GOAL ACHIEVED

Mitigate Flood Impacts by Demonstrating Improved Decision Support Services to Emergency Managers

Goal Leader:

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Deputy Goal Leader:

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Overview

Goal Statement: By September 30, 2019, NOAA National Weather Service will improve decision support services by demonstrating a new flood inundation mapping capability serving 25 million people (approximately 8%* of the continental U.S. population) residing in flood-vulnerable freshwater basins, and delivering an enhanced excessive rainfall outlook product that extends the lead time of high risk predictions from two days to three days.

APG Two-Year Goal Was Met

Emergency Managers will use this information to more effectively mitigate flood impacts by prepositioning resources, ensuring critical infrastructure (e.g., hospitals, evacuation routes, etc.) are viable, and ordering evacuations[1].

*Future out-year goal is to incrementally expand flood inundation mapping to near 100% of the continental U.S. population residing in flood-vulnerable freshwater basins.

Challenge:

- Flood and other water emergencies increasingly are associated with property damage and threats to safety. For example, in 2016, just four flooding events led to $16.6 billion in damages and 49 deaths.** Losses associated with flooding events in 2017, which are still being tabulated, are expected to exceed 2016.
- Emergency managers lack detailed information during flood emergencies to efficiently allocate resources to save lives and property.

Opportunity:

- NOAA can use advances from the state-of-the-art National Water Model (NWM) to demonstrate improved decision-support products to emergency managers.
- Provide emergency managers and the public a longer lead time out to Day 3 for "High Risk" of Excessive Rainfall. Excessive rainfall expresses the probability of rainfall exceeding flash flood guidance.

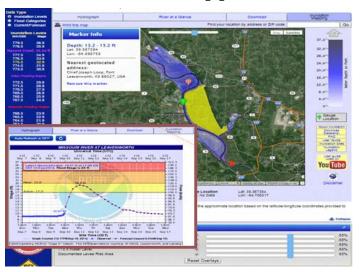** https://www.ncdc.noaa.gov/billions/events/US/1980-2017

1 Execution of the APG is subject to availability of staff resources, especially at the Weather Prediction Center, River Forecast Centers, and the National Water Center which could be affected by implementation of the Analyze, Forecast, and Support reduction.

Long-Range Vision for Flood Inundation Mapping

Flood Inundation Maps: Maps depicting the spatial extent and depth of flood waters, fully resourced for operational production and dissemination, will enable Emergency Managers to better mitigate impacts of flooding and build more resilient communities.
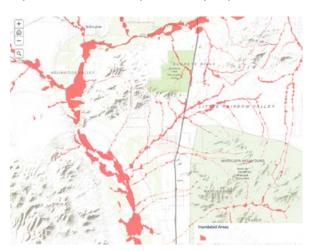
Current Capability: Static Inundation Map libraries at ~150 river locations across the United States.

- Provides the spatial extent and depth of flood waters
- Displays inundation maps for levels from minor flooding through flood of record
- Limited spatial coverage, resource intensive, only at small number of USGS streamgage locations

Next Steps -- NWM enabled capability: The high spatial and temporal resolution capabilities of the National Water Model coupled with high resolution hydrography datasets will allow us to provide real-time flood inundation mapping capabilities at neighborhood-level in a more consistent and timely way.

- Provides spatial extent of flood waters
- Technique can be driven by official streamflow forecasts or NWM guidance (to be demonstrated in this APG for the WGRFC domain)
- Incrementally expand flood inundation mapping demonstration to 2.7 million stream reaches nationwide
- Seek adequate resources to operationally implement FIM

Future Planned Enhancements (resource dependent): Build on and enhance the NWM enabled capability to include:

- Flood Inundation maps informed by the (to be developed) NWM hyper-resolution capabilities to provide improved resolution of maps and better depict the urban built environment
- Flood Inundation maps informed by the (to be developed) NWM coupled with estuarine and coastal processes, and groundwater models
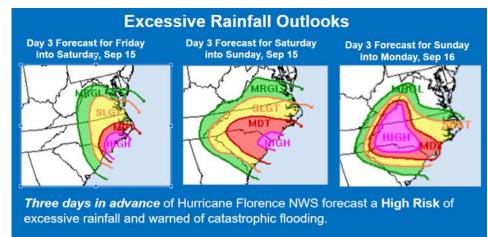
Summary of Progress – FY 19 Q4

