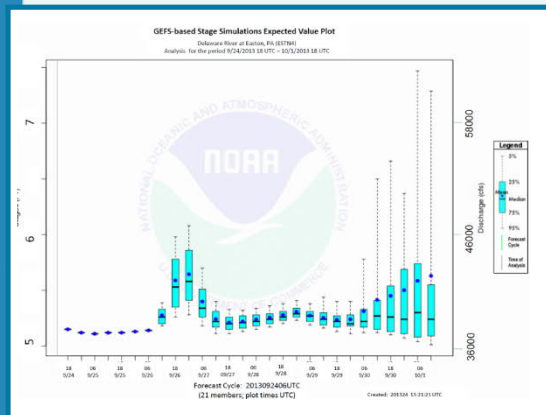


Uncertainty

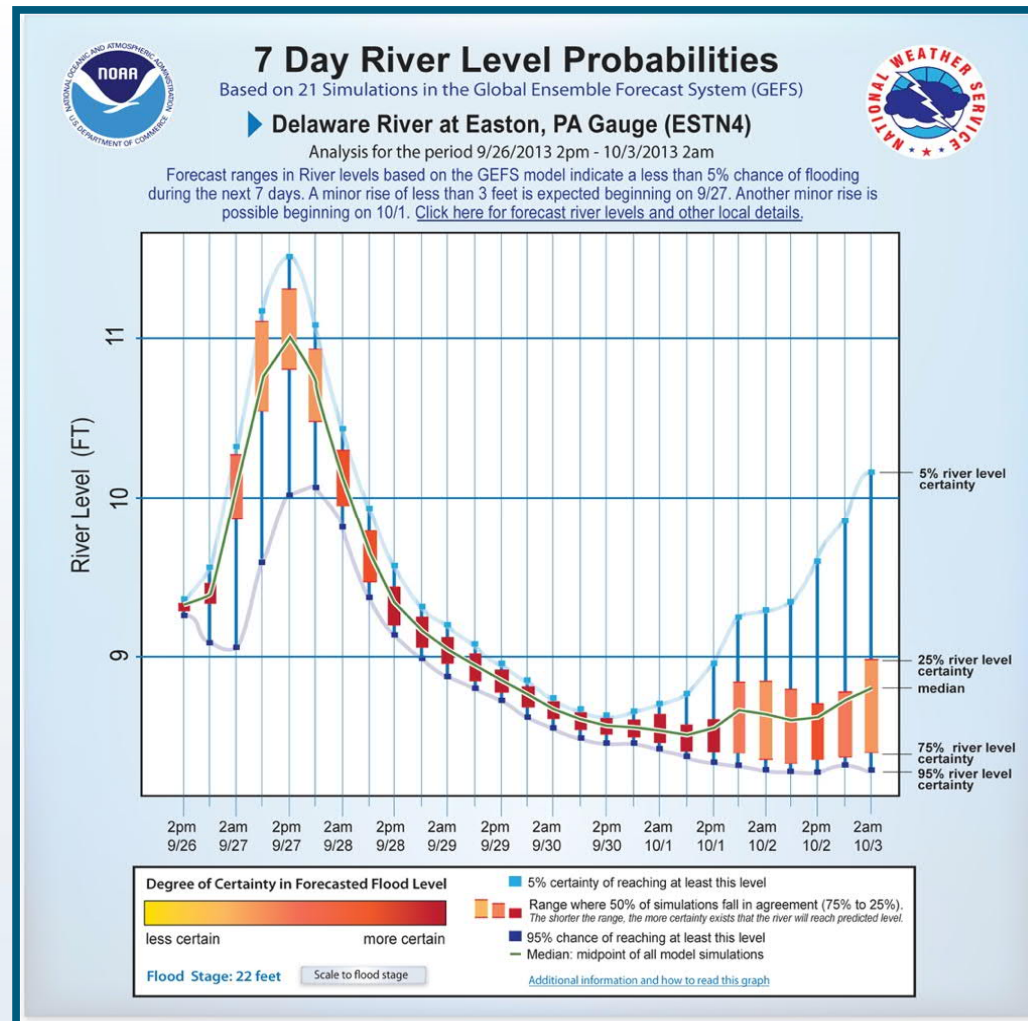
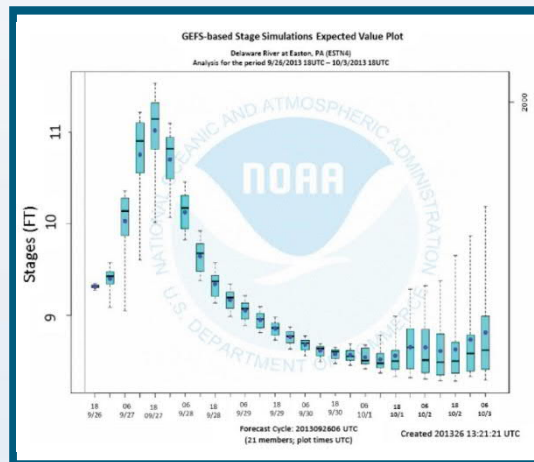
UNCERTAINTY MESSAGES need to be carefully considered.

- Current ensemble forecast graphics were very confusing
- Some participants did want to receive uncertainty information
- Almost no participants could properly interpret the information from the current suite of Meteorological Model Ensemble River Forecasts (MMEFS) graphics

MMEFS Graphics:



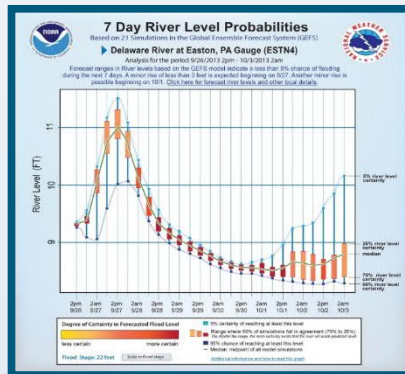
Example of a Draft Mocked-up Uncertainty Graphic



Incorporate various focus groups recommendations, including the careful use of text, and color variation

Transition to Operations

- Revised MMEFS operationalized in 2015

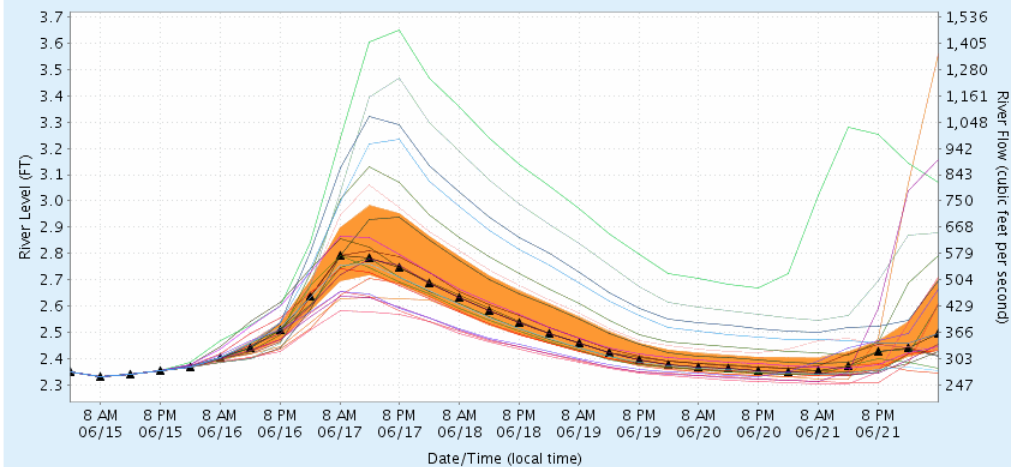


7 Day GEFS River Level Simulations

Used to Estimate the Chance of Flooding and the Range of Possible River Levels
 Each Line Shows an Individual Model Simulation (21 Total)



Sinnemahoning Creek at Sinnemahoning, PA (SNNP1)



- Individual Model Simulations (21 Total)
- ▲ Median River Level (Simulations indicate a 50% Chance of Exceeding this Level)
- More Likely Range (Simulations indicate a 40% chance river levels will fall within this range)

06/15/2016 06 UTC GEFS Model

Current Study

How can the potential of the Hydrologic Ensemble Forecast System (HEFS) to be a central decision-making support tool for users including residential, emergency management and water resource management audiences on a national level be best realized.

