

National Water Model: Geospatial Tool, Services, Inundation Maps

Mark Glaudemans

NWS / AFSO / Water Resources Services Branch Chief

2023 FFaIR Seminar Series - August 8, 2023

Outline

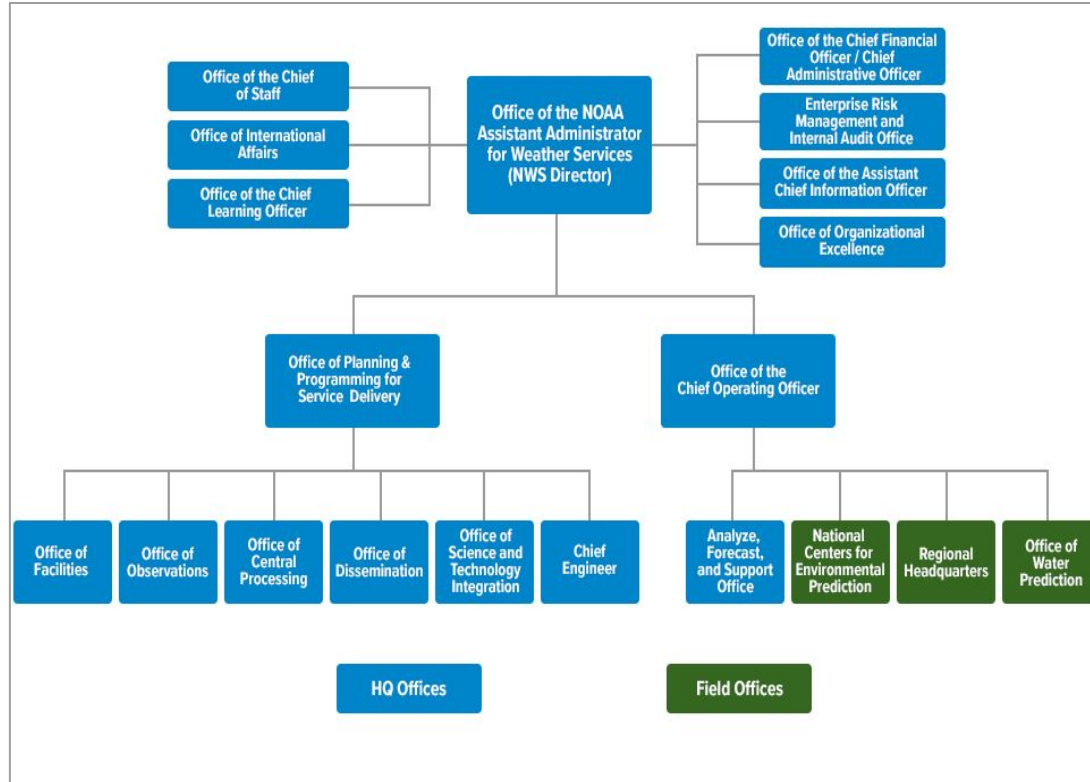
- **National Water Model**
 - Overview and FFaIR Context
- **NWC Map Visualizations (experimental)**
 - Water in the stream
- **NWC Products (experimental)**
 - AHD, FHO, NHD
- **NWC Flood Inundation Mapping (experimental)**
 - RFC and NWM FIM for 10% of country
- **Hazard Services and IDSS**
 - Future service delivery



Water Services Delivery



National Water Center - Tuscaloosa, AL



Water Resources Team

Chief Operating Officer (COO)

- Analyze, Forecast, Support Office (AFSO) Water Resources Services Branch
- Office of Water Prediction (OWP) / National Water Center
- NCEP Weather Prediction Center (WPC)
- River Forecast Centers (RFCs)
- Weather Forecast Offices (WFOs)
- Regional Operations Centers (ROCs)

Planning, Programming for Service Delivery

- All portfolios

Collaborators

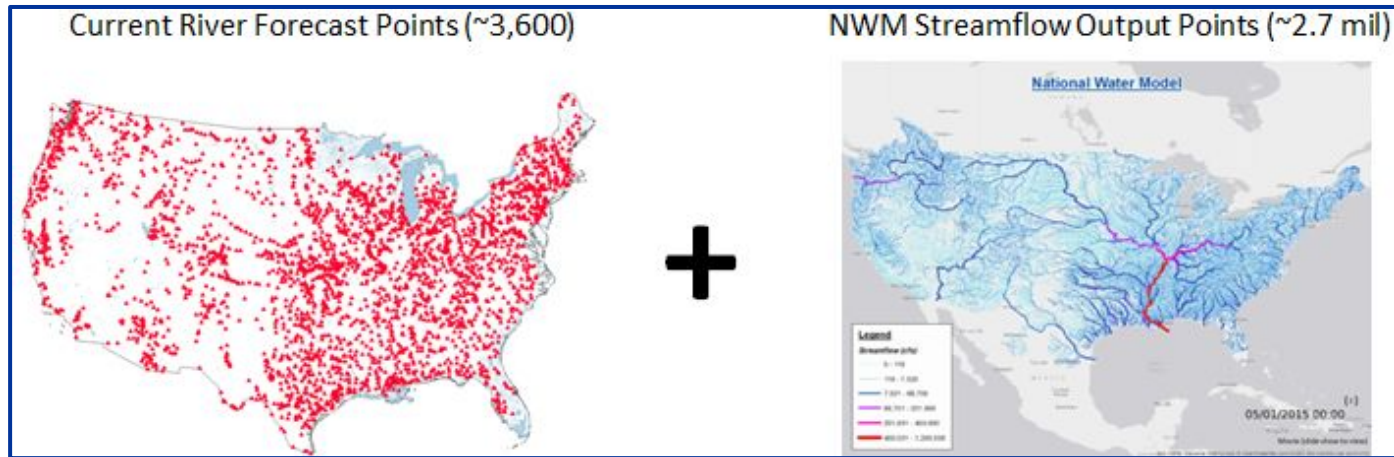
- IWRSS partners (USACE, USGS, FEMA)
- IDSS partners
- NOAA partners (NOS, OAR, NESDIS)
- Cooperative Institute (CIROH)



National Water Model (NWM)

