NOAA Climate Science and Services: Working to Meet the Needs of the Water Sector

National Centers for Environmental Information (NCEI)

October 19, 2023

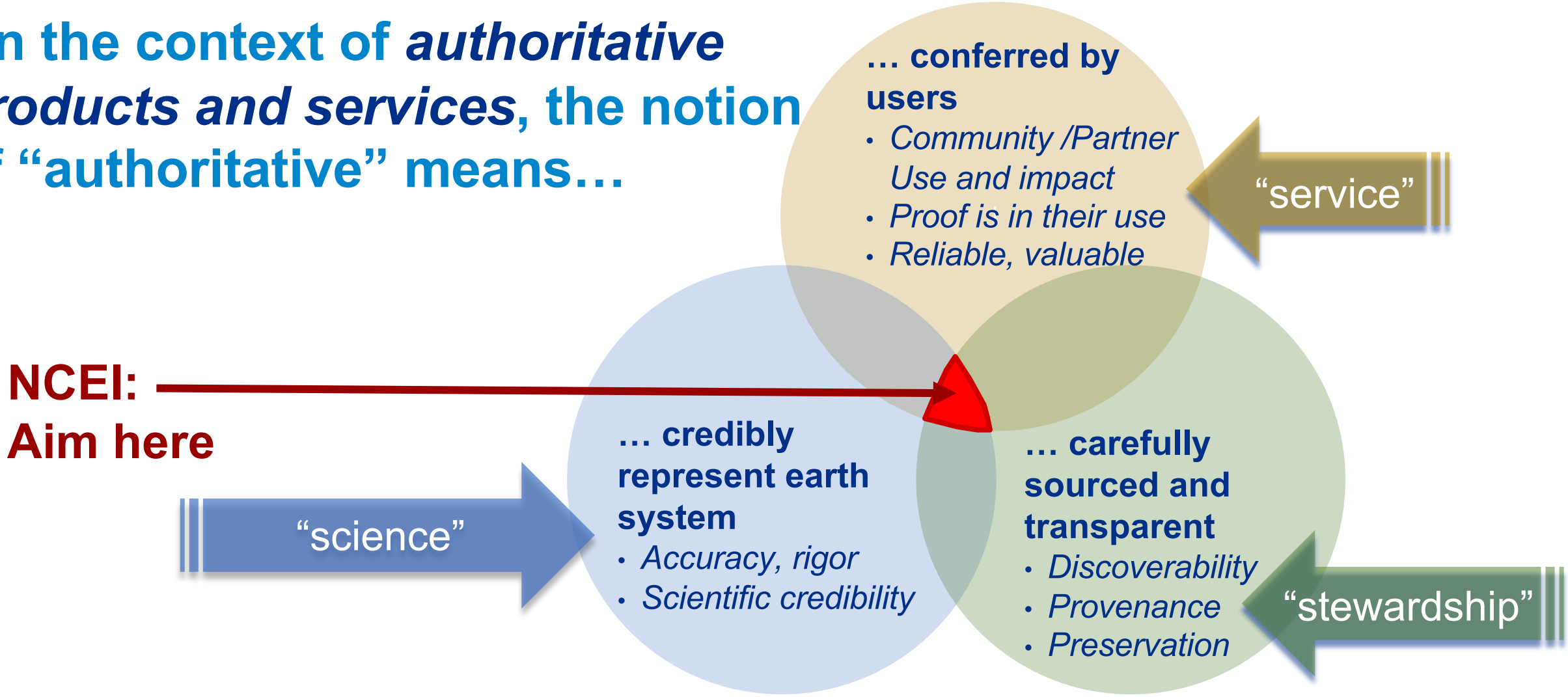
Ellen Mecray, NOAA Regional Climate Services Director-Eastern Region