- Jefferson County, WV and Frederick County, MD
- 2 rounds of focus groups + surveys with residents and emergency managers
- 2 virtual focus groups with water resource managers
- 4 day Tropical Storm scenario

This project was funded by the NOAA National Weather Service Grant number NA16NWS4680004.

FOCUS GROUP STUDY SEEKS PARTICIPANTS

Jefferson County Area Residents

Have you experienced flooding?
Do you rely on flood forecasts to decide when to prepare?



Nurture Nature Center is recruiting participants for focus groups, as part of a research project with National Oceanic and Atmospheric Administration, about the use of National Weather Service flood forecast and warning tools.



Participants will be asked to answer questions and provide input about various flood warning tools and products issued by the National Weather Service.

Participants should live in the Jefferson County area and be at least 18 years of age. Each participant will receive \$20 compensation for their time and input. Light refreshments will be provided.

Wednesday, October 19 — 7 p.m.
Jefferson County Maintenance Department
128 Industrial Blvd.
Kearneysville, WV 25430

Focus groups will also be held for residents in Frederick County, MD and Water Resource and Emergency Managers in both Jefferson County, WV and Frederick County, MD. For information on those sessions, see socialscience.focusonfloods.org or contact Rachel Hogan Carr at rhogan@nurturenature.org or 610-253-4432.

THE NURTURE NATURE CENTER

The Nurture Nature Center is a non-profit organization whose focus is on flood education.

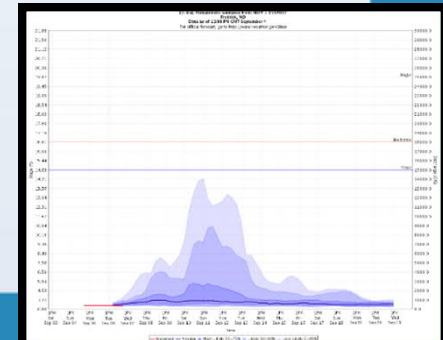
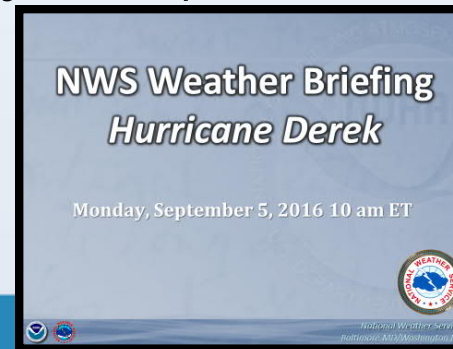
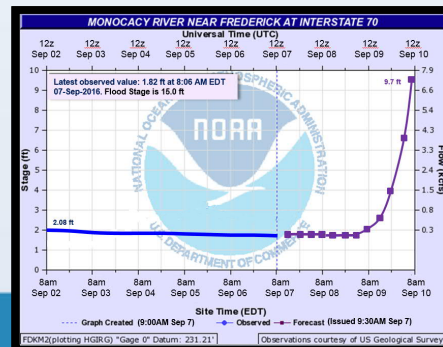
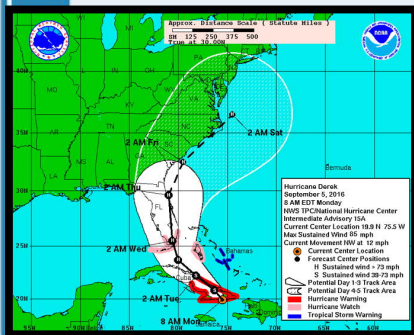


This project was funded by the NOAA National Weather Service, Grant number NA16NWS4680004.

Register online at socialscience.focusonfloods.org
or by email or phone at: rhogan@nurturenature.org or 610-253-4432.

Research Questions and Products

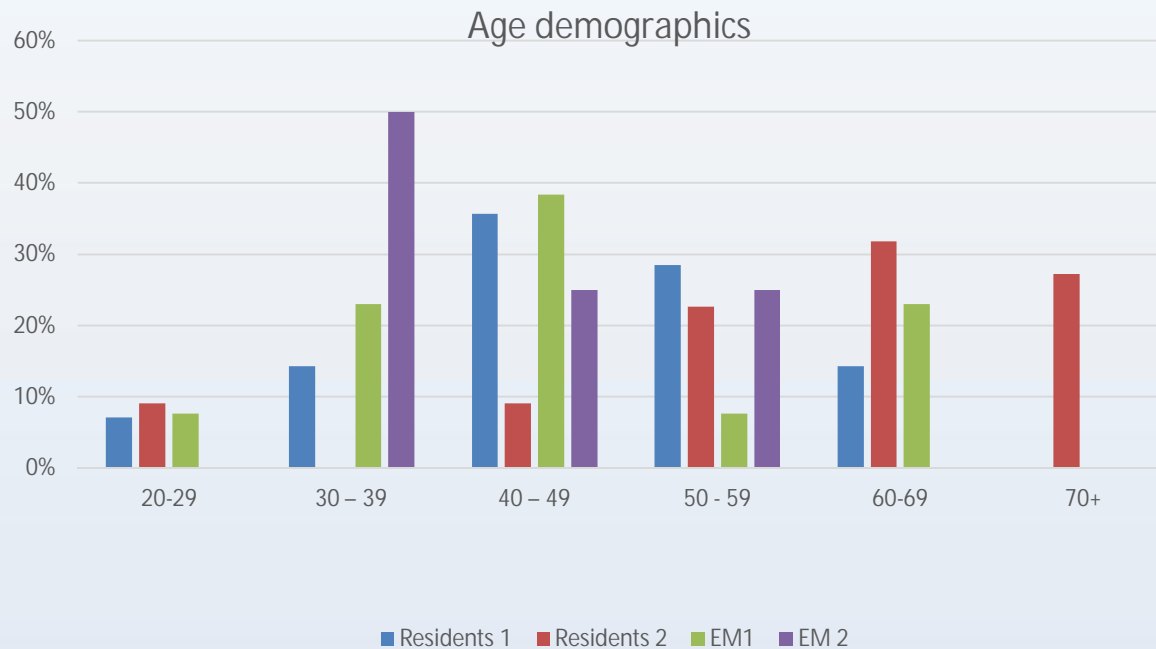
- What improvements to NWS flood forecast products would better motivate people to take flood preparedness and response actions?
- How do residential, emergency manager, and water resource managers identify the utility of HEFS products? How will they use these products?
- What barriers do each of these audiences identify in understanding and accessing the HEFS products?
- What modifications to the product design will help improve the utility, understandability, and accessibility of the products?