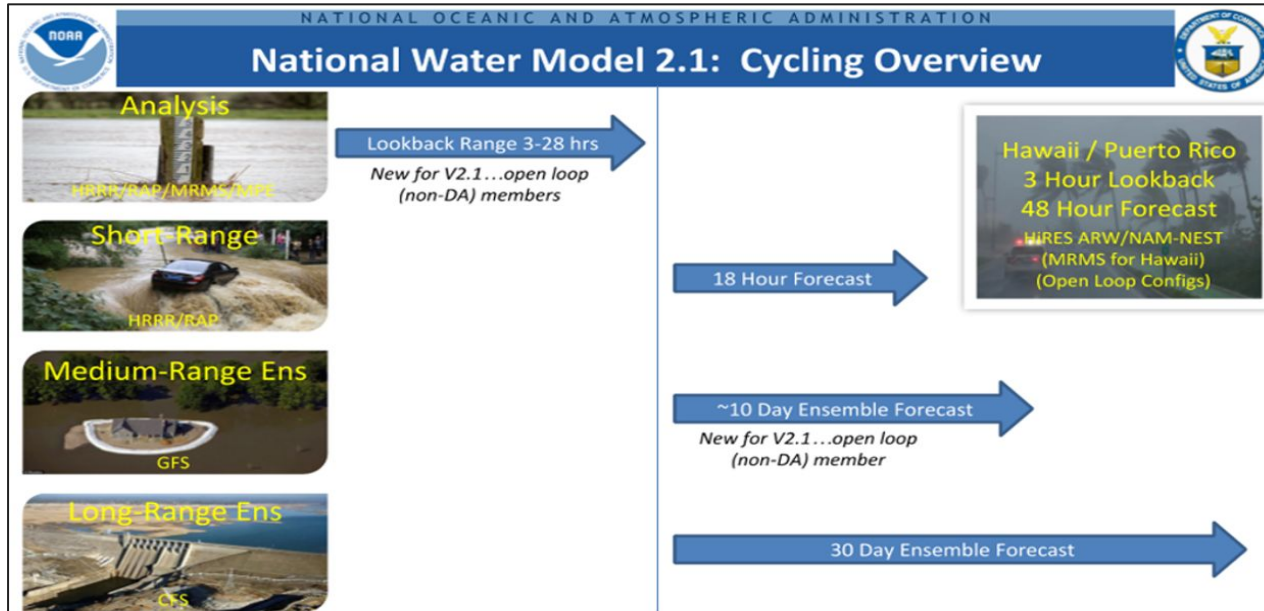
National Water Model - New Water Prediction Information

- NWM is a hydrologic model that simulates observed and forecast **streamflow**
- *Compliments* official NWS river forecasts at ~3,600 locations
- Models using fine spatial and temporal scale with large spatial coverage
 - 2.7 million river reaches = 3.4 million river miles



National Water Model - Versions

Model info at: <https://water.noaa.gov/about/nwm>



NWM v3.0 Update in August 2023

SCN23-76: Updated:
Upgrade of National Water Model on NCEP's WCOSS System and its Post-processing Application on the Integrated Dissemination Platform (IDP), Effective **August 16, 2023**

<https://www.weather.gov/notification/>

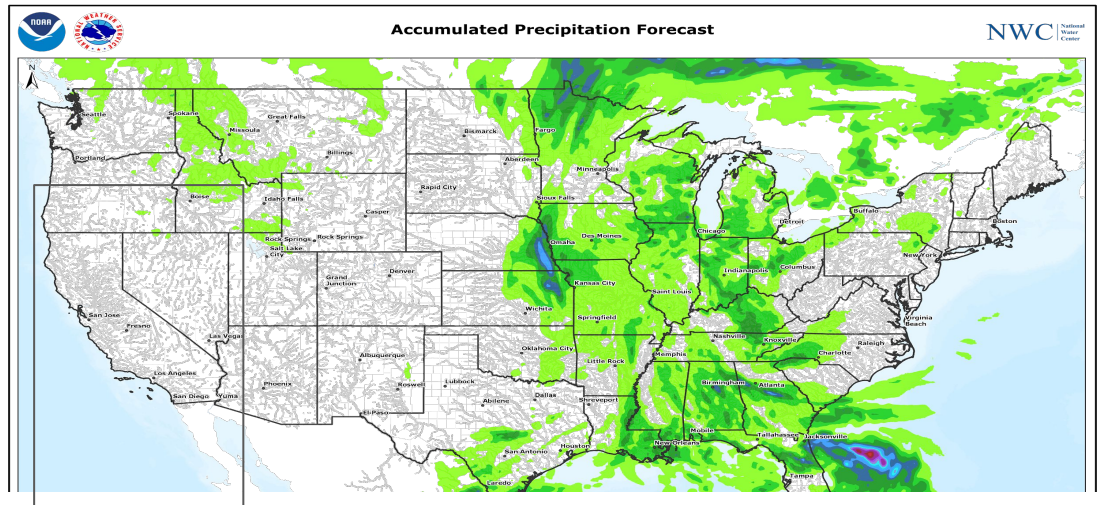
National Water Model - Forcings

Precipitation Sources for NWM v3:

- Analysis (Current Conditions): MRMS (RFC StageIV)
- Short Range Forecast (18-hours): HRRR and RAP
- Medium Range Forecast (10-days): GFS and NBM

NWM v3: Using the National Blend of Models (NBM) for:

- CONUS medium-range 10-day forecasts
- Alaska short-range and medium-range forecasts



NWM Data Delivery - 1 TB/day



18 time steps x 24 forecasts for the NWM Short Range Forecast per day

Raw model output available via NCEP web services:

<https://nomads.ncep.noaa.gov/pub/data/nccf/com/nwm>

<ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nwm>

- How do we extract actionable intelligence from that much data?
- How do we communicate the NWM output to forecasters and decision-makers?

Answer:

- Map services for near-real-time visualizations (70+ services)
- Operational products based on latest guidance





NWC Visualization Services (Experimental)

Available NWM Visualizations / Map Services

Today ... Full access to NOAA, limited access for public

1. WaterView NOAA GeoPlatform

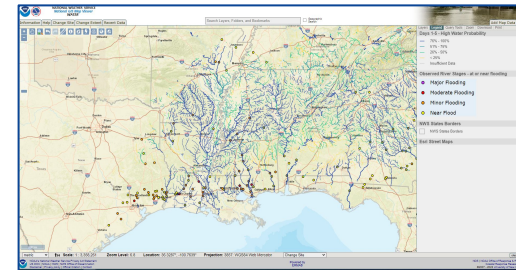
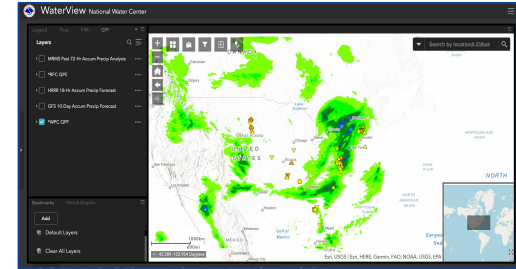
- What: Access to ALL visualizations, including Inundation
- Who: Available to noaa.gov users only
- How: [Access information](#) describes access, content, etc.

