Streamgaging and Flood Forecasting: A Partnership of the U.S. Geological Survey and the National Weather Service

Jeanne C. Robbins, Hydrologist, USGS
South Atlantic Water Science Center, Raleigh, NC

Mike Moneypenny, Senior Service Hydrologist, National Weather Service
Weather Forecast Office, Raleigh, NC

U.S. Department of the Interior
U.S. Geological Survey

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Flood Impacts

- Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss.
- Hurricane Matthew resulted in
  - 28 fatalities in North Carolina
  - Impacting ~ 99,000 structures across NC
  - ~ 600 road closures including I-40 and I-95
  - ~20 dams breached or partially breached
  - Estimated $1.5B in damage

2

USGS and NWS Mission and Partnership in Flood Response

Water Information: Collects and disseminates reliable, impartial, and timely information needed to understand the Nation's water resources to minimize loss of life and property from natural disasters

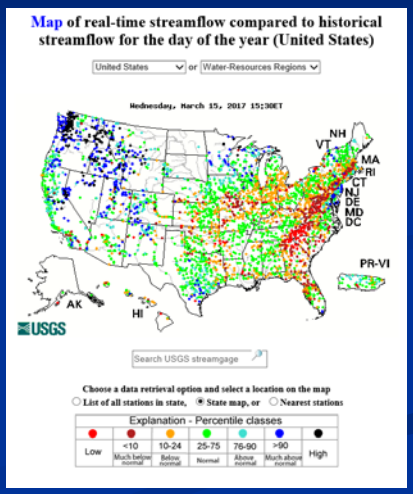
Water Prediction: Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.

USGS

3

USGS Water Data Collection

- Key to developing river forecasts and subsequent warnings is the knowledge of the stream or river
- USGS collects river stage and streamflow information at:
  - 8,100 sites; all real-time
  - 3,400 support NWS forecasts
  - 1,200 support USACE flood control operations



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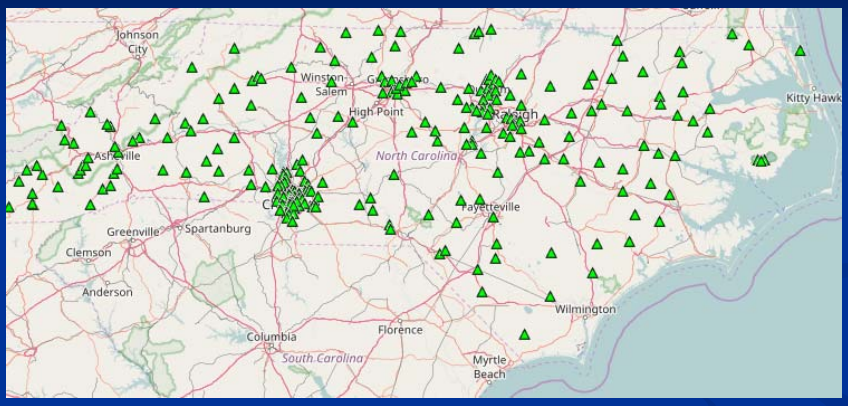
4

Streamgaging in North Carolina

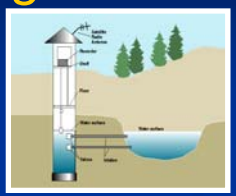


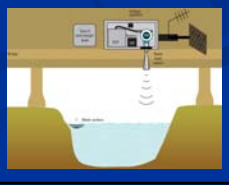
The USGS currently collects data at over 260 streamgages in North Carolina

USGS

USGS Water Data Collection Stage or Gage Height

- River Stage or Gage Height is the basic piece of data monitored at USGS streamgages by:
  - Float systems at stilling wells
  - Pressure transducers via orifice lines
  - Radar sensors from bridges





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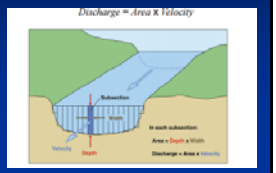
6

Most users of streamflow information need to know the discharge of the stream

USGS

USGS Water Data Collection Discharge Measurement

- Discharge is measured using the velocity-area method by:
  - Mechanical Current Meters
  - Acoustic Doppler Current Profilers
  - Indirect discharge methods