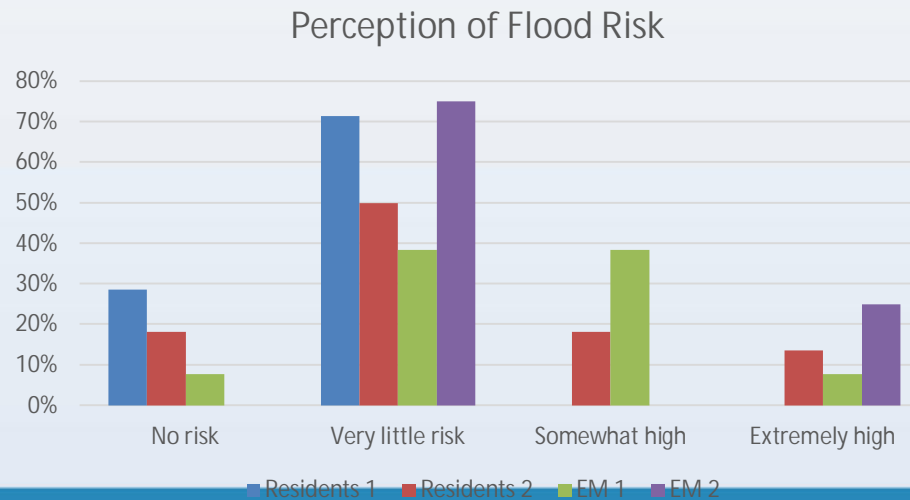
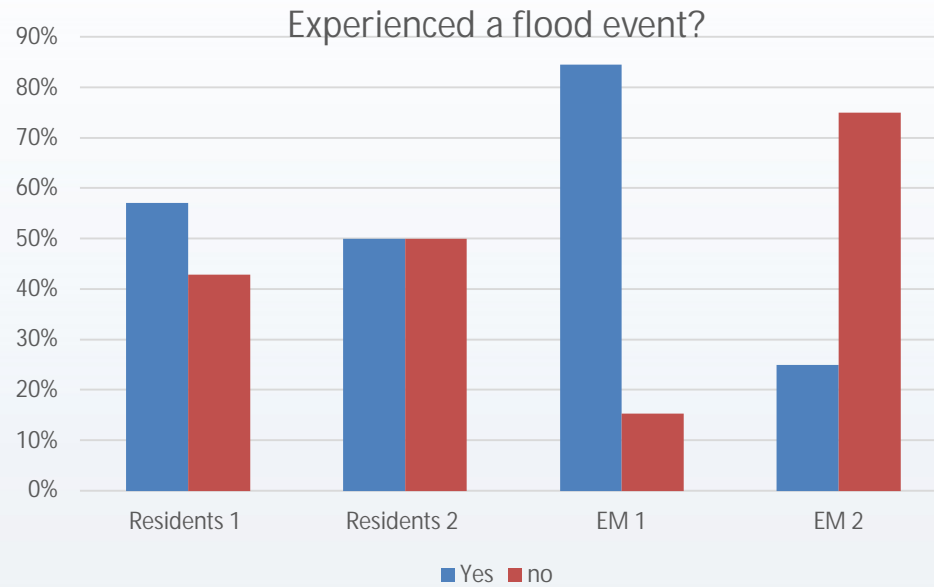
Focus Group Participants

Round one: 14 residents and 13 emergency managers (Oct 2016)
- two resident focus groups and two EM groups

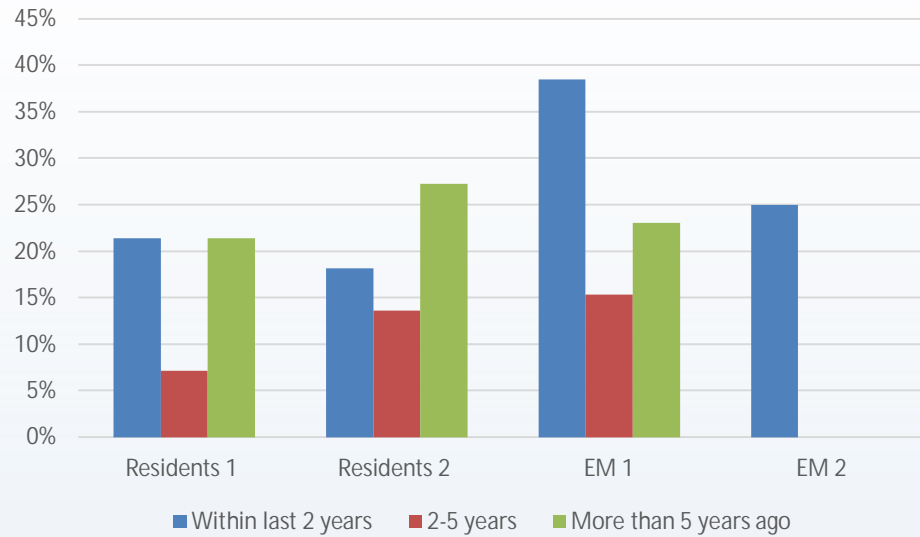
Round two: 22 residents and 4 emergency managers (March 2017)
- two resident focus groups and one EM group