2. National GIS Viewer

- What: Limited set of visualizations per [Public Handbook](#)..
- Who: Available to public. Simple web page access.
- How: Water layers: <https://viewer.weather.noaa.gov/water>

HydroVIS (Hydrologic Visualization and Inundation Services) is cloud based system that:

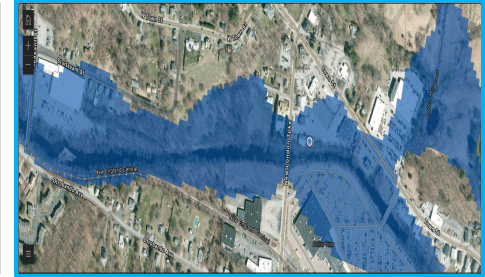
- Serves map services to both the GIS Viewer and WaterView.
- Allow direct access to public map service for local GIS viewing tools.



Available NWM Visualizations / Map Services

October 2023 ... Adding public Flood Inundation Mapping (FIM)

- **GIS Viewer**
 - Adding FIM services covering 10% of county (~ TX, PA, NY)
 - In future, adding FIM for 30%, 60%, 100% in FY24, 25, 26



February/March 2024 ... New web portal for water prediction

- Replacing primary NWS hydrologic web portal for public
 - Currently AHPS (Advanced Hydrologic Prediction Service) at water.weather.gov being retired.
 - Upgrading to NWPS (National Water Prediction Service) at water.noaa.gov
 - Mobile-friendly with expanded data services and features

Public NWM Visualizations / Map Services

River Forecast Center Services

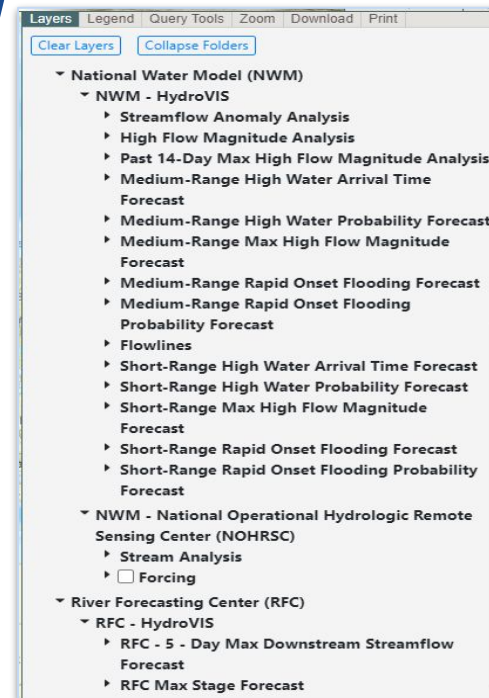
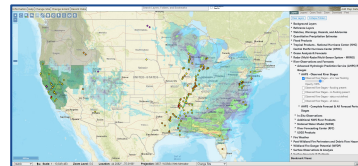
- AHPS Maximum Stage Forecast
- RFC 5-Day Maximum Streamflow Forecast

National Water Model Services

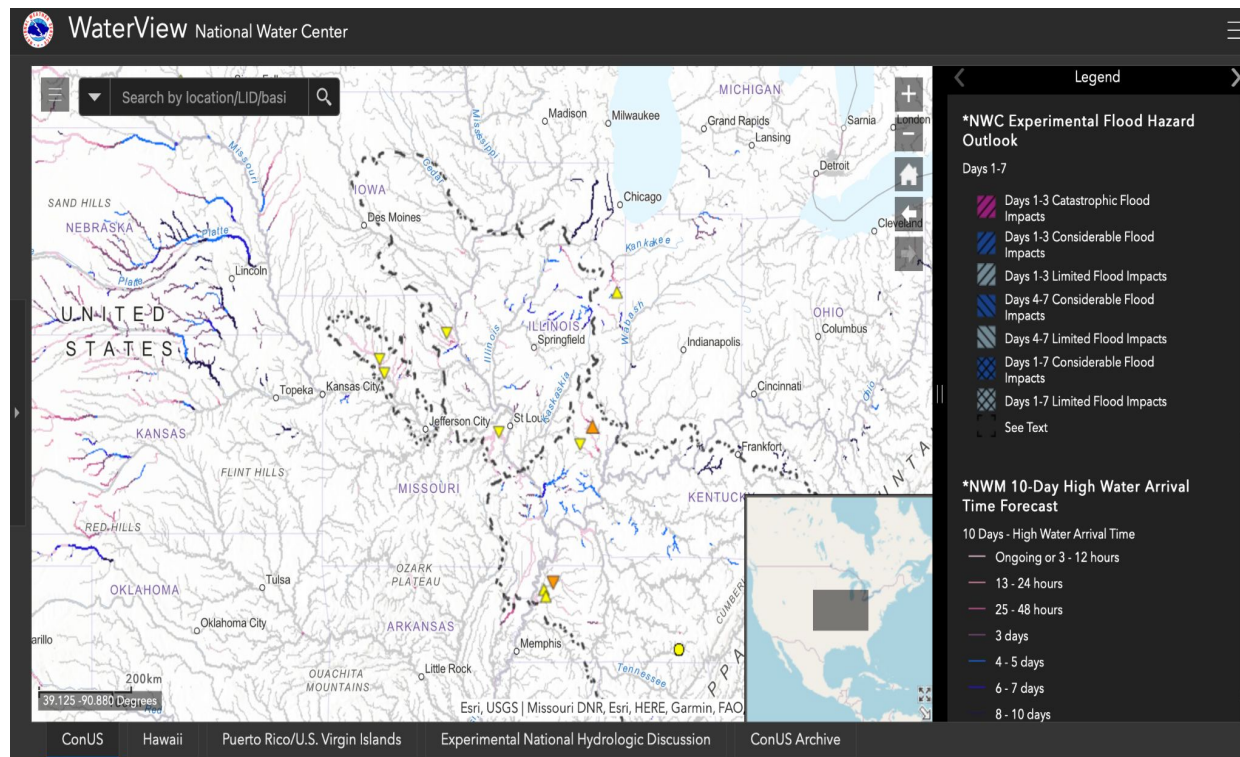
- Current Conditions (Analysis and Assimilation)
 - NWM Streamflow Anomaly
 - NWM High Flow Magnitude
 - NWM Past 14-Day High Flow Magnitude
- Short-Range Forecast
 - NWM 18-Hour Maximum High Flow Magnitude (48 hrs for HI, PR/VI)
 - NWM 18-Hour High Water Arrival Time (48 hrs for HI, PR/VI)
 - NWM 12-Hour High Water Probability
 - NWM 18-Hour Rapid Onset Flooding / Probability
- Medium-Range Forecast
 - NWM 10-Day Maximum High Flow Magnitude
 - NWM 10-Day High Water Arrival Time
 - NWM 5-Day High Water Probability
 - NWM 10-Day Rapid Onset Flooding / Probability