- Milestones Completed:
  - Flood Inundation Mapping: Q4FY19: Incorporate feedback from tabletop exercises. Complete FIM demonstration
  - Excessive Rainfall Outlook: Q4FY19: Execute tabletop exercises with Emergency Managers
  - Excessive Rainfall Outlook: Q4FY19: Enhance operational excessive rainfall outlook to add High Risk category out to 3 days
- Why these milestones are important
  - Feedback from the FIM tabletop exercises was incorporated to ensure the demonstrated product is, and remains, useful to users and can support emergency operations for better protection of life and property. Completing the FIM demonstration marks a successful end to the APG. FIM products remain non-operational as the NWS builds off this success and expands demonstrations to other regions of the country.
  - Tabletop exercises were conducted with Emergency Managers on the changes to the Day 3 Excessive Rainfall Outlook. This showcased the new use of "High Risk" on Day 3 and allowed users to engage with the NWS on the product, its intended use and provide feedback.
  - The Excessive Rainfall Outlook has now been enhanced to include the "High Risk" category out to 3 days. This is a permanent policy change for the NWS and will better serve partners and the public by highlighting threats for potentially deadly excessive rainfall sooner, increasing awareness of the hazard.
- APG **Completed** Q4 FY19
- APG targets were **met**

Example of Success – Hurricane Florence, September 2018

- ## 3-Day Excessive Rainfall Outlook
  - The NWS forecast a High Risk of excessive rainfall and warned of catastrophic flooding 3 days in advance of Hurricane Florence. The excessive rainfall outlook was posted prominently on the National Hurricane Center homepage and shared extensively with decision makers and the public. This allowed the message of excessive rainfall risk to be repeated and amplified by private sector and media partners. With this amount of lead time, FEMA and States were able to pre-position assets to save lives and property

Excessive Rainfall Outlooks

Day 3 Forecast for Friday into Saturday, Sep 15 | Day 3 Forecast for Saturday into Sunday, Sep 15 | Day 3 Forecast for Sunday into Monday, Sep 16

Three days in advance of Hurricane Florence NWS forecast a **High Risk** of excessive rainfall and warned of catastrophic flooding.

- ## Flood Inundation Mapping
  - During Hurricane Florence, the National Water Center (NWC) provided a number of National Water Model based experimental guidance products, including the demonstration forecast flood inundation extent maps that depicted areas of inundation based on peak forecast streamflow over the next ten days. These products helped provide additional situational awareness (beyond the 100 and 500 year flood maps typically used) of what shelters would be accessible given the historic extent of the flood. Plans were made to utilize each location based on their proximity to the maximum flood inundation extent.
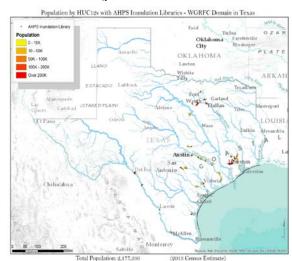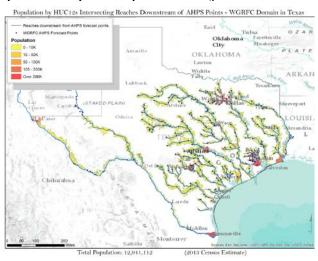
Key Milestones (Flood Inundation Mapping)