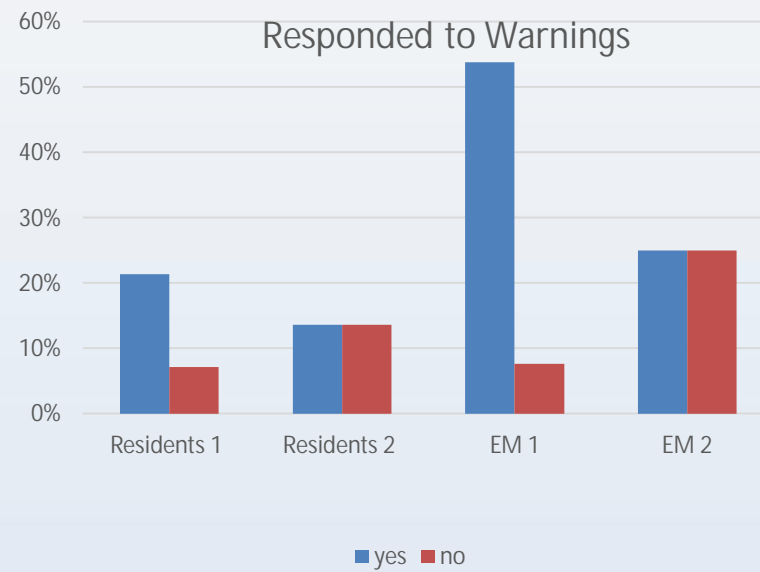
Focus Group Participants



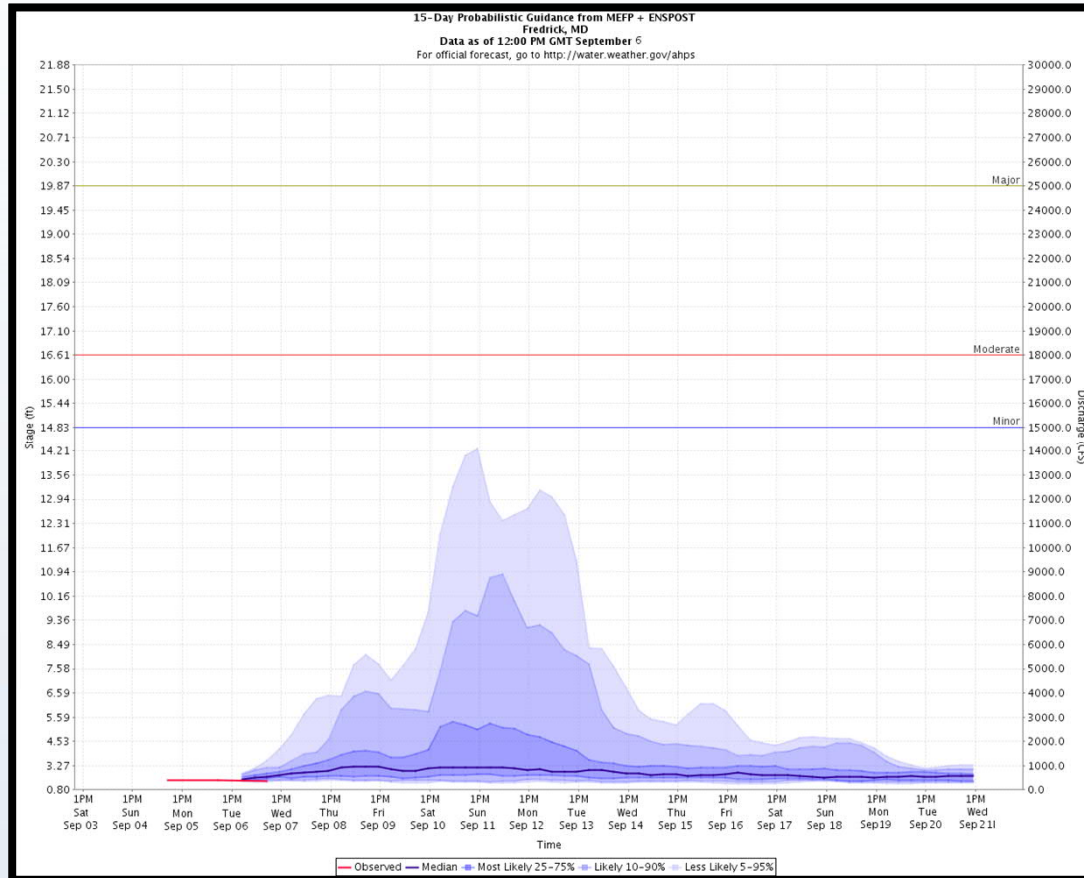
Timing of flood experience



Responded to Warnings



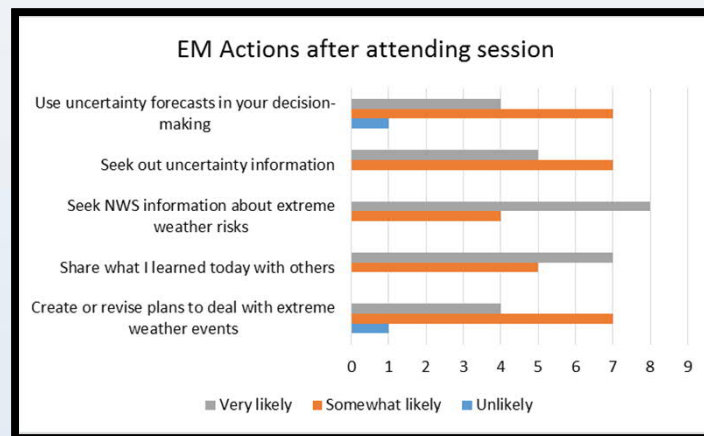
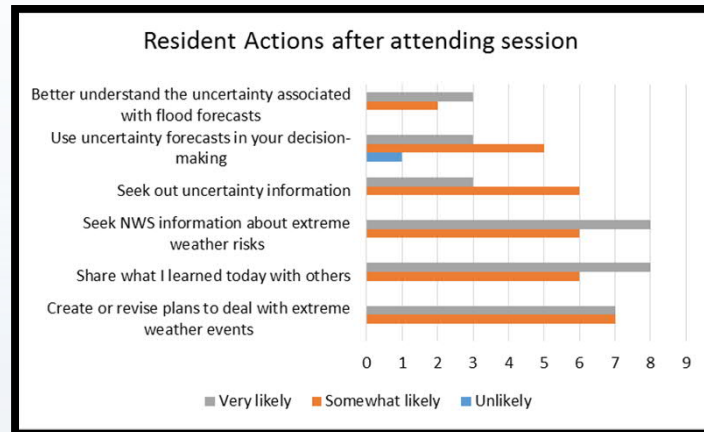
Round One: Focus Group Results



Residents found the product confusing.

Emergency managers noted utility in the information conveyed.

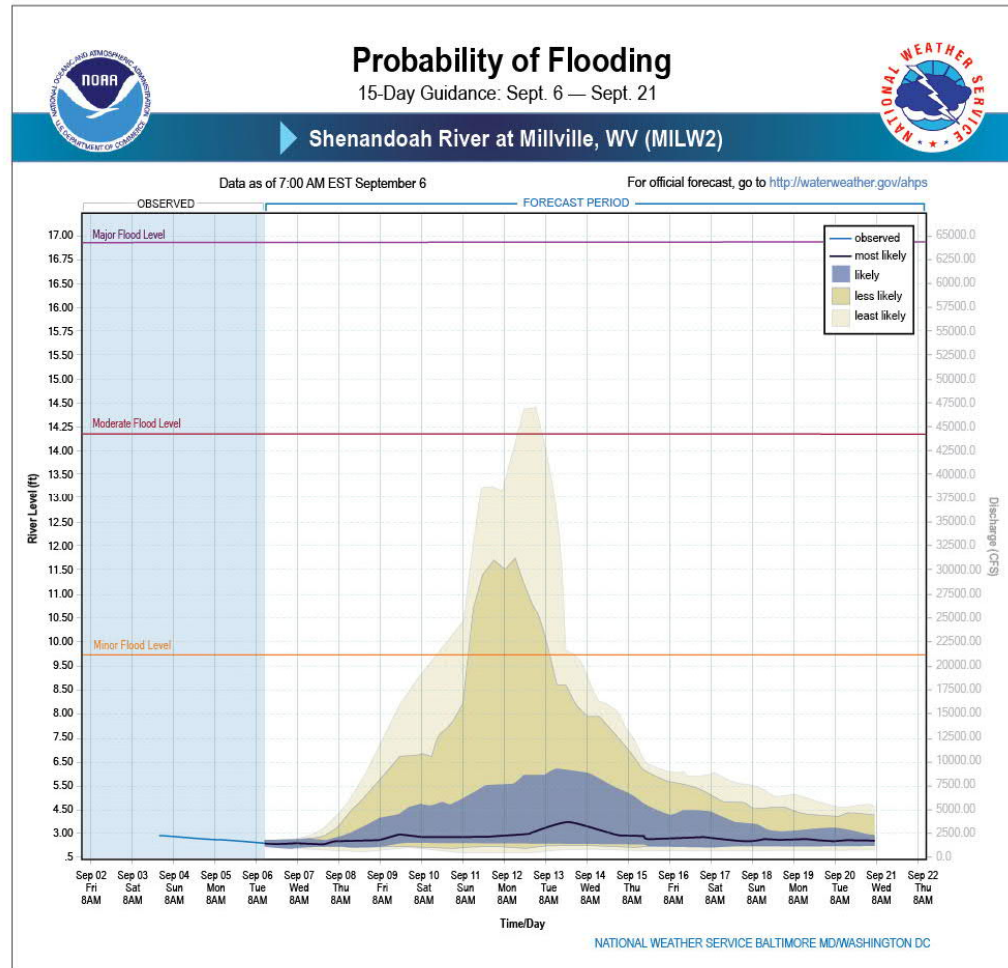
Presentation Impacts:



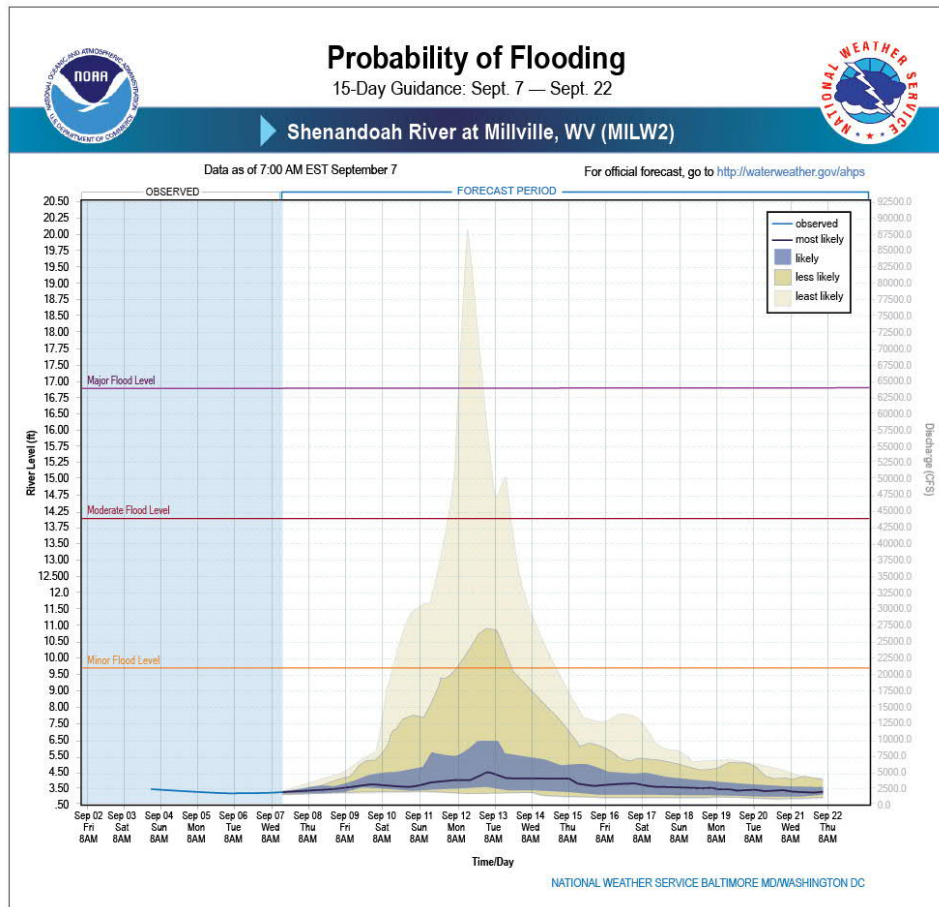
Round Two

- Revision to the tested products
- Second round of focus groups in March for Frederick and Jefferson Counties
 - Two resident sessions and one emergency manager session
 - Held March 15 and 16, 2017

Preliminary Revisions

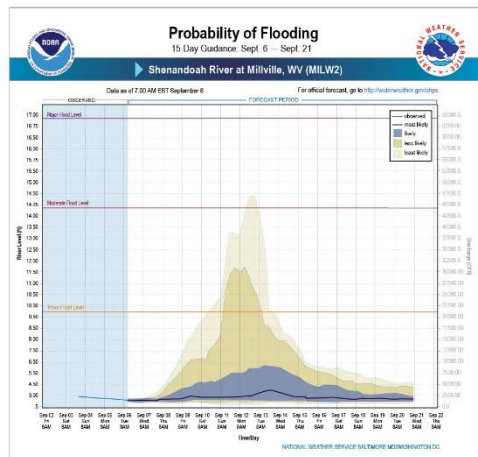


Preliminary Revisions



Several examples were tested in each scenario, representing low, moderate and higher river levels

Preliminary Revisions

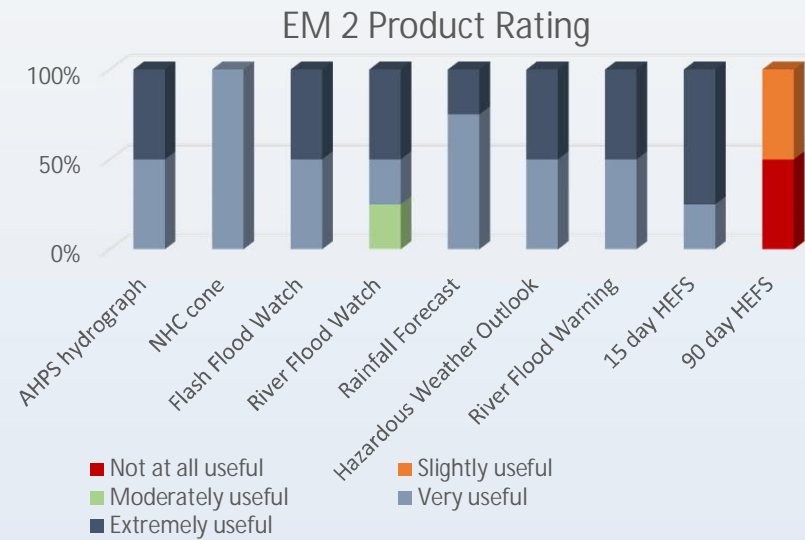


- Better visual clarity on confidence – differentiate the colors
- Improved location details
- Consistent logo placement/source of information
- Simplified title with time period front and central
- Demarcate observed/forecast periods
- Reduce extra information that audience does not need (i.e. discharge shaded to gray)
- Revised legend (vertical; changed mean to projected, most likely to most probable; removed percentages)
- Shorter time period (week)
- River level instead of stage
- Major, moderate and minor levels are color coded to AHPS and clearly labeled

Feedback from Round 2:

- Add % level for probability! (emergency managers)
- Add similar recorded floods to gage flood lines on graph (historical comparison)
- Change color of observed line to differentiate
- Include more info on flood stage vs. local interpretation
- Change colors on graphs based on severity (i.e., change shading to show when reaching flood levels)
- 15-day probability graphic needs improved readability, deeper color variation
- Simpler use of language

Results: Emergency Managers

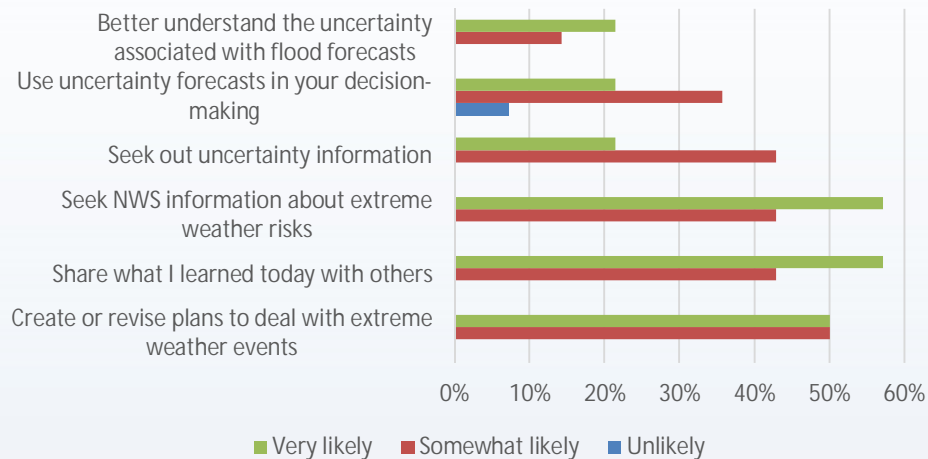


Results: Residents

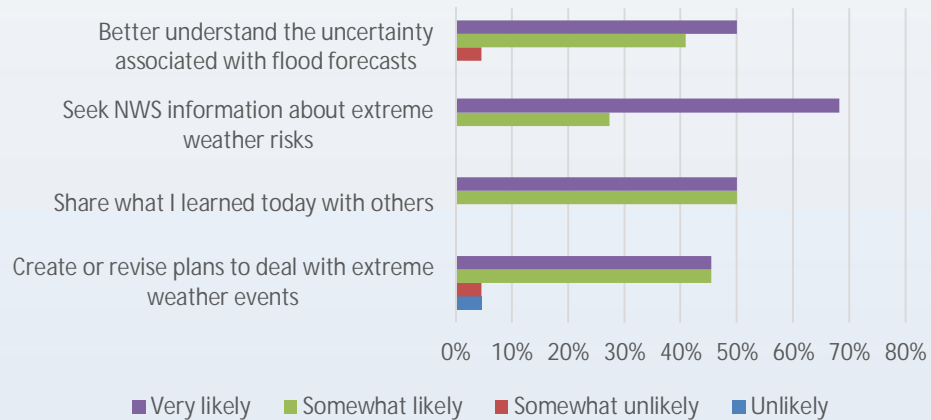
Average Rank 1	Average Rank 2	Product
1.2	2	National Hurricane Cone
2	4.8	AHPS hydrograph
2.8	4.4	Hazardous Weather Outlook
3.4	3.5	WFO Rainfall Forecast
4.2	5	WFO River Flood Watch
4.4	4	WFO Flash Flood Watch
5	4.8	WFO River Flood Warning
6.6	7.4	15 day HEFS

15-day ensemble forecasts were less valuable than other products to residential audiences. Most said they would prefer 7 day projections.