When?
Arrival Time

How much?
High Flow
Magnitude



WaterView - Access to All Visualizations



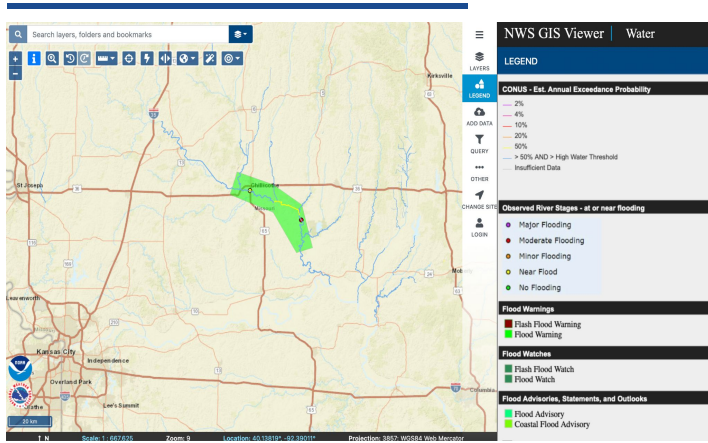
Situational awareness needs synthetic thresholds, given that 99.9% of country is unengaged.

- For “magnitude” displays, river reaches colored by the estimated annual exceedance probability (AEP) of their current flow.
- “High water” thresholds are also used (regionally varied use of AEP flow).
- AEPs were derived using the 40-year NWM v2.1 reanalysis simulation.

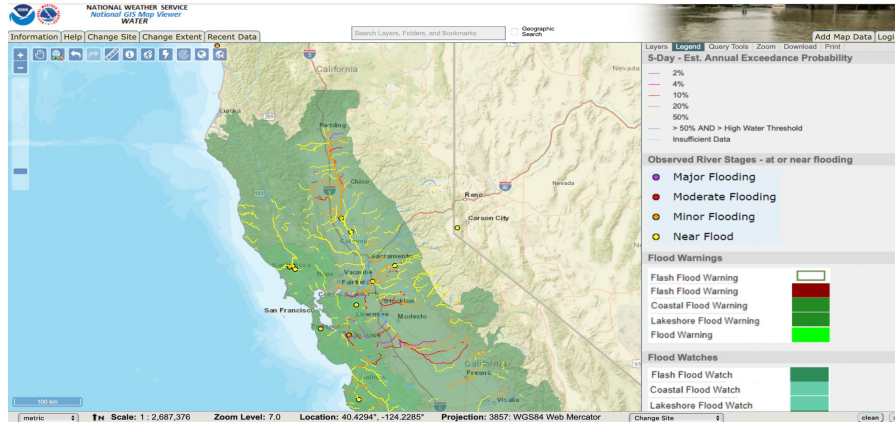
Waterview showing FHO and High Water Arrival Time



GIS Viewer - Access to Limited Visualizations



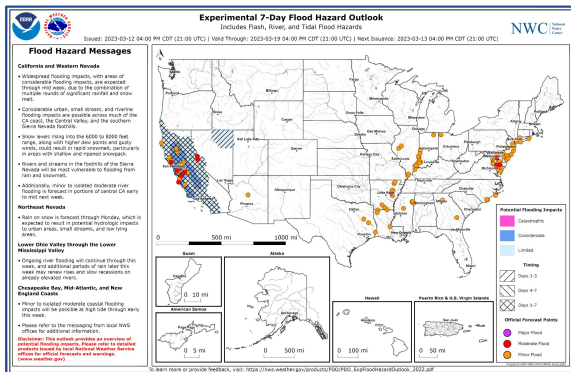
GIS Viewer samples showing forecast flows colored by AEP for river reaches and watch/warnings





NWC Products (Experimental)

Experimental Products (Publicly available)



Flood Hazard Outlook

NATIONAL WEATHER SERVICE
 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HOME FORECAST PAST WEATHER SAFETY INFORMATION EDUCATION NEWS SEARCH ABOUT

National Water Center Products and Services
 Operational and Experimental

Office of Water Prediction
 National Program

Area Hydrologic Discussion

Experimental short range, episodic, discussion and graphic which highlights locations across the nation that may be impacted by rapid-onset flooding, using National Water Model and other guidance.

AHD Product Description Document
 Provide Feedback on AHD
 AHD One-Pager

National Hydrologic Discussion

Experimental discussion of the current and forecast hydrologic conditions across the nation, including a variety of short and medium range (Days 1-10) observed and modeled hydrologic guidance.

NHD Product Description Document
 Provide Feedback on NHD
 NHD One-Pager

NWC Visualization Services

Experimental geospatial services depicting forecasts from the River Forecast Centers and the National Water Model. Services available via the prototype NWS National Map Viewer, or directly via URLs hosted on the Hydrologic Visualization and Inundation Services (HydroVIS) cloud resource. Refer to the "Public Handbook" for additional details.

NWC Visualization Services
 Description Document
 Provide Feedback on NWC Visualization Services

High Flow Magnitude
 High Water Arrival Time
 High Water Probability
 Rapid Onset Flooding
 Streamflow Anomaly

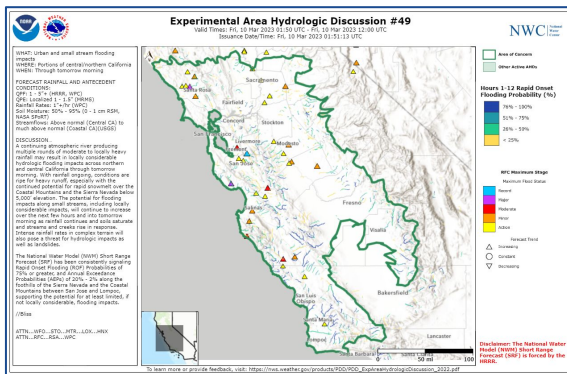
Flood Hazard Outlook

High Level graphical depiction and key messages highlighting the potential threat of inland flood hazards (flash, urban, small stream and riverine), and their associated impacts (catastrophic, considerable, and limited) for the next seven days.

FHO Product Description Document
 Provide Feedback on FHO
 FHO One-Pager

Significant River Flood Outlook

Operational flood outlook intended to provide a general outlook for significant (moderate and above) river flooding. It is not intended to depict all areas of minor flooding or small-scale events such as localized flooding and/or flash flooding.