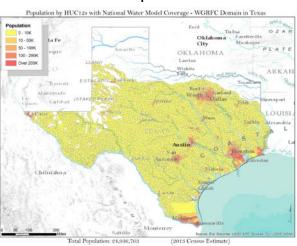| Milestone Summary				
Key Milestone	Milestone Due Date	Milestone Status	Change from last quarter	Anticipated Barriers or other Issues Related to Milestone Completion
Initiate flood inundation mapping (FIM) techniques using the River Forecast Center (RFC) official forecast for West Gulf River Forecast Center (WGRFC) domain	FY18 Q3	Complete (FY18 Q3)	n/a	
Internal validation of FIM (using official forecast) with OWP and WGRFC	FY18 Q4	Complete (FY18 Q4)	n/a	
Initiate flood inundation mapping techniques using the National Water Model (NWM) guidance for WGRFC domain	FY18 Q4	Complete (FY18 Q3)	n/a	
Internal validation of FIM (using NWM guidance) with OWP and WGRFC	FY19 Q1	Complete (FY19 Q1)	n/a	
NWM version 2.0 released	FY19 Q2	Complete (FY19 Q3)	n/a	
Complete tabletop exercise planning	FY19 Q2	Complete (FY19 Q3)	n/a	
Execute tabletop exercises with demonstration area Emergency Managers	FY19 Q3	Complete (FY19 Q3)	n/a	
Incorporate feedback from tabletop exercises. Complete FIM demonstration.	FY19 Q4	Complete (FY19 Q4)	Completed	

Key Indicators (Flood Inundation Mapping)

Population served by inundation information, considering areas within NWS West Gulf Forecast Center service area in Texas.*

- Baseline: < 1% of population (2.2M) served by current Advanced Hydrologic Prediction Service (AHPS) static inundation maps near specific river locations
- FY18 Q3: Initiate demonstration on 4% of population (12.9M) served with NWM hydrography and Height Above Nearest Drainage (HAND) technique near NWS official forecast locations.
- FY18 Q4: Initiate demonstration on 8% of population (24.9M) served with NWM guidance and HAND technique along full river/stream network.
- FY19 Q4: Complete demonstration on 8% of population and incorporate emergency manager feedback.
- Out-year: ~100% of CONUS population (317M) served by NWM model and HAND technique

Baseline   FY18 Q3   FY18 Q4

*Population totals based on 2013 population in adjacent hydrologic areas, defined by Hydrologic Unit Code (HUC) 12 delineations.
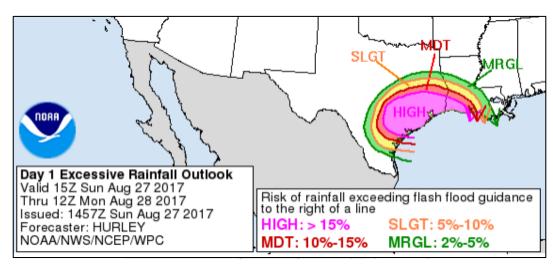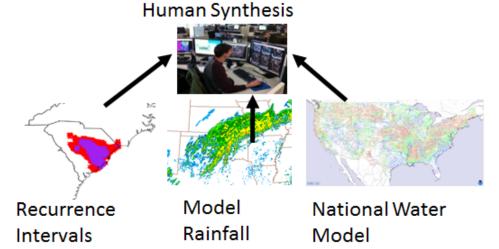
Excessive Rainfall Outlook

The Excessive Rainfall Outlook (ERO) provides a national summary of rainfall threat by expressing the probability of rainfall exceeding flash flood guidance.

The ERO raises situational awareness that conditions are favorable for impactful rainfall.

The risk of excessive rainfall is expressed both probabilistically and categorically (e.g., Marginal 5-10%, Slight 10-20%, Moderate 20-50%, and High >50%).

"High" risk forecast days have been correlated to events with fatalities and large damages. Currently "High Risk" is only used in Day 1 and Day 2 products.

Day 1 Excessive Rainfall Outlook
Valid 15Z Sun Aug 27 2017
Thru 12Z Mon Aug 28 2017
Issued: 1457Z Sun Aug 27 2017
Forecaster: HURLEY
NOAA/NWS/NCEP/WPC

Risk of rainfall exceeding flash flood guidance to the right of a line
HIGH: > 15%   SLGT: 5%-10%
MDT: 10%-15%   MRGL: 2%-5%