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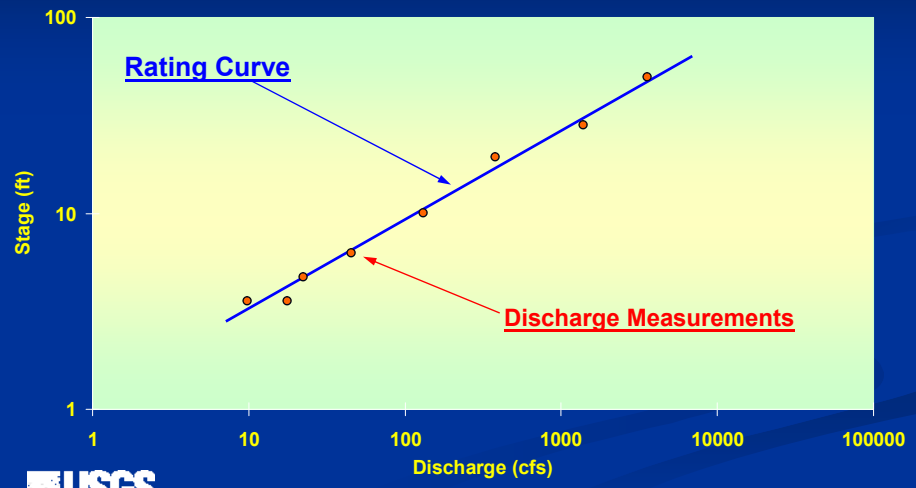
8

USGS Water Data Collection
Stage-Discharge Rating Development



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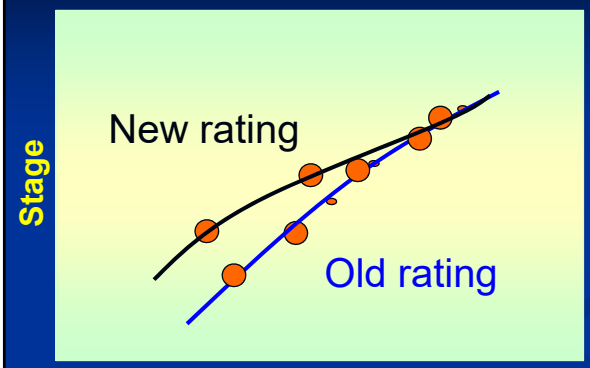
Measurements must be made over the entire range of stage

USGS

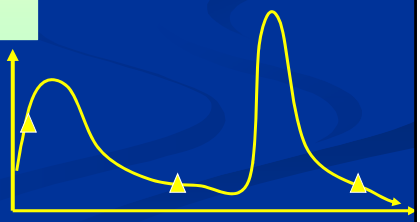
10

Ratings Shift as Channels Change



-Where (along the rating) does the change apply?

-When does the change apply?



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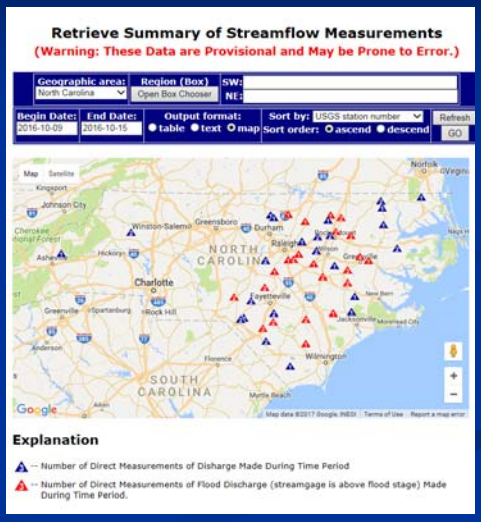
11

Matthew Flood Measurements

- October 9 – 14, 2106
- 76 discharge measurements
- 26 sites in NC
- Verified, updated and extended stage-discharge ratings



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12

Lumber River Discharge Measurements and Rating extension

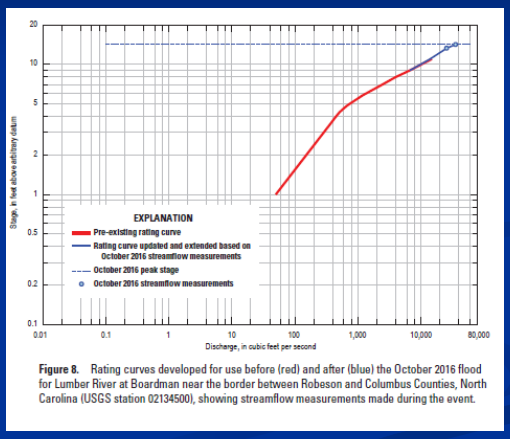

Figure 8. Rating curves developed for use before (red) and after (blue) the October 2016 flood for Lumber River at Boardman near the border between Robeson and Columbus Counties, North Carolina (USGS station 02134500), showing streamflow measurements made during the event.