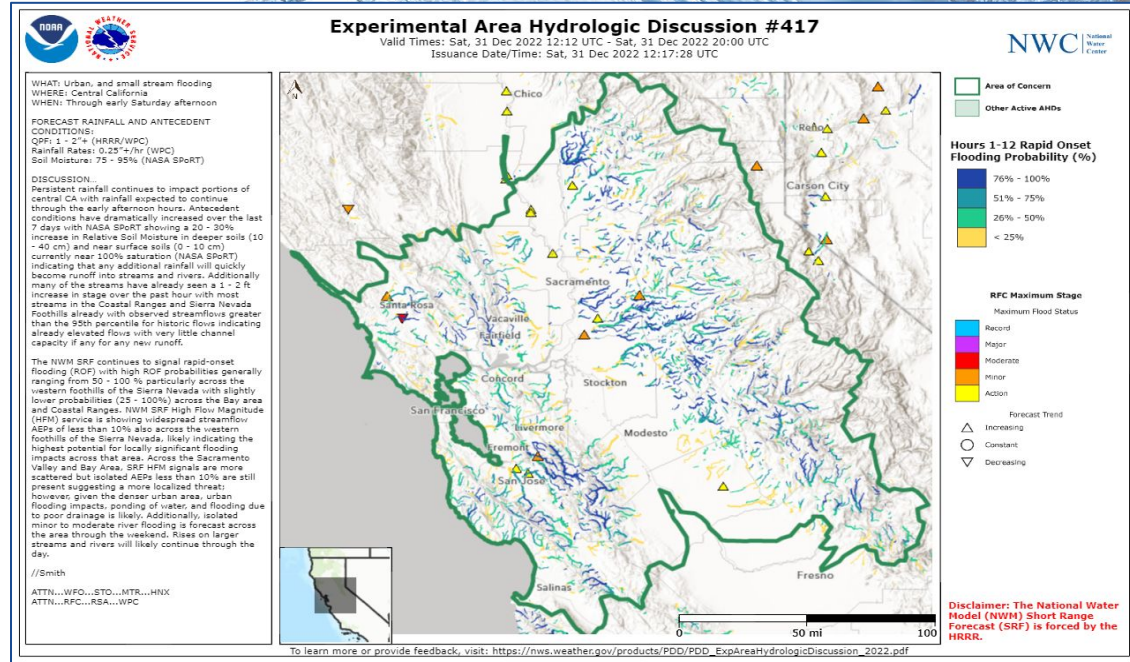
Area Hydrologic Discussion



<https://www.weather.gov/owp/operations>

Area Hydrologic Discussion (AHD)

- Episodic
- 2-6 hrs
- Rapid-onset Flooding
- Flash
- Urban / Small Stream
- WPC Coordination
- Inform WFO Warning Workflow
- PIL: AHDNWC
- Archive



<https://www.weather.gov/owp/operations-ahd>

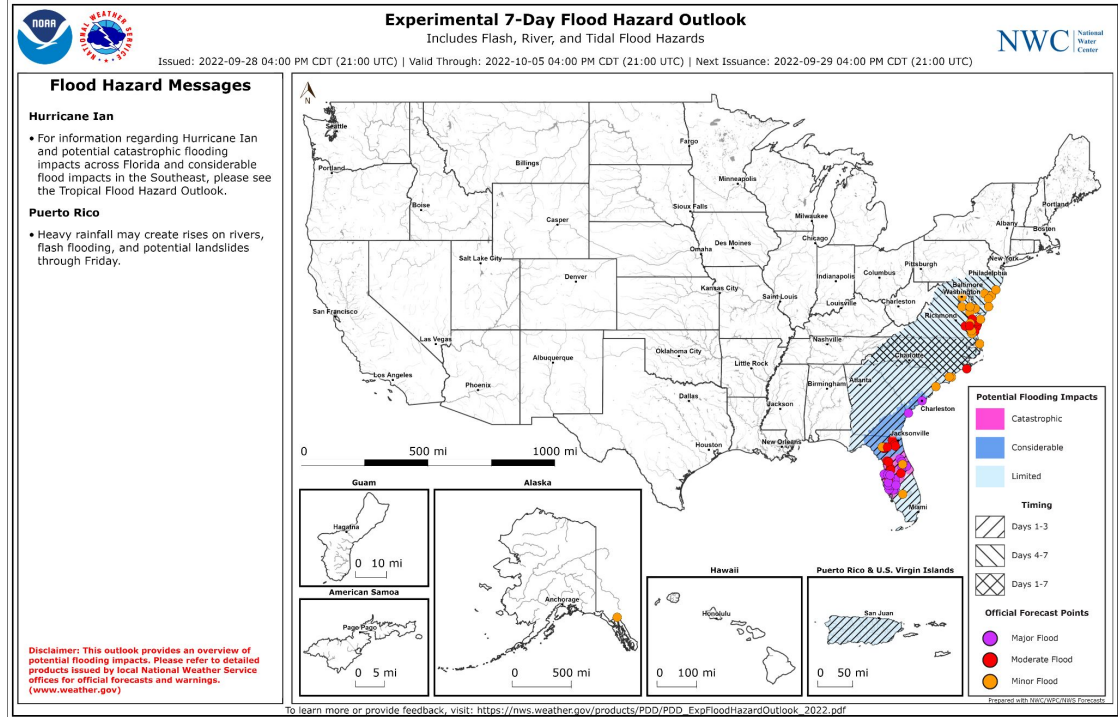
Instructions for adding AHD AWIPS Ingest and Local Alert

https://www.wpc.ncep.noaa.gov/hmt/hmt_webpages/seminars/2023/June12023_HowtoReceiveAlertsforAreaHydrologicalDiscussionsforyourSite_NWC.pdf



Flood Hazard Outlook (FHO)

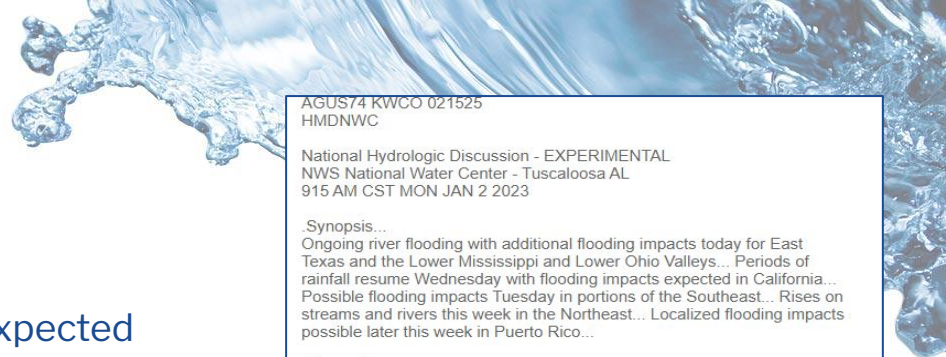
- High Level
- Heads-up
- 7-Day Outlook
- Comprehensive
- 3 Categories
- 3 Timing Bins
- 1xday* @2100Z
- Static Map
- Map Service



<https://www.weather.gov/owp/operations-fho>

Future Consideration: Incorporate Significant River Flood Outlook ([SRFO](#)) from RFCs into an enhanced FHO.