NOAA's Authoritative Products and Services

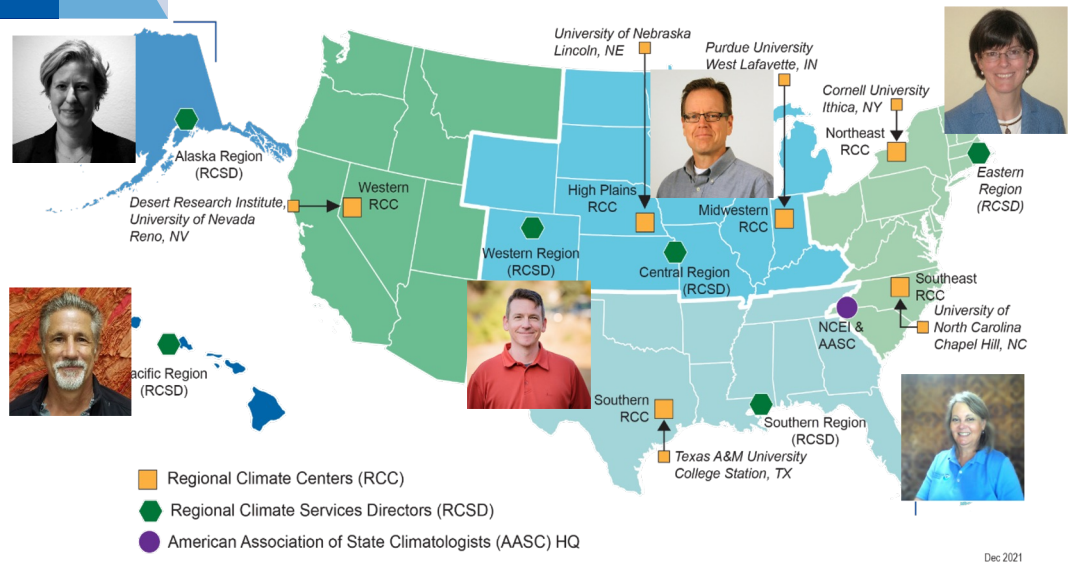
NOAA's Mission: To understand and predict changes in climate, weather, oceans, and coasts; to share that knowledge and information with others; and to conserve and manage coastal and marine ecosystems and resources.

Authoritative Information and Services

"In the context of *authoritative products and services*, the notion of "authoritative" means…



NCEI National Climate Services Partnership

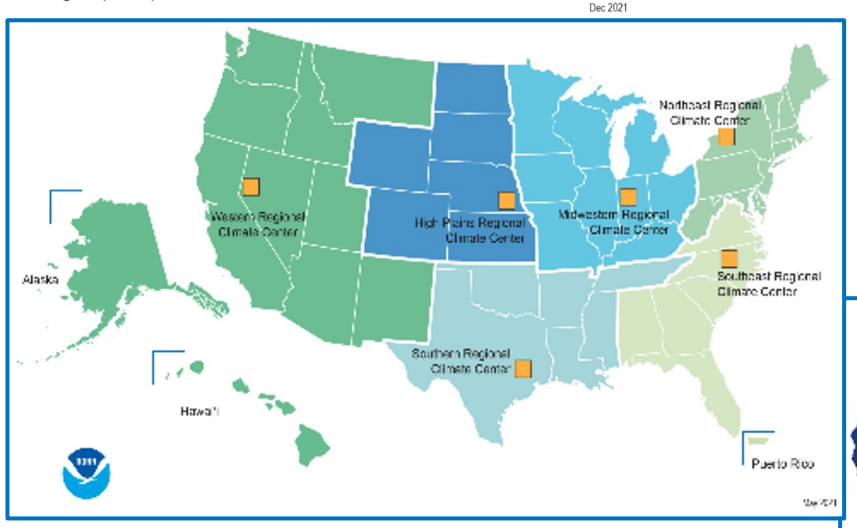


National Scope

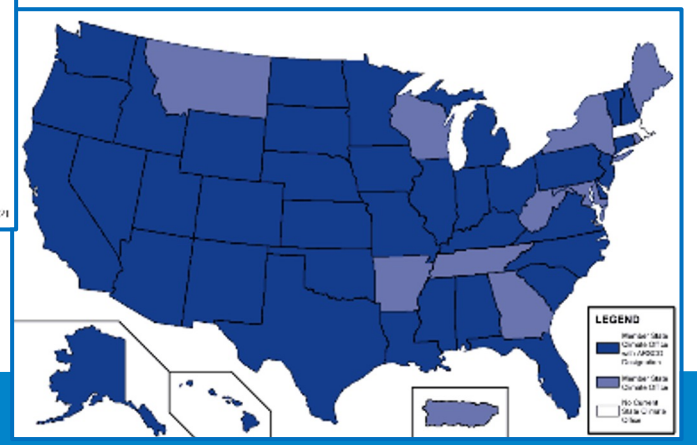
- 6 Regional Climate Service Directors
- *Voice of NOAA Climate* in each region
- NOAA and cross-Agency engagement and coordination

