



NOAA's National Water Model: Comprehensive Continental-Scale Water Intelligence



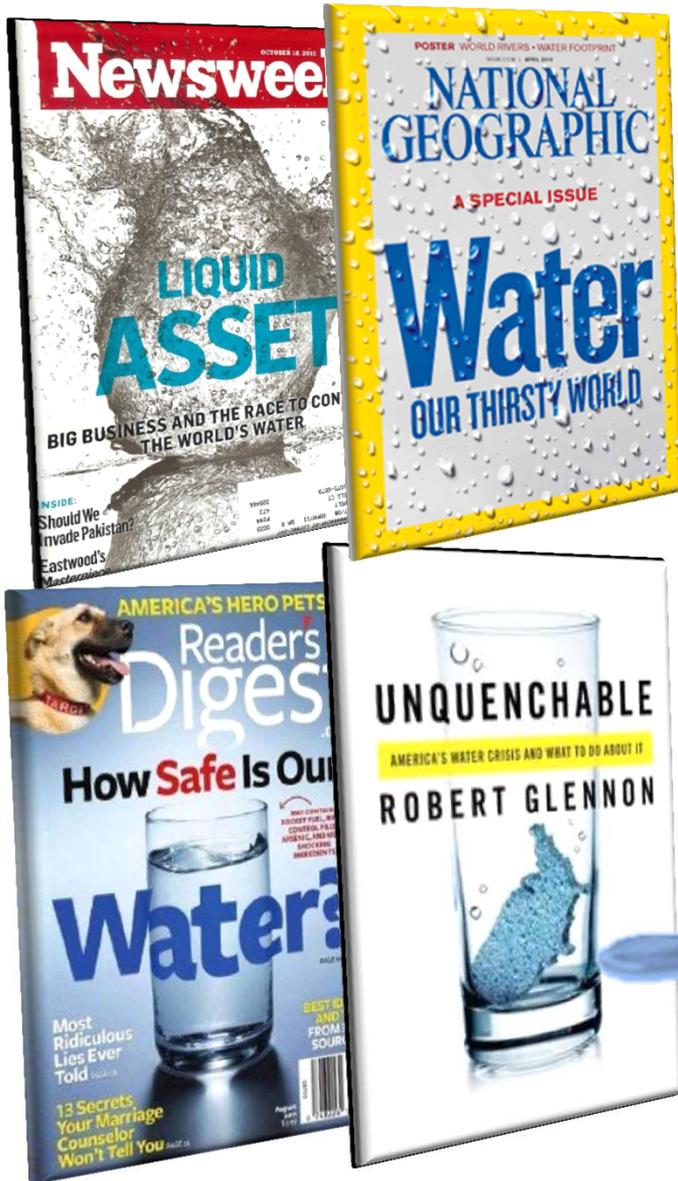
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Impetus for Change