National Hydrologic Discussion (NHD)



- **What:** Discussion for observed, modeled, and expected hydrologic conditions for the United States days 1-10
 - NOT just a National Water Model (NWM) diagnostic discussion
 - Uses all available resources and forecaster knowledge
- **Audience:** Internal & external surface water information users
- **Issuance:**
 - 1530Z
 - PIL: **HMDNWC**
 - <https://www.weather.gov/owp/operations-nhd>

AGUS74 KWCO 021525
HMDNWC

National Hydrologic Discussion - EXPERIMENTAL
NWS National Water Center - Tuscaloosa AL
915 AM CST MON JAN 2 2023

.Synopsis...

Ongoing river flooding with additional flooding impacts today for East Texas and the Lower Mississippi and Lower Ohio Valleys... Periods of rainfall resume Wednesday with flooding impacts expected in California... Possible flooding impacts Tuesday in portions of the Southeast... Rises on streams and rivers this week in the Northeast... Localized flooding impacts possible later this week in Puerto Rico...

.Discussion...

.East Texas and the Lower Mississippi and Lower Ohio Valleys... Moderate to locally heavy rainfall is expected to affect these regions today, bringing a threat for isolated flash, urban, small stream, and riverine flooding impacts. The latest WPC QPF indicates widespread 1 - 3" of rainfall from extreme East TX through northern LA and AR and into southeast MO, southern IL, and western TN/KY, with the highest amounts expected in eastern AR and western TN. Antecedent conditions are wettest in east TX, northern LA, and eastern AR, where riverine flooding is ongoing and forecast from recent rainfall, and soils are primed for flooding impacts from additional rainfall. Top and mid-layer soils are in the 40 - 50% relative soil moisture (RSM) range in southeast MO into the Lower OH Valley, but are dry below those layers (NASA SPoRT). The NWM Short Range Forecast (SRF) indicates rapid-onset flooding (ROF) probabilities of less than 50% from southwest AR into northeast AR; expect these signals to gradually increase in coverage as the day progresses. The NWM MRF also continues to indicate ROF probabilities of generally less than 50% in northern LA, AR, western TN/KY, and southeast MO and southern IL. Overall, with the highest rainfall amounts not overlapping with the most vulnerable areas in the region based on antecedent conditions, widespread flooding impacts are not anticipated; however, isolated lower AEPs on smaller streams in northeast AR and southern IL, depicted in the NWM SRF High Flow Magnitude Forecast, suggest some potential for locally significant flooding impacts in these areas. In addition, new and renewed minor riverine flooding is forecast in East TX, LA, and eastern AR, along with forecasts of in-bank rises in these same areas.

.California...

Periods of moderate to heavy rainfall and mountain snow will again impact much of the state through day 7 (Sun), providing a threat for additional urban, small stream, and riverine flooding impacts. Light to moderate rainfall through day 2 (Tue) is not expected to produce flooding impacts, and it will not likely allow the entire wet soil column to make room ahead of multiple rounds of heavier rainfall beginning on day 3 (Wed), when the threat for more significant flooding impacts increases. SNODAS and the National Water Model (NWM) continue to indicate that there is very little, if any, snow water equivalent (SWE) left to melt in the lower elevations of northern and central CA; as a result, snowmelt should not be a significant