Implemented Regionally

- 6 Regional Climate Centers (RCC)
- Regional themes
- Regional partners in NOAA and with other Federal and tribal partners
- Inter-state coordination



https://www.ncei.noaa.gov/regional

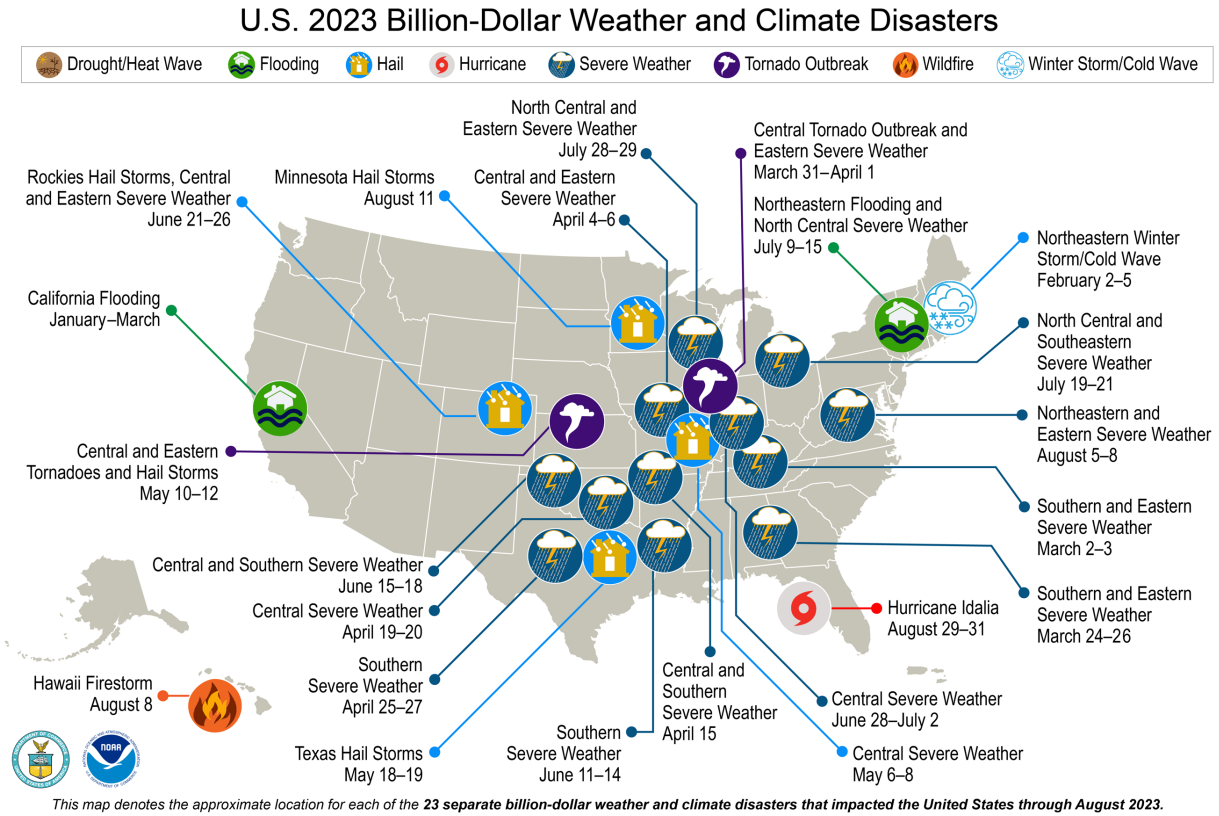


and at the

State level

- State climatologists

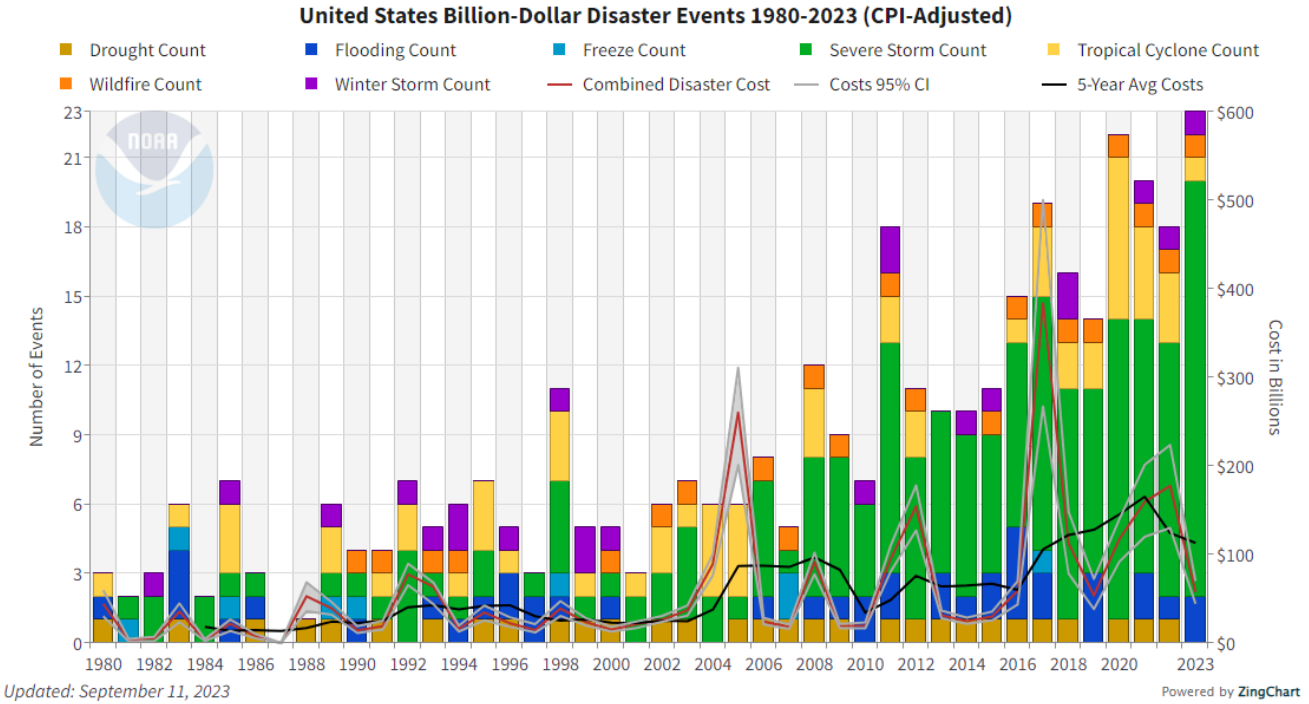
Disaster Trends and Why Our Work Matters



*This map denotes the approximate location for each of the **23 separate billion-dollar weather and climate disasters that impacted the United States through August 2023.***

- Western wildfires, severe storms, inland flooding and hurricane costs all on the rise
- **5-year annual cost average = $124.1 billion;** disaster costs over the last **6.5 years** (2017-2023) = **$1.061 trillion**

U.S. Billion-dollar event frequency (1980–2023), annual cost, 5-year cost avg



NOAA's Goal: Deliver Information Useful to Society

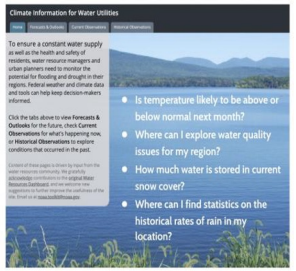
- Improve delivery of actionable scientific information and meet data needs for building resilience to a changing climate by:
  - Understanding information needs of water utilities and local governments,
  - Collaborating with the water sector organizations that serve them

2010: Water Sector Forum

2011-2012: Extreme Events Study

2013-2016: Water Resources Dashboard

The original Water Resources Dashboard displays sample graphics and brief dataset descriptions. Links take you directly to each data site.



Plain-language questions in the Water Data Web App direct you to relevant data tools. You'll see information about how to use each tool, displayed directly next to the embedded data site in most cases.

2020: Filling the Gaps Study

2021: Our Changing Precipitation Webinar Series

2021/22: Showcasing Leading Practices Webinar Series

DETAILS

2022 Sea Level Rise Technical Report

- Federal Interagency Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Task Force
- Most up-to-date sea level rise projections available
- Key input for 5th National Climate Assessment
- Data informs sea level rise adaptation plans at all scales

https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html

Sea Level Calculator

Goal: Provide actionable information on how sea level and flood frequency are changing over time.