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13

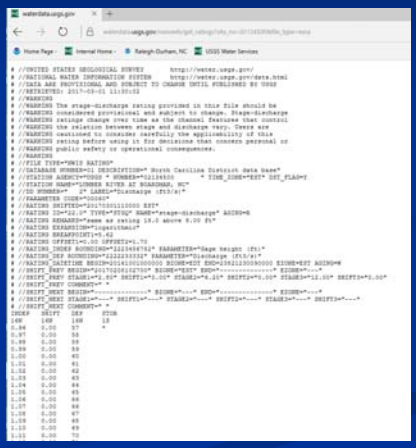
Stage-Discharge Ratings posted to the USGS Rating Depot

Ratings are available to the NWS and other interested parties from the depot via http at the following URL

http://waterdata.usgs.gov/nwisweb/get_ratings?site_no=XXXXXXXX&file_type=exsa

where XXXXXXXX is the 8-15 digit USGS station number.

Example:
http://waterdata.usgs.gov/nwisweb/get_ratings?site_no=02085000&file_type=exsa



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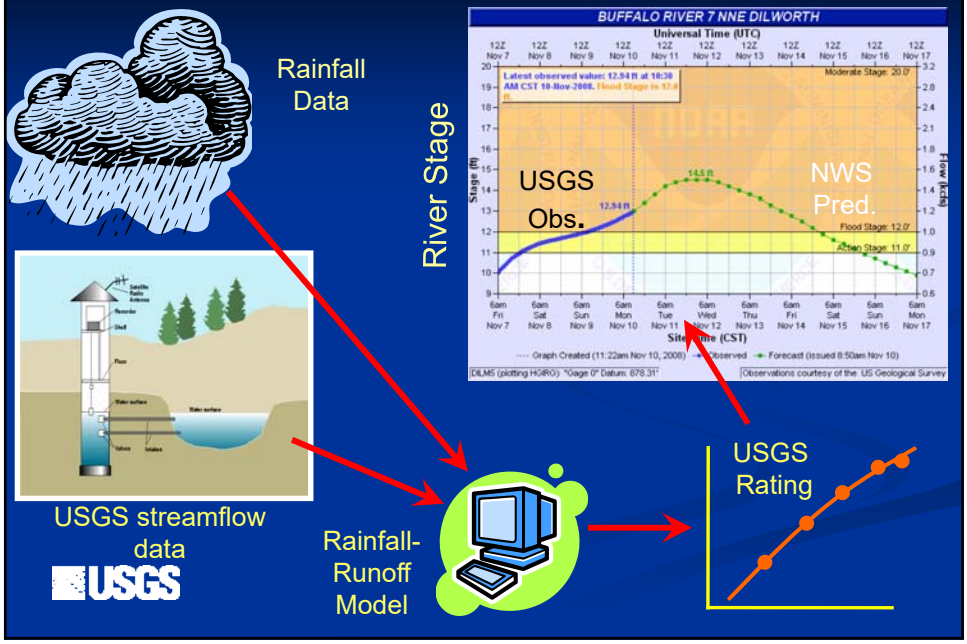
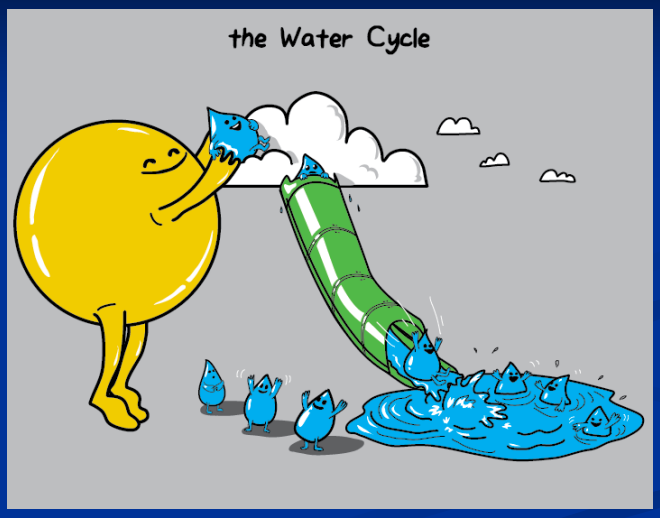
14