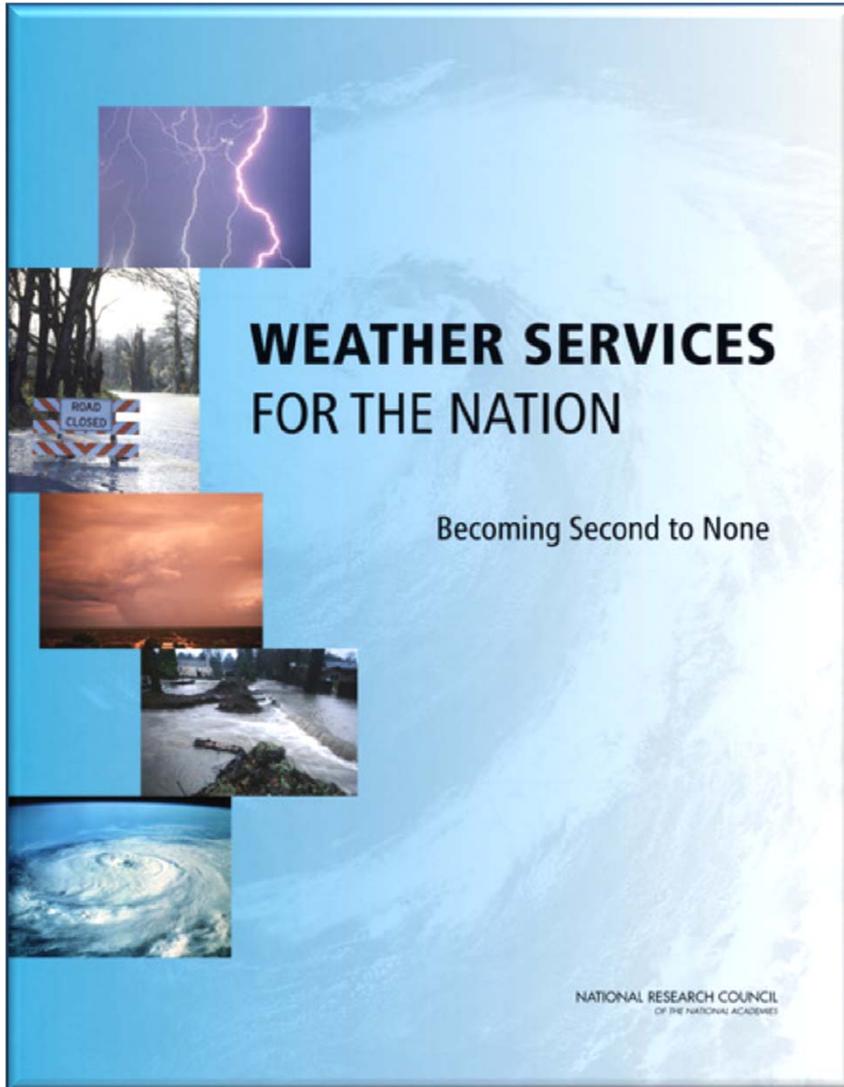
Growing Water Challenges



Multiple Threats

- Population growth and economic development are stressing water supplies and increasing vulnerability
- A changing climate is impacting water availability and quality, increasing uncertainty
- An aging water infrastructure is forcing critical, expensive decisions
- Socio-economic risks of floods and droughts are escalating

National Academy of Sciences Report: *Weather Services for the Nation: Becoming Second to None*



Finding

- A significant gap exists between the state of hydrologic science today and current NWS hydrologic operations
- The level of sophistication, representation of processes, and characterization of uncertainties in external research and operational communities outpace those used in NWS hydrology operations

Recommendations

- Improve pathways for collaboration & accelerate R2O
- Implement a consistent framework for hydrologic prediction skill assessment

Initial Stakeholder Priorities



Flooding



**Water
Quality**



**Water
Availability**



Drought



**Climate
Change**

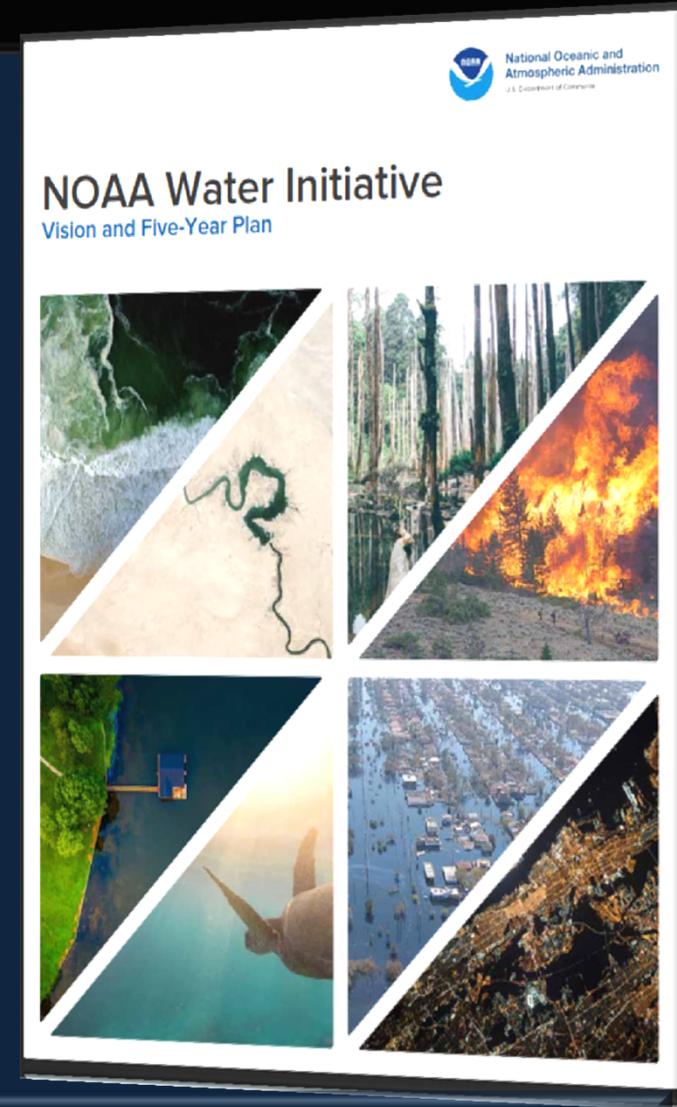
Need integrated understanding of near- and long-term outlook and risks

- ◆ Provide consistent, high resolution (“street level”), integrated water analyses, predictions and data to address critical unmet information and service gaps
- ◆ Transform information into intelligence by linking hydrologic, infrastructural, economic, demographic, environmental, and political data
- ◆ Integrate Social Science to create *Actionable Water Intelligence*

NOAA Water Initiative

Overarching Goal: Transform water information service delivery to better meet and support evolving societal needs