Human Synthesis

Recurrence Intervals

Model Rainfall

National Water Model

Key Milestones (Excessive Rainfall Outlook)
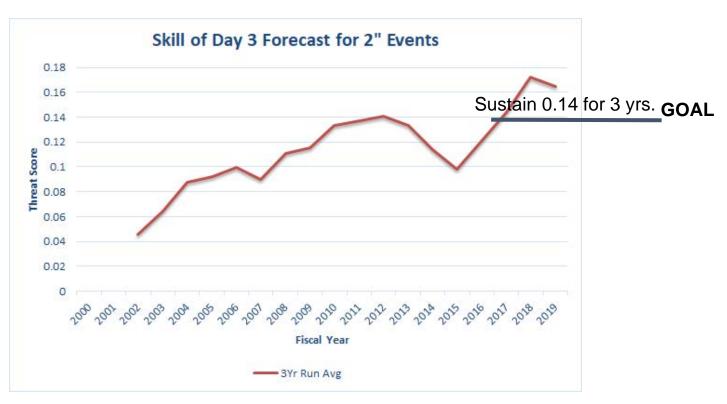
Milestone Summary				
Key Milestone	Milestone Due Date	Milestone Status	Change from last quarter	Anticipated Barriers or other Issues Related to Milestone Completion
Enhance excessive rainfall outlook to include improved definition and calibration	FY18 Q1	Complete (FY18 Q1)	n/a	
Execute Flash Flood and Intense Rainfall Experiment and assess Day 3 rainfall tools	FY18 Q4	Complete (FY18 Q4)	n/a	
Test machine-learning first guess field for Excessive Rainfall Risk areas	FY18Q4	Complete (FY18 Q4)	n/a	
Internal issuance of test 'high' risk areas on Day 3	FY19 Q1	Complete (FY19 Q1)	n/a	
Add excessive rainfall outlook to National Hurricane Center webpage for landfalling tropical cyclones.	FY19 Q3	Complete (FY19 Q3)	n/a	
Execute tabletop exercises with Emergency Managers	FY19 Q3	Complete (FY19 Q4)	Completed	Delayed due to impacts of Federal Government shutdown.
Enhance operational excessive rainfall outlook to add High Risk category out to 3 days.	FY19 Q4	Complete (FY19 Q4)	Completed	

Key Indicators (Excessive Rainfall Outlook)

Threat score of two inch rainfall events forecast 3 days in advance
(3 FY running average)

3-year running average goal = 0.14
Sustaining a 0.14 Threat Score gives confidence to provide 'high risk' excessive rainfall outlook category on Day 3
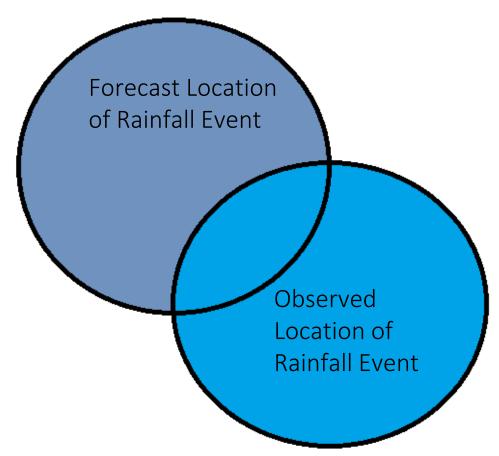

FY19 performance data will be available at the end of the fiscal year. The NWS is currently on track to meet the three-year running average goal of 0.14.

What does a 0.14 Threat Score Mean?

Threat Score of 0 = NO overlap between forecast & observed location.

Threat Score of 1 = COMPLETE overlap between forecast & observed location.

Threat Score of 0.14 = Index score which represents 25% overlap between forecast and observed location

Note: Predictions with some variation are still highly useful to planning for and responding to extreme weather.

Forecast Location
of Rainfall Event

Observed
Location of
Rainfall Event

Additional Information

Contributing Programs

Organizations:

- o   OMB, DOC, NOAA -- Oversight
- o   NWS -- Implementing Organization for APG

Program Activities:

- o   Office of Water Prediction -- Demonstrate Flood Inundation Map
- o   National Centers for Environmental Prediction -- Deliver Enhanced Excessive Rainfall Outlook

Regulations:

- o   N/A

Tax Expenditures:

- o   N/A

Policies:

- o   None

Other Federal Activities:

- o   None

Stakeholder Consultations

The APG advances decision support, which is authorized in the Weather Research and Forecasting Innovation Act of 2017.