Streamgaging/Forecasting Data Interoperability



NWS Organization of Hydro Ops

The Hydro Forecast Process



17

The Hydro Forecast Process

- Start with a Snapshot of Current/Antecendent Conditions
  - Season = Evaporation/Evapotranspiration
  - Prior Rainfall = Soil Moisture
  - Current Streamflows and Reservoir Levels

18

The Hydro Forecast Process

- Forecasts
  - Precipitation (Quantitative Precip Forecast – QPF)
  - Reservoir Re

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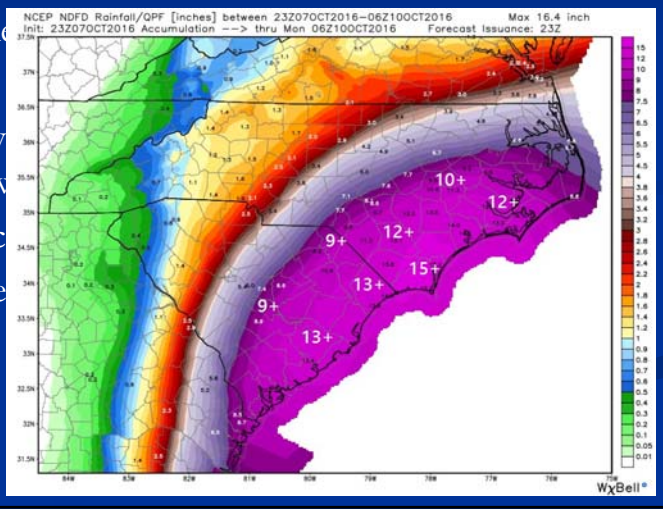
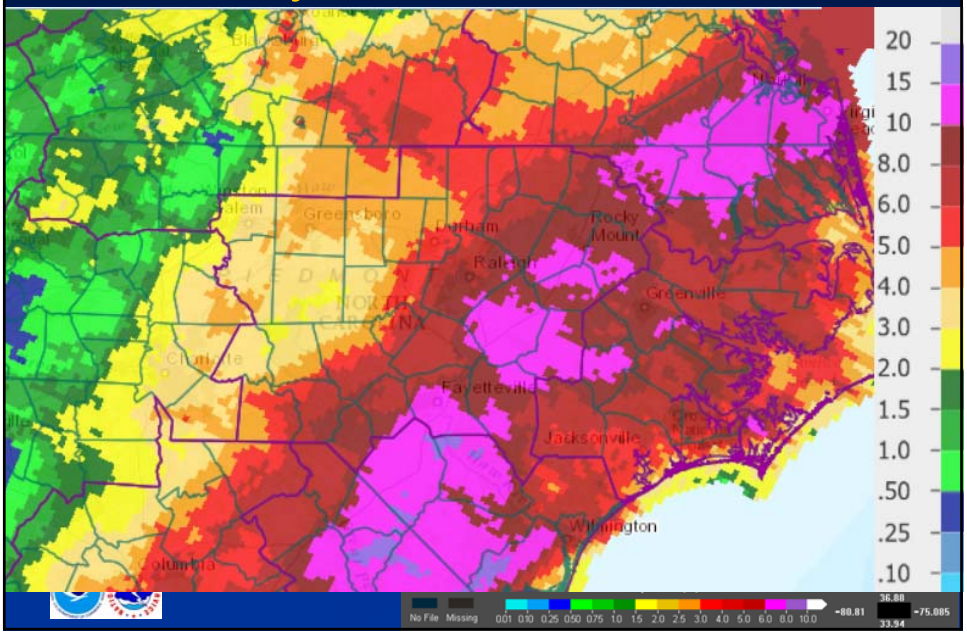
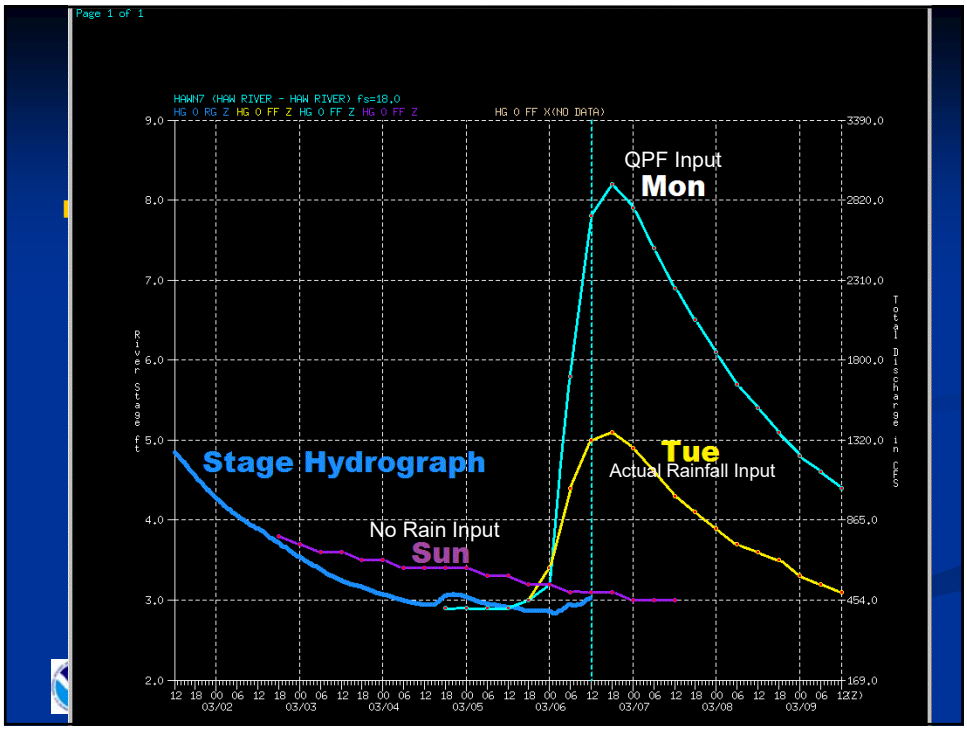
adjusts outflov
Consistenc
Lower lake