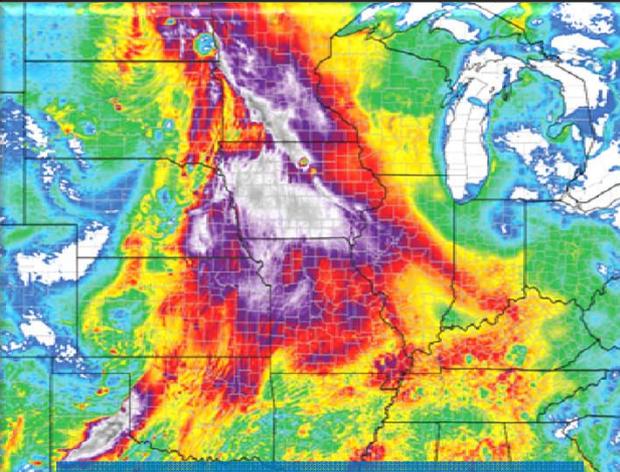
- User-Oriented, informed by Regional and National Conversations on Integrated Water Information
- Leverages the National Water Center to provide next-generation, science-based water information and decision support services.
- Calls for collaboration across federal agencies and with partners outside government
- Released in December 2016



<http://www.noaa.gov/water>

NOAA Water Initiative

Key Objectives



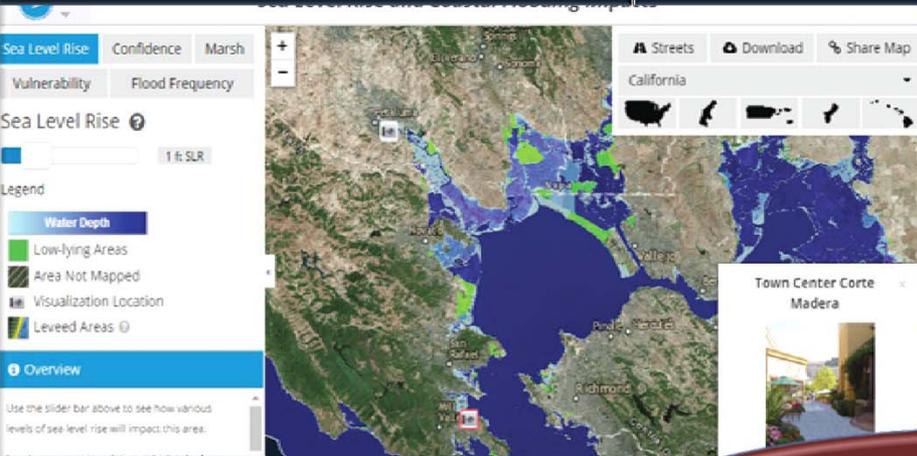
Improve Modeling & Prediction



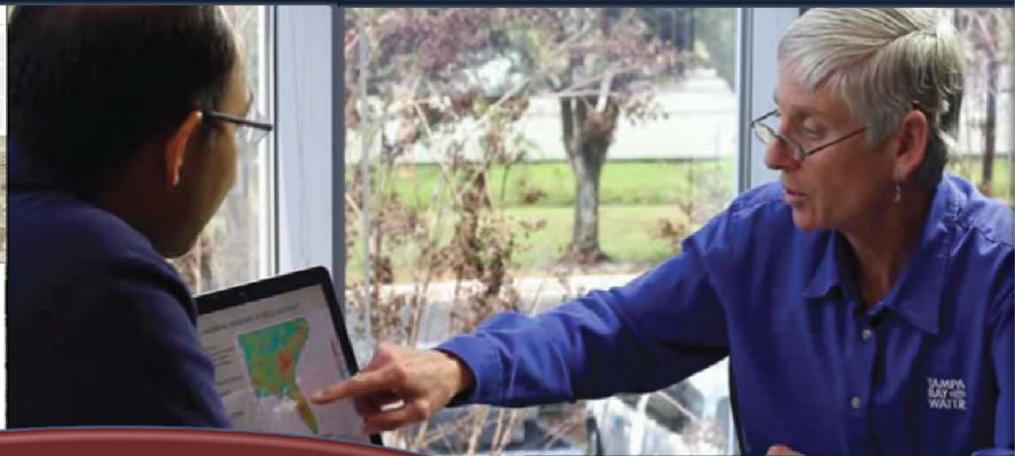
Enhance Water-Related Observations



Accelerate Research & Development



Strengthen Decision Support Tools



Informed by social science

Enhance Service Delivery

Integrated Water Prediction

Setting the Stage for Transformation

Centralized Water Forecasting Demonstration (2015)

- National Water Model (NWM) Development and Demonstration
- Centralized Water Resources Data Services
- Water Resources Test and Evaluation Service

Enhanced Water Prediction Capability (2016)

- Hyper-Resolution Modeling
- Real-Time Flood Forecast Inundation Mapping
- Enhance Impact-Based Water Resources Decision Support Services