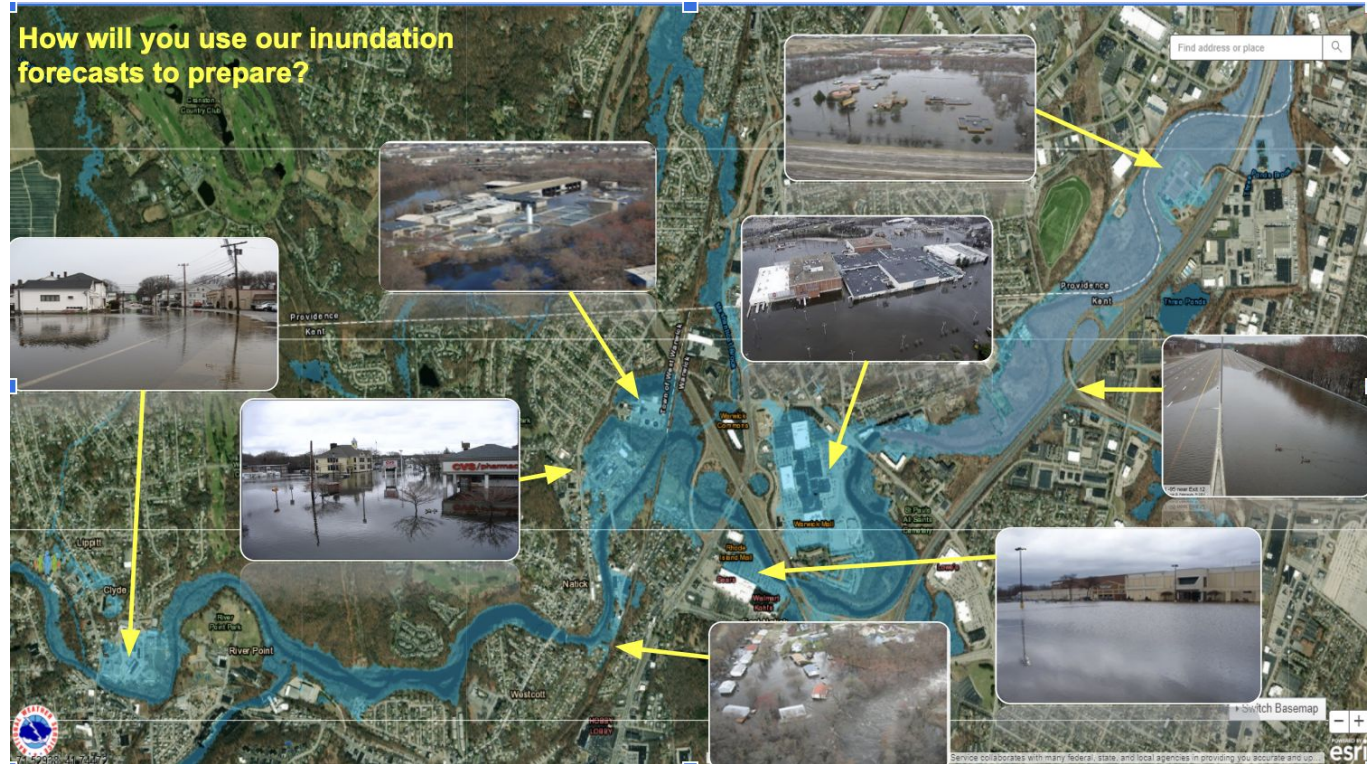




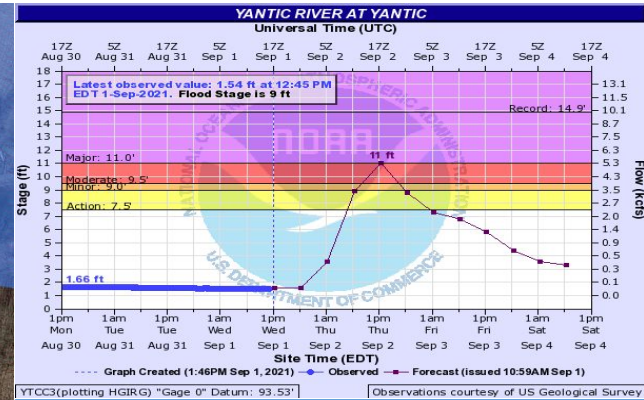
NWC Flood Inundation Mapping

Flood Inundation Mapping - Service Delivery

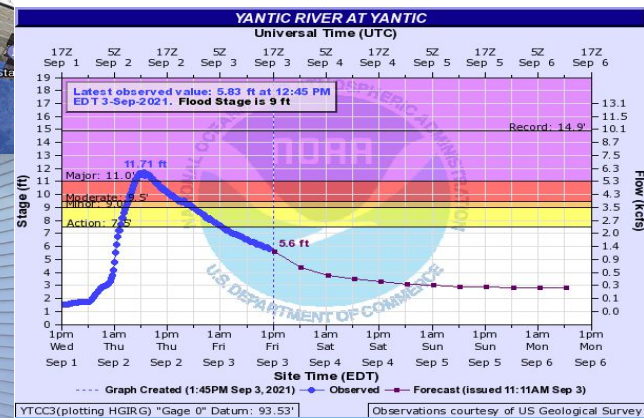
- IDSS and FIM services
- New generation of high-resolution geospatial information
- Must ALWAYS represent uncertainty



Visualizing FIM: Remnants of Ida in Connecticut



Official NERFC forecast issued on September 1st, 2021



Observed crest above Major on September 2nd, 2021


Image above is the RFC FIM based on the late morning forecast from NERFC for the Yantic River at Yantic on September 1st, 2021.

Image to the right depicts the Yantic river the morning of September 2nd, 2021 with inundation in and around Domino's Pizza in Norwich, CT. This photo was taken several hours after the river had crested.



Photo credit: Trevor Ballantyne
Norwich Bulletin

Flood Inundation Mapping

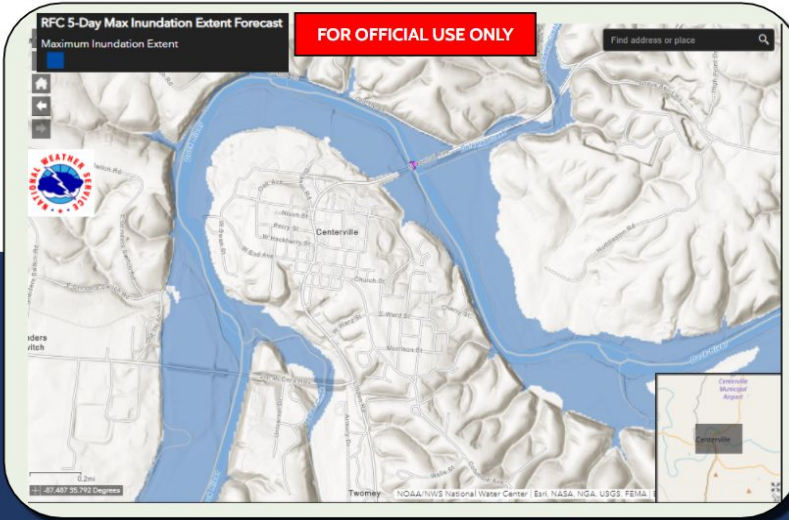


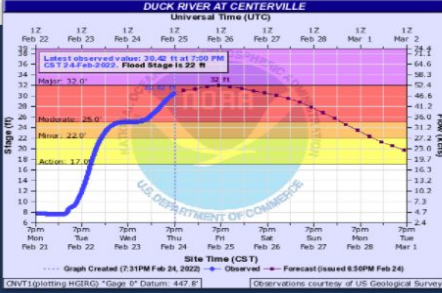
NWS Flood Inundation Mapping Services


Disclaimer: This map shows the flood extent based on a river crest near 43 feet. This is an approximate-based FIM which should be used conservatively. Depicts maximum inundation extent derived from the official RFC forecast routed through the National Water Model (v2.1) stream network downstream of AHPS gauge (Replace and Route). Please note there are some limitations for backwater flooding effects away from major river systems.

**Duck River
Centerville, TN (colt1)**


Forecast Crest Height: 40.5 Feet
 Map Height Shown: ~43 Feet
 FIM Source: NWC RFC FIM
 FIM Type: Dynamic (Depth NOT Included)
 FIM Creation Time: 2/24/22 @ 6:00pm CST