The Hydro Forecast Process



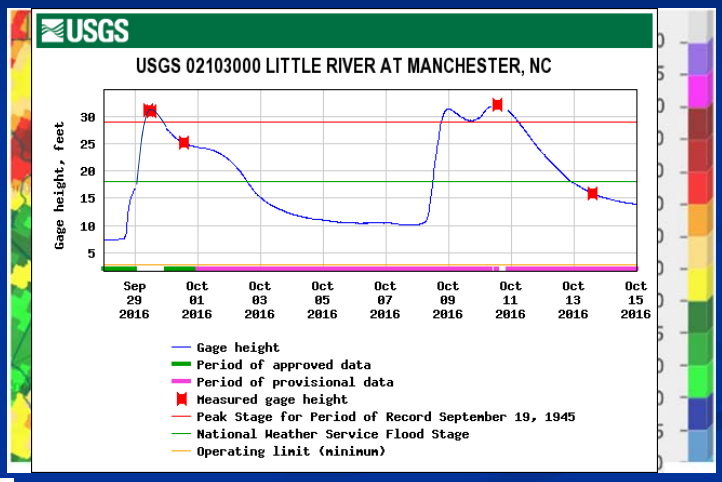


The Hydro Forecast Process

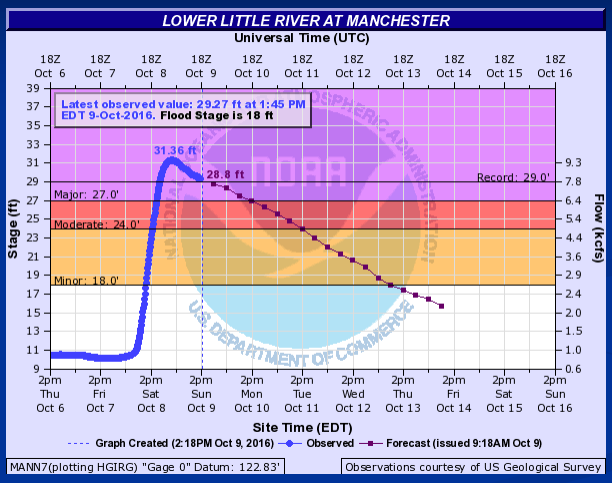
- The Hydrologist must possess extensive knowledge of both the meteorological event as well as the river basin characteristics to assure that data used in the models are accurate and reliable. Hydrologists interact with the models to make adjustments to the river simulations to compensate for differences between the observations and assumptions of the models.
- A river forecast for flooding does not always trigger a flood warning. The SERFC forecast is guidance, and it is up to the local Weather Forecast Office to issue the warning and get the word out.