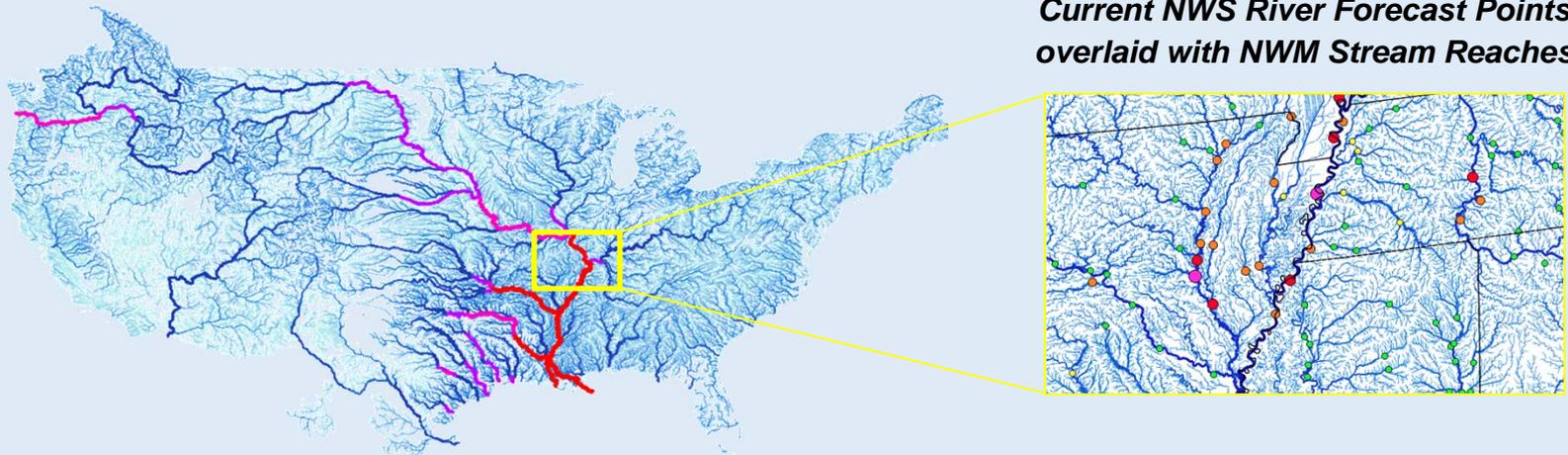
Integrated Water Prediction (2017 Proposed)

- Stand up the National Water Center Operations Center
- Couple terrestrial freshwater and coastal estuary models for total water predictions in the coastal zone
- Increase high performance computing capacity

National Water Model

Initial Operating Capability – v1.0 implemented in Aug. 2016

- **Spatially continuous estimates of major water cycle components** (snowpack, soil moisture, channel flow, major reservoir inflows, flood inundation)
- Operational forecast **streamflow guidance for currently underserved locations**: 3,600 forecast points -> 2.7 million (NHDPlus river reaches)
- Implement an **Earth system modeling architecture** that permits rapid model evolution of new data, science and technology (i.e. **WRF-Hydro**)
- Ongoing **Water Resource Evaluation Service (WRES)** and **Data Service (WRDS)** to compliment implementation efforts



Current NWS River Forecast Points overlaid with NWM Stream Reaches

National Water Model v1.0/1.1

Analysis and Forecast Cycling Configurations

Cycling

Forecast

Forcing

Outputs



Hourly

0 – 18 hrs

MRMS QPE

Downscaled
HRRR/RAP
Blend

1-km spatial fluxes
(water & energy);
250-m routed
fluxes (water);
NHDPlus channel
routing



4x Daily

to 10 days

Downscaled
GFS

1-km spatial fluxes
(water & energy);
250-m routed
fluxes (water);
NHDPlus channel
routing



Daily x 16
ensembles

to 30 days

Downscaled &
NLDAS2 Bias
Corrected CFS

1-km spatial fluxes
(water & energy);
NHDPlus channel
routing

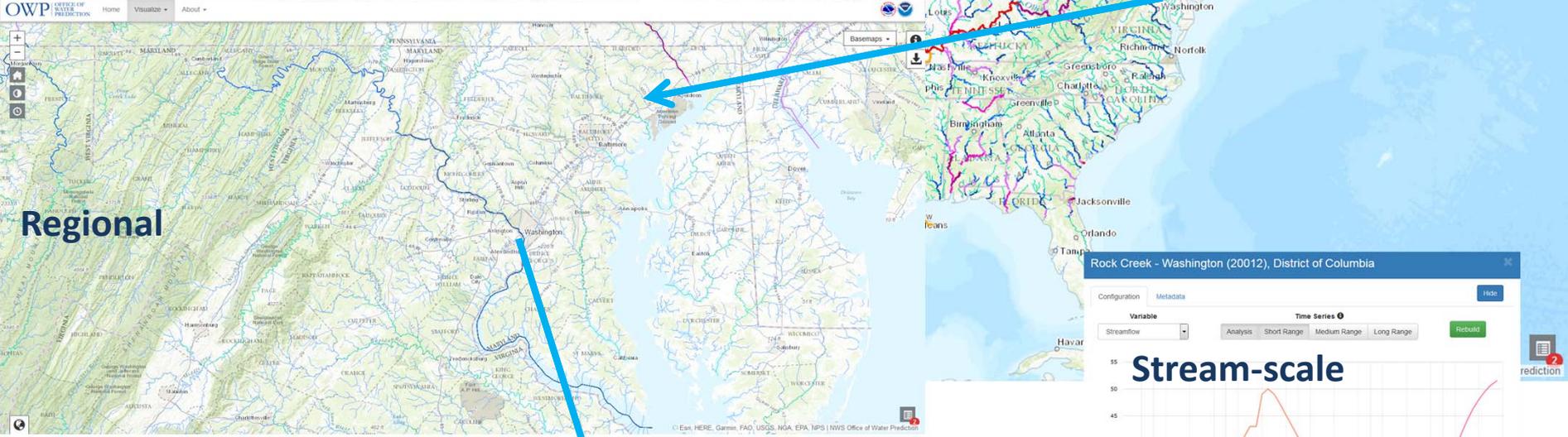
Model output available at: <https://water.noaa.gov>