Resident 1 Actions after attending session



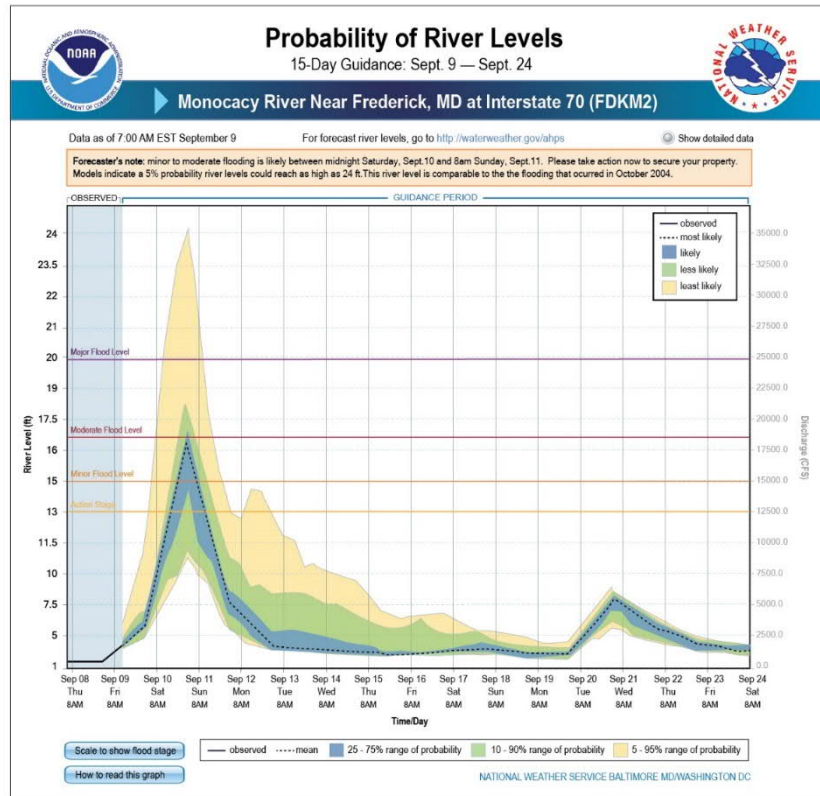
Resident 2 Actions after attending session



Final Testing

- Two webinars with water resource managers about the HEFS product's utility held June 20 and 22, 2017 informed a new set of revamped products
- Online survey to all participants in August 2017
- 23 participants completed the survey

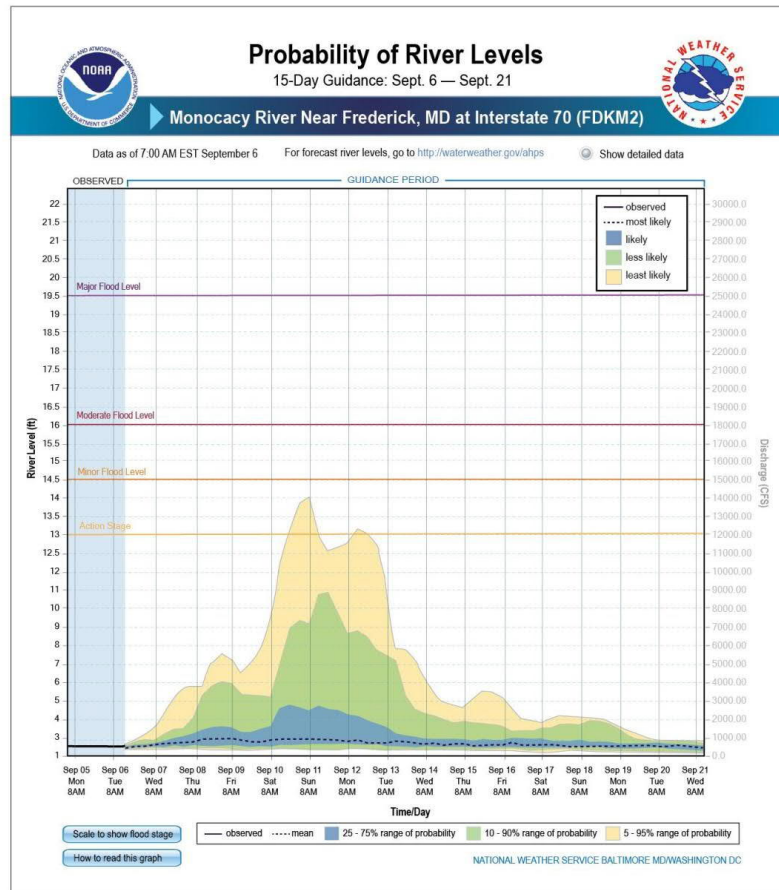
Survey example: High flow



Survey questions asked about:

- understanding of information
- usefulness of product
- actions taken after seeing product
- helpful elements
- confusing elements

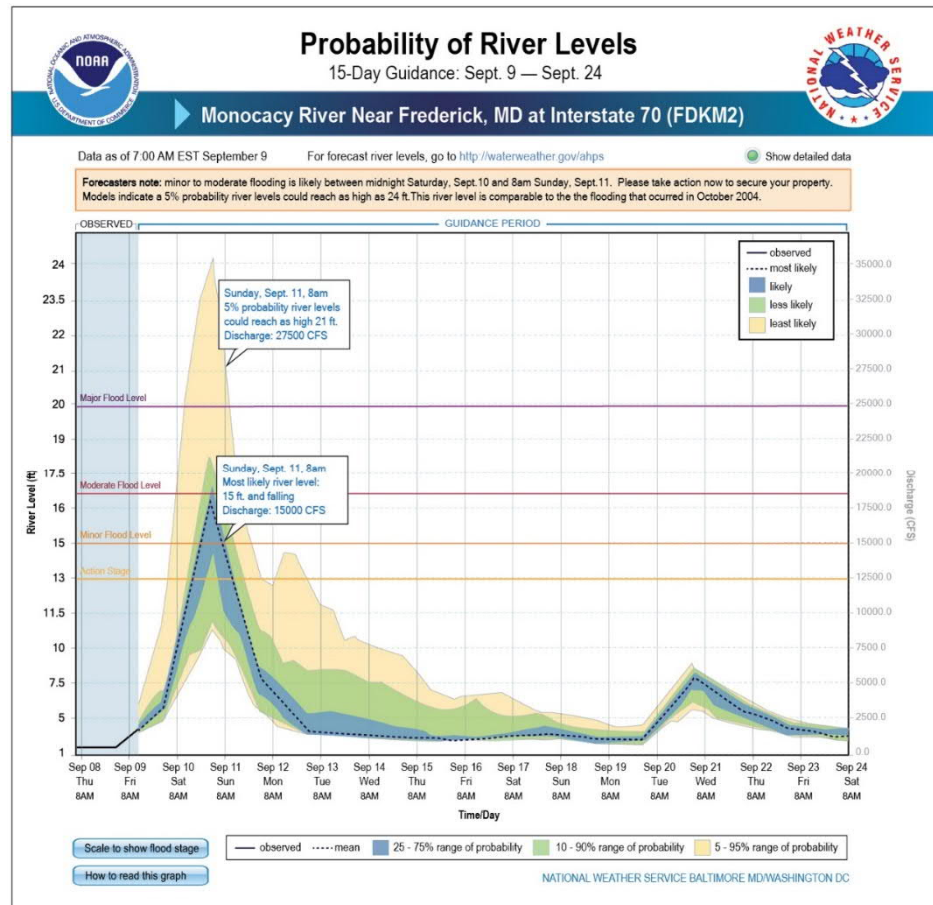
Survey example: Low flow



Survey questions asked about:

- understanding of information
- usefulness of product
- actions taken after seeing product
- helpful elements
- confusing elements

Survey example: Forecaster's note and text boxes



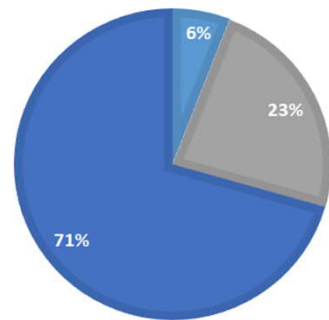
Survey questions asked about:

- Usefulness of forecaster's note
- Influence of forecaster's note on decision-making
- Usefulness of text boxes
- Influence of text boxes on decision-making

Low flow graphic

RISK OF FLOODING FOR LOW FLOW GRAPHIC

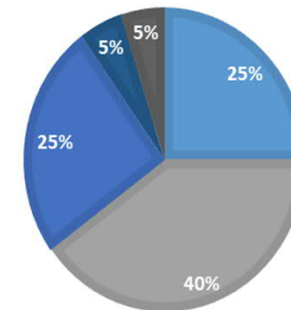
■ Somewhat high ■ Somewhat low ■ Very low



High flow graphic

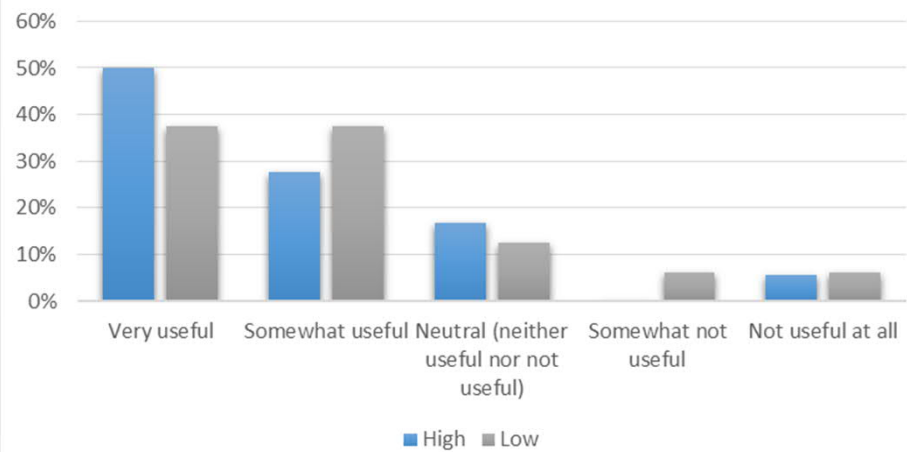
RISK OF FLOODING FOR HIGH FLOW GRAPHIC

■ Very high ■ Somewhat high ■ Neither high nor low ■ Somewhat low ■ Very low

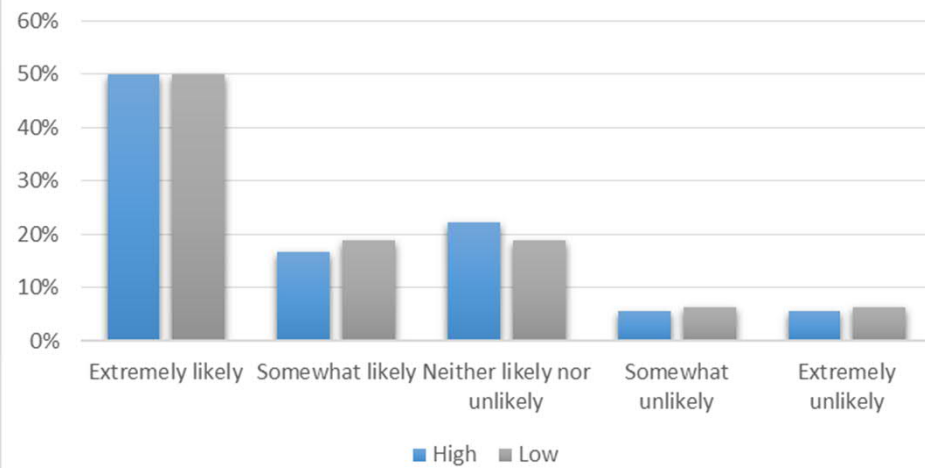


Users could properly interpret their risk from revised products.

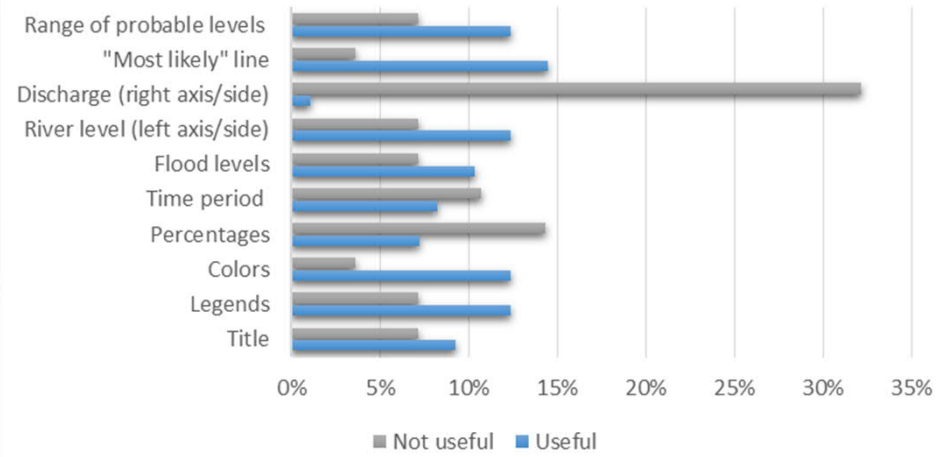
How useful is this product?



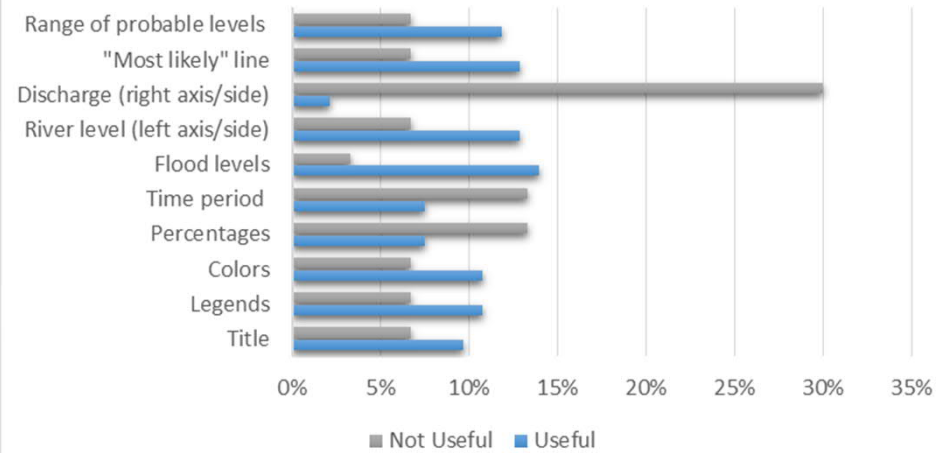
How likely are you to use this product?