Matthew was preceded by heavy rain from 9/29 – 10/7, resulting in wet antecedent conditions

10+ inches!



Flood Stage – Based on Impacts



Minor Flooding: Minimal or no property damage, but possibly some public threat or inconvenience.
Moderate Flooding: Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
Major Flooding: Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

Different Degrees of Forecast Products

Urban and Small Stream Advisory — issued when flooding of small streams, streets and low-lying areas, such as railroad underpasses and urban storm drains, is occurring or is imminent. Advisories are issued when such events warrant notification of the public in a product less urgent than a warning.

Flood Watch — issued when flooding is possible – typically within a 6 to 48 hour time frame before the event.

Flood Warning — issued when flooding conditions are actually occurring or are imminent.

Flash Flood Watch — issued when flash flooding is possible. Flash Flood Watches are generally issued for flooding that is expected to occur within 6 hours of the event, which could be heavy rainfall or a dam or levee failure.

Flash Flood Warning — issued when flash flooding is actually occurring or imminent. Flash flood warnings tend to be fairly localized areas such as a county or small group of counties, and the specific locations threatened within those areas are often highlighted. Flash Flood Warnings are issued for short-term events, which require immediate action to protect lives and property, such as dangerous small stream flooding or urban flooding and dam or levee failures.

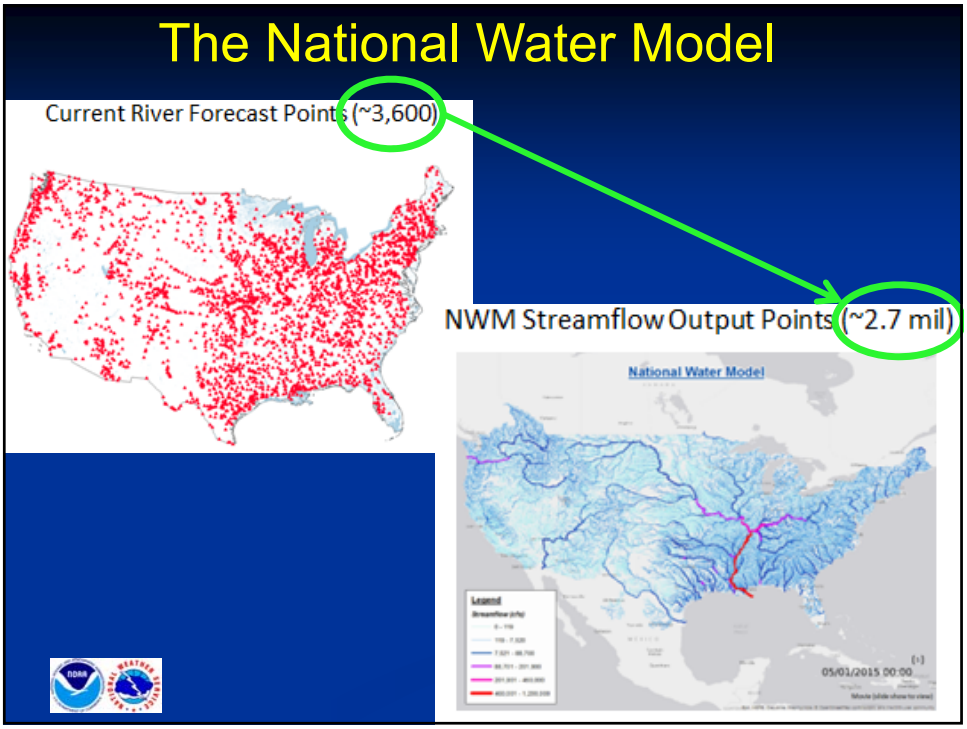
25

Future of the Hydro Forecast Process

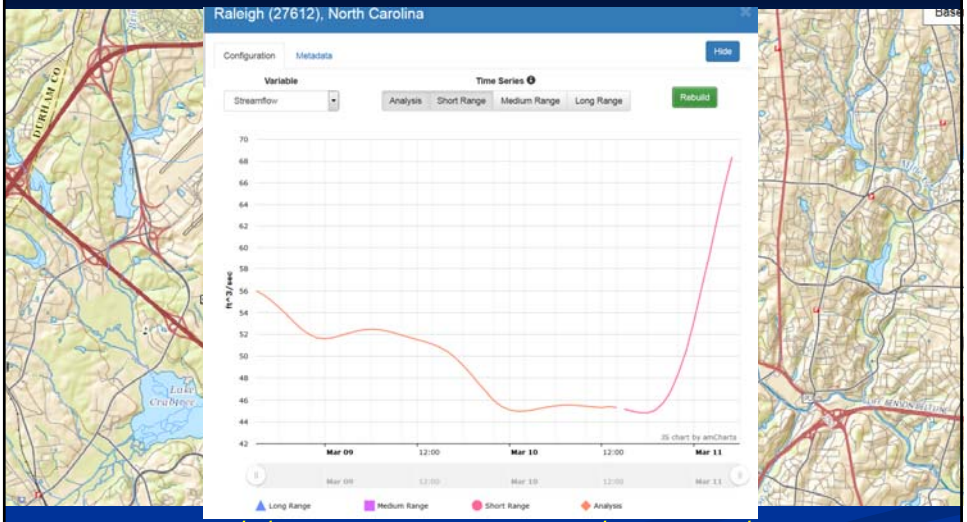
- Many tools are under development or refinement, including higher resolution forecast models, probabilistic and ensemble river forecasts, more advanced incorporation of tidal effects, as well as new dissemination technologies.

26

The National Water Model



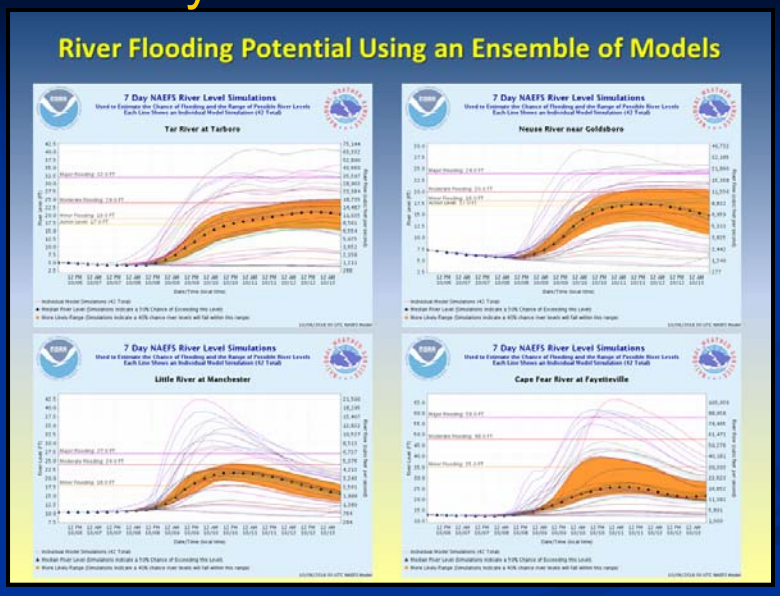
http://water.noaa.gov/map



http://water.noaa.gov/about/nwm

28

The Hydro Forecast Process



29

Spreading the Word

30

Signs of the Times

USGS

Links for selected USGS and NWS Online Information

USGS South Atlantic Water Science Center – North Carolina

http://nc.water.usgs.gov

USGS Current Streamflow Data in North Carolina:

https://waterdata.usgs.gov/nc/nwis/current/?type=flow

National Weather Service – Raleigh Weather Forecast Office

http://www.weather.gov/rah/

National Weather Service – Southeast River Forecast Center

http://www.weather.gov/serfc/

Contact info:

Jeanne C. Robbins, PE, USGS SAWSC - NC
Phone: (919) 571-4017 // Email: jrobbins@usgs.gov

Mike Moneypenny, NWS, Raleigh NC
Phone: (919) 515-8209 // Email: Michael.moneypenny@noaa.gov

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32