Multi-Scale Hydrologic Analysis and Forecast Guidance

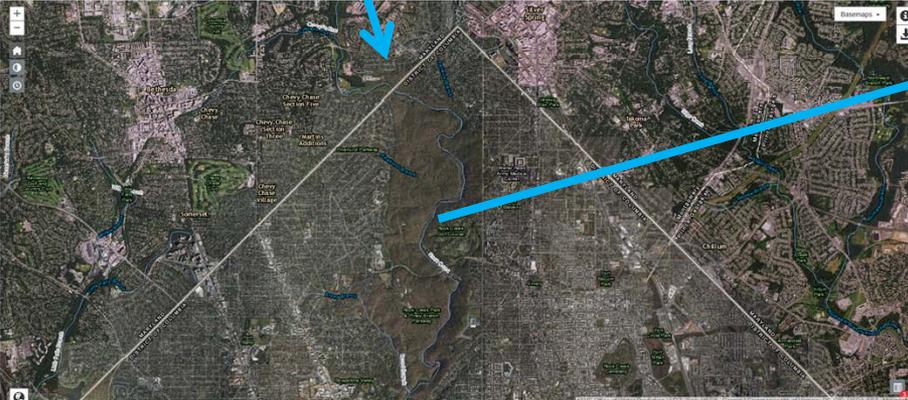
National



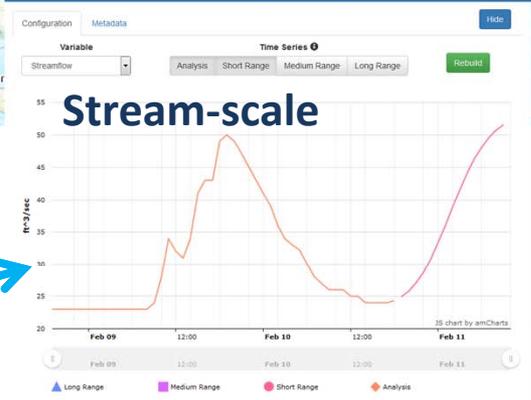
Regional



Neighborhood

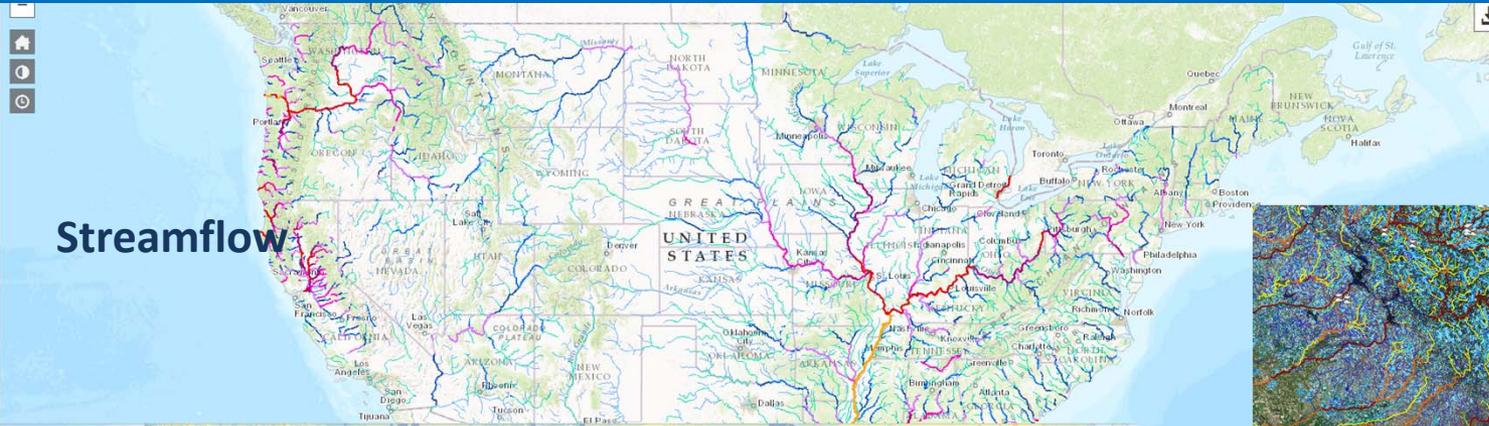


Rock Creek - Washington (2012), District of Columbia