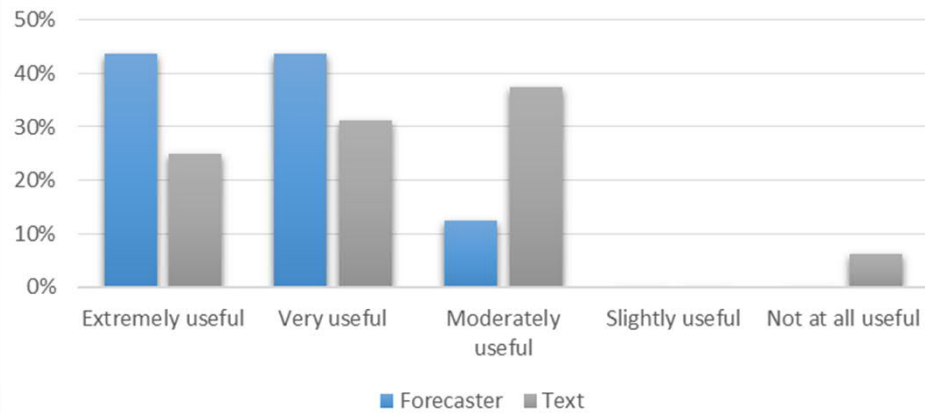
Usefulness of High Flow Product Elements



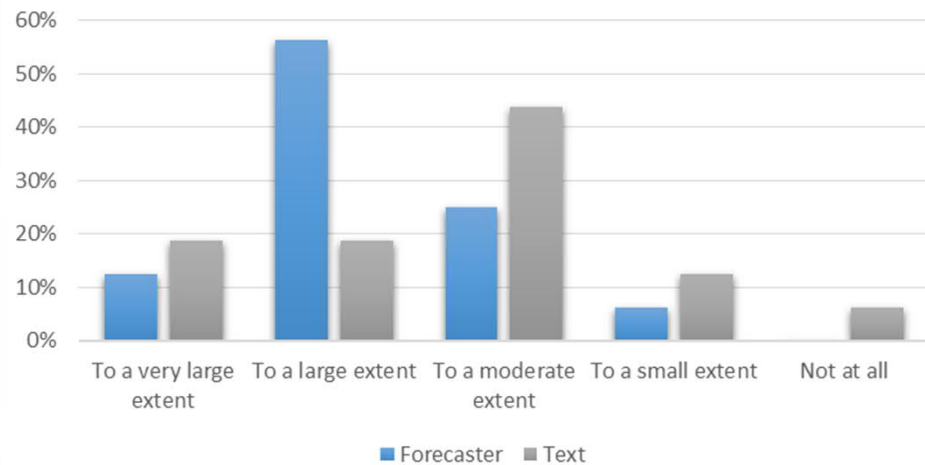
Usefulness of Low Flow Product Elements



Usefulness of Forecaster Note and Text Box



Influence on Decision-Making

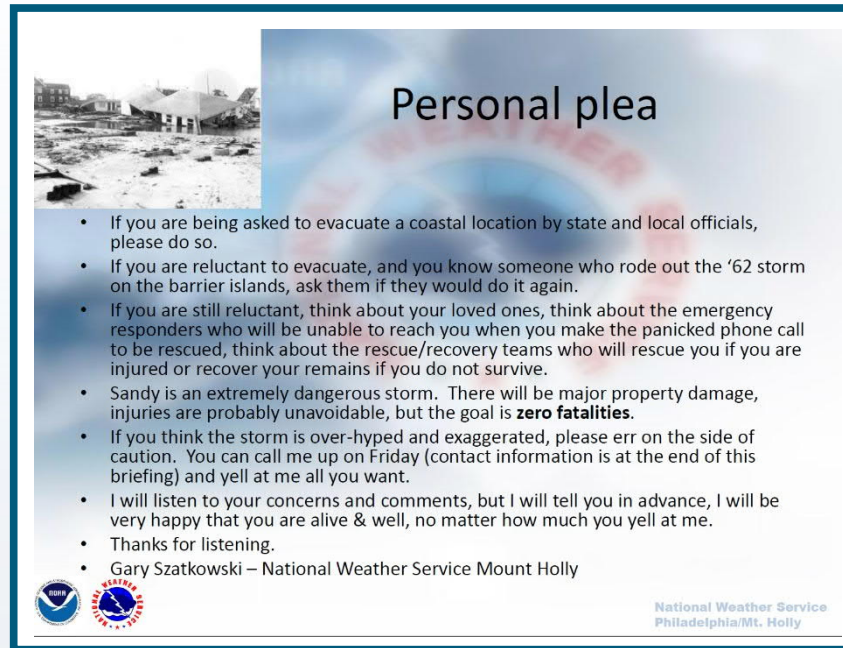


What does this mean for us as risk communicators?

People favor direct, plain spoken communication from trusted sources?



We've seen this in previous studies...

Emergency Briefings: Connecting to the forecaster



Personal plea

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



National Weather Service
Philadelphia/Mt. Holly

Briefings:

Inclusion of a “Personal Plea” was highly motivational

Briefings can convey tone, and prioritize risk

Briefings should be reserved for high-impact events

NOAA is the authoritative source for information, but residents expect and want to receive weather information from local municipal officials and EMS

Socialscience.focusonfloods.org

THE NURTURE NATURE CENTER FOCUS ON FLOODS SOCIAL SCIENCE

Home About Resources Reports and Findings search...

Can Social Science Help Improve Public Use of Flood Forecast Tools?

The National Weather Service (NWS) offers many flood forecast and warning tools that individuals can use during a predicted flood event. From tools that allow users to monitor projected river heights to flood inundation maps that show which areas in the community will be underwater during floods, the capability and accuracy of flood forecasting has increased dramatically in recent years. Despite this, many people still fail to understand and respond properly to flood forecasts and warnings issued by NWS.

Beyond technological advances in forecast lead-time and accuracy already achieved, what else can NWS do to improve its flood forecast and warning tools so they better motivate flood preparedness and warning response? In partnership with Nurture Nature Center (nurturenaturecenter.org), NWS is undertaking a social science research study in the four-state Delaware River Basin. The study will ask individuals living in flood-affected communities to participate in focus group interviews to help answer two questions:

- How do people living in the Delaware River Basin use NWS flood forecast and warning tools in understanding their flood risk?
- How can these tools be improved so they better motivate flood preparedness and warning response?

"Given the frequency and intensity of flooding not only in this region, but across the country, improving how people prepare for flooding is critical to reducing losses," said NNC Director Rachel Hogan Carr. "This project provides an excellent opportunity to help NWS understand how the public uses its flood forecast and warning tools, and what further refinements might improve public preparedness as people respond to news of impending flood events."

Nurture Nature Center, Inc. is a non-profit organization in Easton, Pennsylvania, with a focus on flooding issues. NNC's social science project, "Flood Risk and Uncertainty: Assessing the National Weather Service's Forecast and Warning Tools," supports NOAA's new Weather-Ready Nation initiative, designed to help the nation become better equipped to prepare for and respond to weather events.

For more information see our published articles in:

BAMS September 2016 –
"Effectively Communicating Risk and Uncertainty to the Public: Assessing the NWS's Flood Forecast and Warning Tools." Carr et al.

WCAS October 2016 –
"Motivating Action under Uncertain Conditions: Enhancing Emergency Briefings during Coastal Storms." Carr et al.

Partners:

- East Carolina University (current study)
- National Weather Service (NWS) Mid-Atlantic River Forecast Center (current study)
- (NWS) Mt. Holly, NJ Weather Forecast Office (past study)
- (NWS) Binghamton, NY Weather Forecast Office (past study)
- (NWS) Sterling, VA Weather Forecast Office (current study)
- RMC Research Corporation (evaluators on previous studies)

