

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

## OVERVIEW

For those living or working in communities near rivers and streams, having information about forecast water levels is critical for planning. Property owners and emergency managers need to know if a flood is possible or imminent, while water resource managers need detailed information to control infrastructure and water supply. While National Weather Service (NWS) deterministic forecasts, represented as a hydrograph, are a go-to resource for decision makers, often it is useful to know the full range of possible levels that could occur, and understand the inherent uncertainty in river forecasts at longer timeframes.

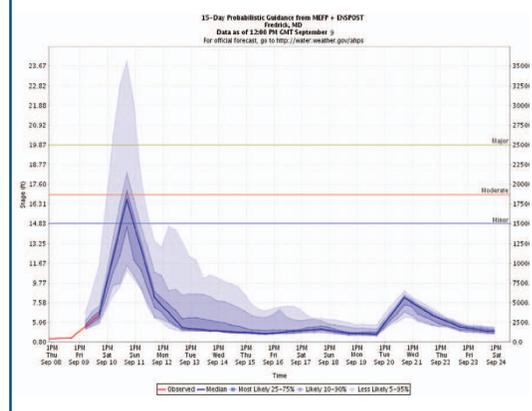
In 2016, Nurture Nature Center, working with East Carolina University, undertook a study to test a suite of products from NWS' emerging Hydrologic Ensemble Forecast System (HEFS) which provides short and long-range forecasts showing uncertainty. The goal of the study was to assess the utility of some newly developed HEFS products (15 day and 90 day timeframes), identify any barriers to proper understanding of the products, and suggest modifications to product design that could improve the understandability and accessibility for various users.

The research team held focus groups in Jefferson County, WV and Frederick County, MD with emergency managers and residents, along with online sessions for water resource managers, leading participants through a 4-day extratropical storm scenario illustrated with various NWS products, including the HEFS. Multiple sessions and surveys allowed for testing of revisions to the graphical design of the suite of products and for assessment of the utility and understandability of the products.

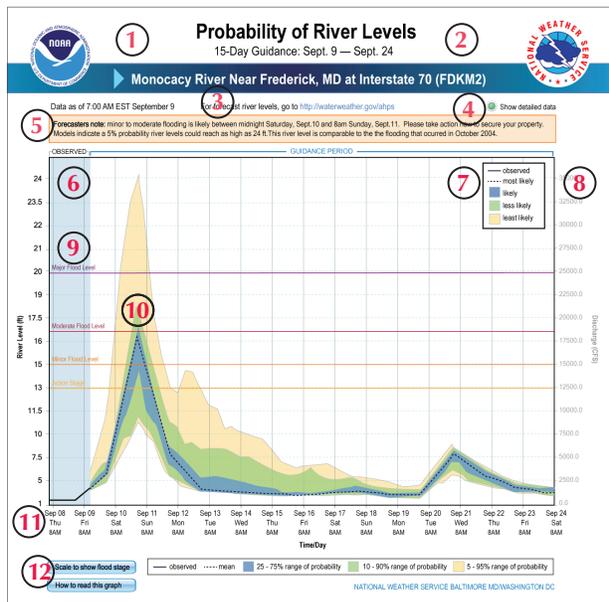
## What are ensemble forecasts?

There is inherent uncertainty in meteorological and hydrological forecasting, especially at longer timeframes. Instead of making a single forecast, an ensemble forecast provides a set of forecasts from models run multiple ways multiple times to reflect the actual range of possible outcomes. HEFS is an ensemble system that quantifies uncertainty in hydrologic forecasts and provides probabilities of reaching certain stage and flood levels. With this information, emergency managers, water resource managers and residents can better understand the full range of possible outcomes, and can use this information for planning and decision-making about when and whether to take action.

Example of the original tested 15-day HEFS product shown in the first round of focus groups



Example of redesigned HEFS product based on feedback from focus groups and surveys with explanation of changes made.



1. Key information on top and up front
2. Simplified title and river location
3. Quick link to the AHPs hydrograph
4. Ability to activate data point text boxes on hover
5. Optional forecaster's note box
6. Differentiation between "observed" and "guidance periods"
7. Streamlined vertical legend up top for lay audiences; detailed legend with range of probabilities along bottom for professionals.
8. Discharge info de-emphasized
9. Key river level colors changed to align with hydrograph colors
10. More variation between colors (tested for color-blindness)
11. Reordering of day/time to day on top
12. Buttons that offer quick, additional information: "Scale to Flood Stage" and "How to Read this Graph"

## FINDINGS

Emergency managers found the tested hydrologic ensemble forecasts to be useful, including in some instances at the two week timeframe (up to 15 days), while residential audiences found the forecasts difficult to understand and not useful, preferring products with a shorter forecast time frame. Longer-term forecasts, including 90-day exceedance products, were useful only to water resource managers for situational and seasonal outlooks.

Modifications to the products, shown above, including changes to legend, title and colors improved understanding by both audiences. Specific changes, such as the addition of a "forecaster's note" box to the products was a favored product element.

Emergency managers (along with the other audiences) agreed that hydrologic ensemble forecasts would be one of several tools for decision-making, used as part of a suite, and with increased experience with the tools could advance how much they relied on probabilistic forecasts for planning.

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