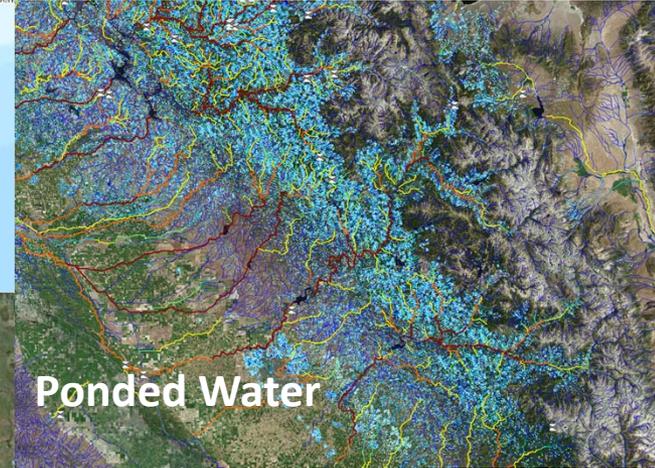


Multi-Variable Hydrologic Analysis and Forecast Guidance

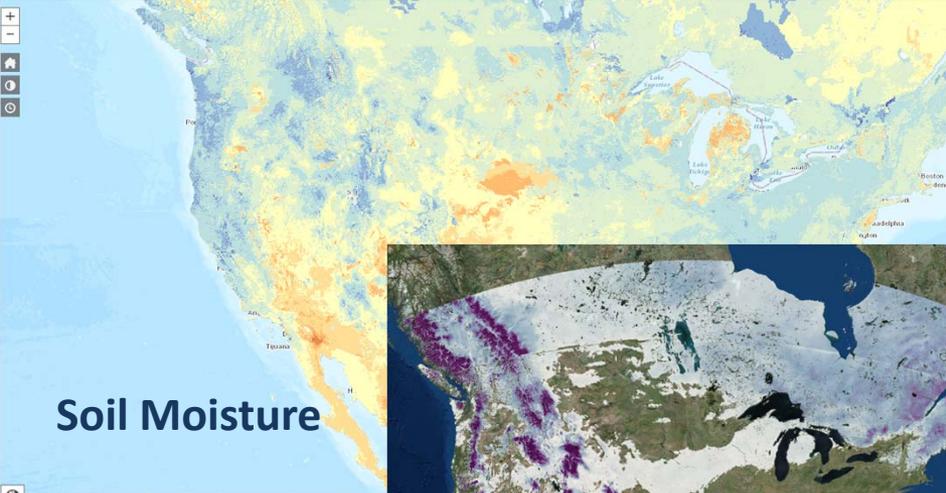
Streamflow



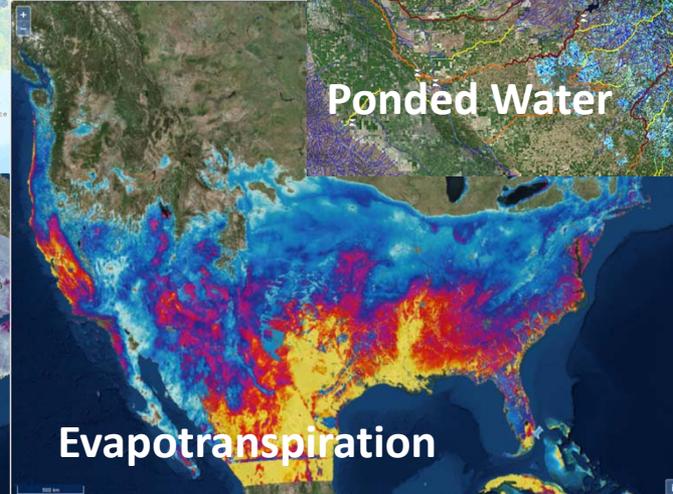
Ponded Water



Soil Moisture



Evapotranspiration



Snowpack