Link: N/A, additional screen captures are available upon request

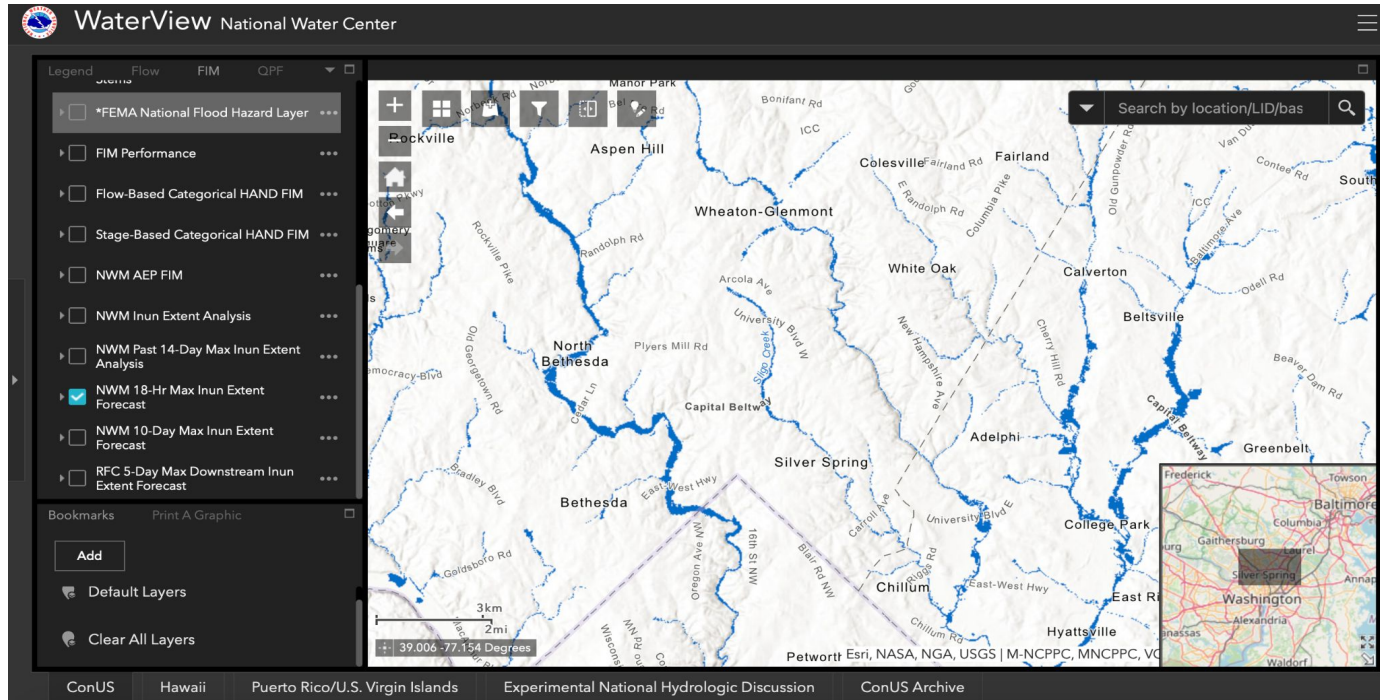


2/24/22 @ 6:00pm

- Prototype DSS information at existing forecast point

Flood Inundation Mapping

- Near-real-time FIM is available now for CONUS
- Viewable through WaterView application for NOAA users

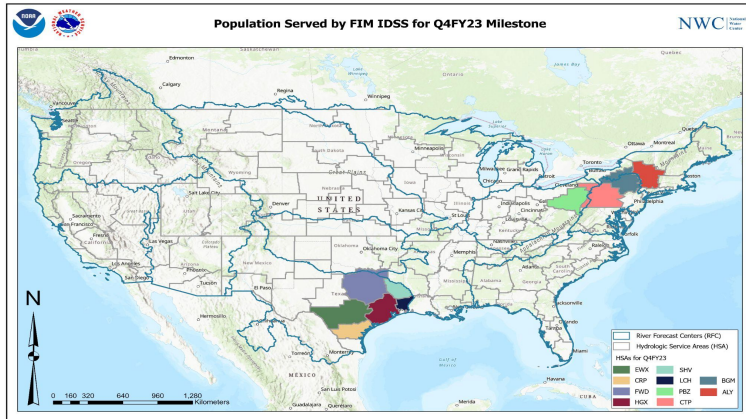


FIM - Public Deployment

Delivering in Phases Over 4-Years

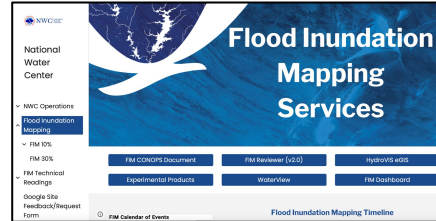
- FY23 10%
- FY24 30%
- FY25 60%
- FY26 100%

Public Services Fall 2023: population served 10.8%

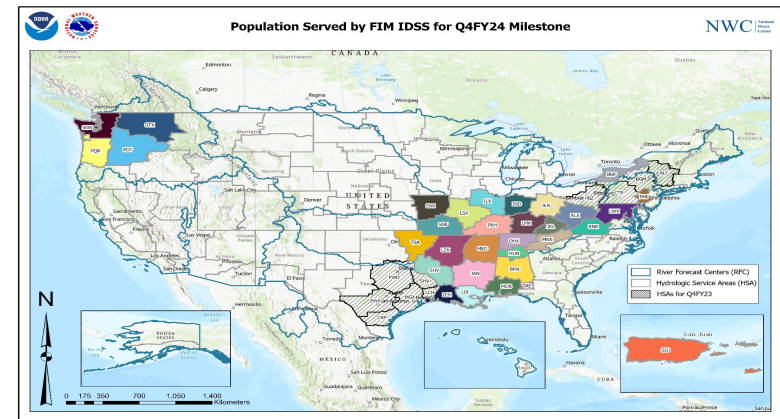


FIM Google Site:

<https://sites.google.com/noaa.gov/nws-nwc/flood-inundation-mapping?pli=1>



Public Services Fall 2024: population served 36.9%



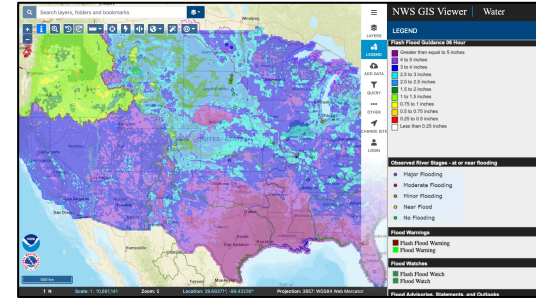


Hazard Services and IDSS - Flood

Hazard Services and IDSS

Future approach to service delivery?

- Hazard Services
 - Polygons (Ken10 Team)
 - Provide NWC map services in AWIPS
- Hazard Simplification
 - Removal of Advisory
- Integration of Information
 - ERO - future of FFG?
 - FLASH - linkage with NWM information
 - MPD -
 - Linkage btw inland and coastal flooding
- IDSS
 - Emergency managers
 - Federal partners



FFG: August 7, 2023 04Z

Practices / Policy Evolution

- NWC Field Service and Evaluation Board (FSEB)
- Social Science
- NWS Directives updates

Thank you!

Mark.Glaudemans@noaa.gov

Can reach NWC Operations (WPOD) at:

(205) 347 - 1500

nws.nwc.ops@noaa.gov

Nwcchat

5 AM - 8:30 PM CT, 7 days/week



FFaIR 2023 Seminar Series Archive:

https://www.wpc.ncep.noaa.gov/hmt/hmt_webpages/seminars/2023/