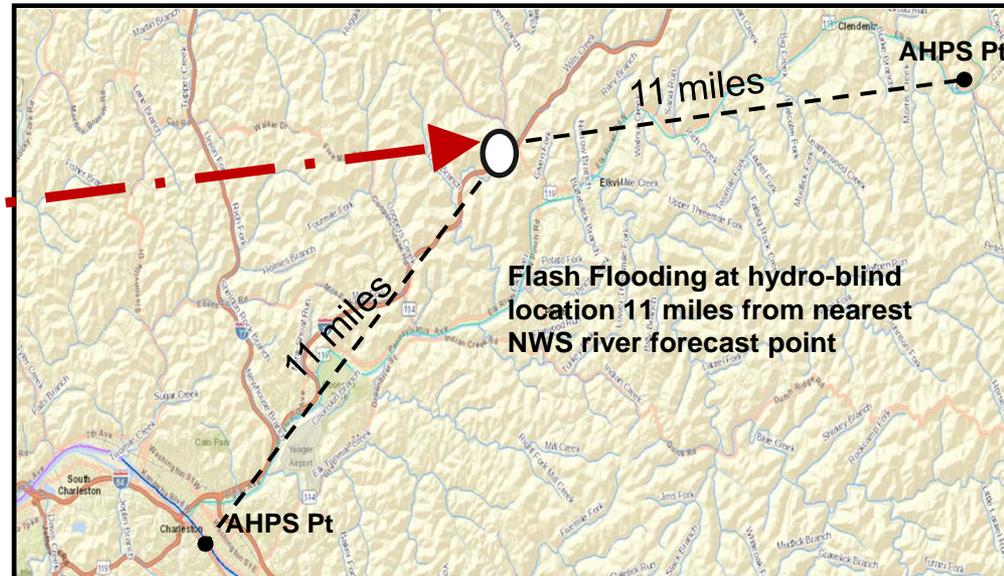
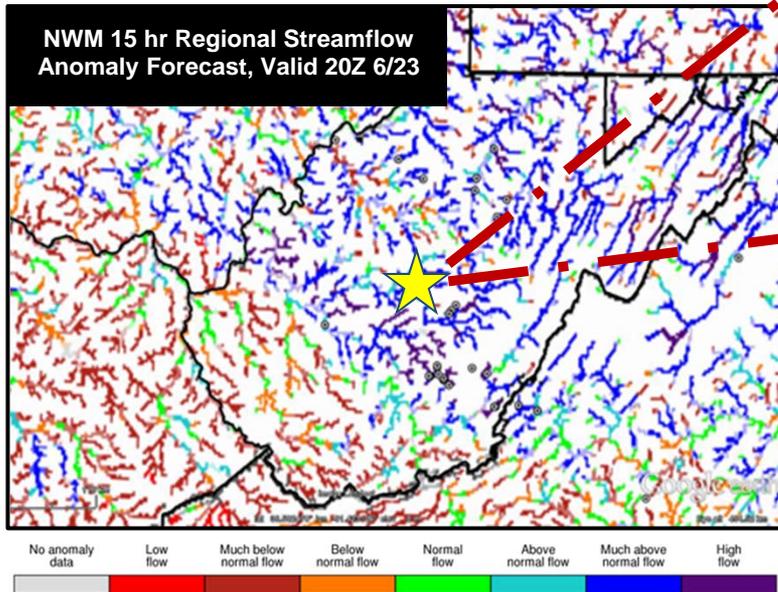
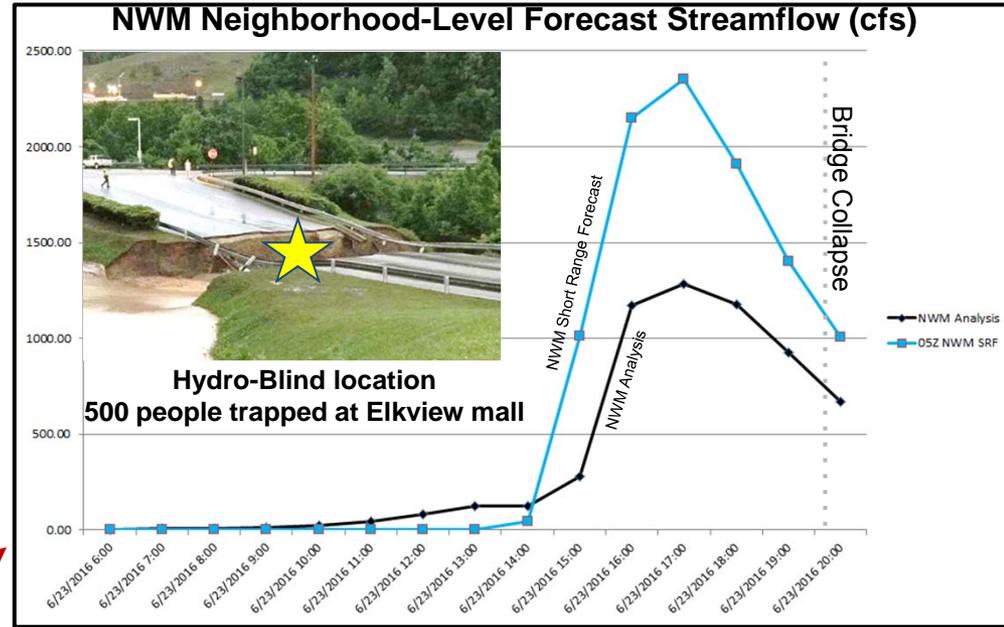


- Many other output fields are available, including meteorological data used to force NWM
- Details are available at: <http://water.noaa.gov/about/nwm>

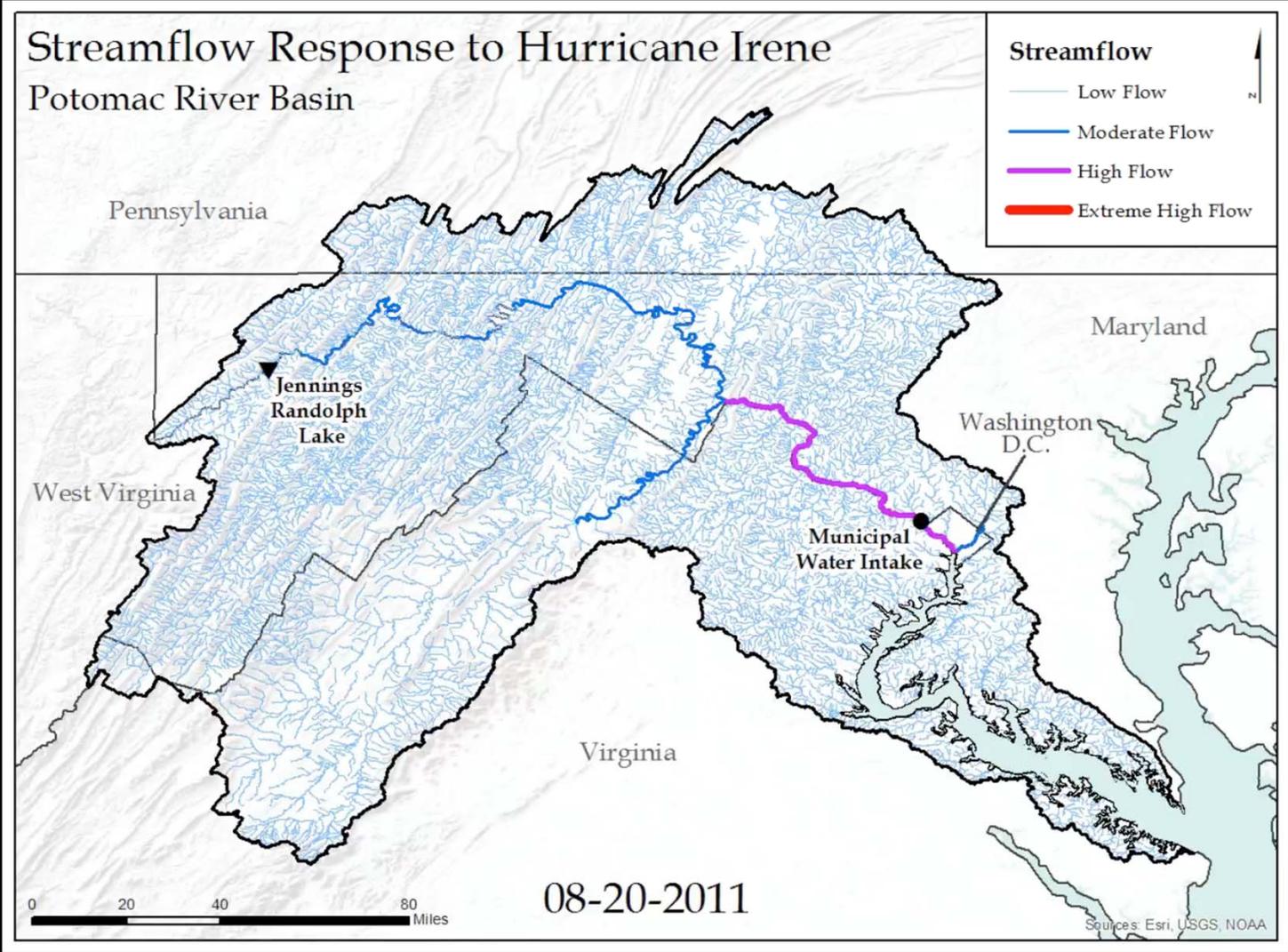
NWM V1.0 Forecast Assessment

Record Setting West Virginia Flood Event, June 23rd 2016

- Thousands of homes damaged, estimated \$300+ million in flood costs
- NWM allows users to drill down from regional to local to neighborhood “street level” scale
- Information complements hydrologic guidance at existing forecast locations, provides insight at of hydro-blind locations



NWM Simulation of Hurricane Irene



Summary

- **NOAA's Water Services are Evolving**
 - We are building a foundation for change – but have a long way to go
 - Stakeholder input will continue to inform future development activities, and the delivery and evolution of new services
- **New Organization, Cornerstone Facility and Philosophy**
 - Office of Water Prediction/National Water Center
 - Collaborative, cross-NOAA, interagency, academic partnerships
- **Implementing State-of-the-Art Technical Approach**
 - Impact-based decision support services underpinned by geo-intelligence
 - NWM V1.0 establishes foundation for sustained improvement in water prediction and first ever nationally consistent operational hydrologic forecasting capability
 - Focus moving forward will be on expanding evaluation capabilities, working with end users to improve NWM's base capabilities and establish new connections
 - NWM V1.1 will be implemented in Spring 2017, followed by V1.2 in Fall of 2017
 - Longer-term efforts will focus on domain expansions, coupling to coastal models, and hyper-resolution, low flow/drought and water quality modeling