- Motivated by user needs assessments, and users will be engaged throughout development
- Version one, scheduled for completion in late fiscal year 2024, will be housed within the Digital Coast and will use existing data from NOAA and NASA.
- Future versions will include additional data and functionality, and ideally will be part of sealevel.gov

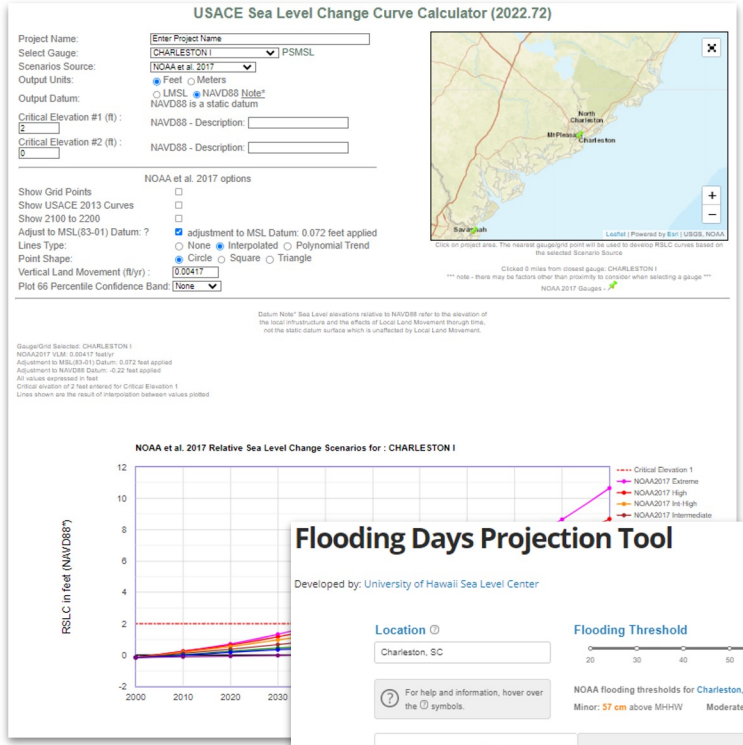
User Needs

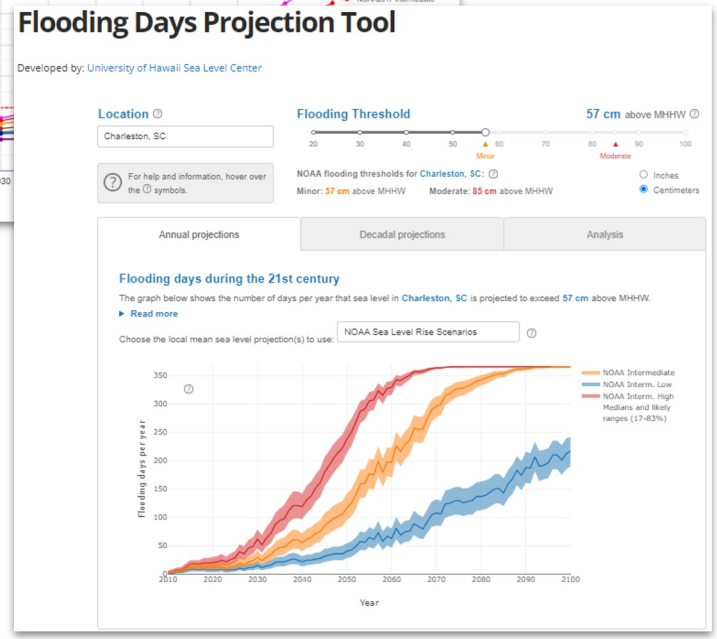
- Data: including the need for greater data granularity, closing data gaps, including historical data, and implementing customization.
- Technical assistance: focusing on who and how to translate to a variety of audiences and ensuring this is done through interagency efforts.
- Accessibility and Usability: centering the needs of communities with limited access by ensuring data and tools are easy to use and readily available.

Sea Level Calculator

- Projections for sea level and flooding, as well as information about current and past conditions.
- Data, maps, visualizations, explainers, and location-specific reports.
- Authoritative and operational sources of data
- Bring together functionality currently scattered across multiple tools

https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html



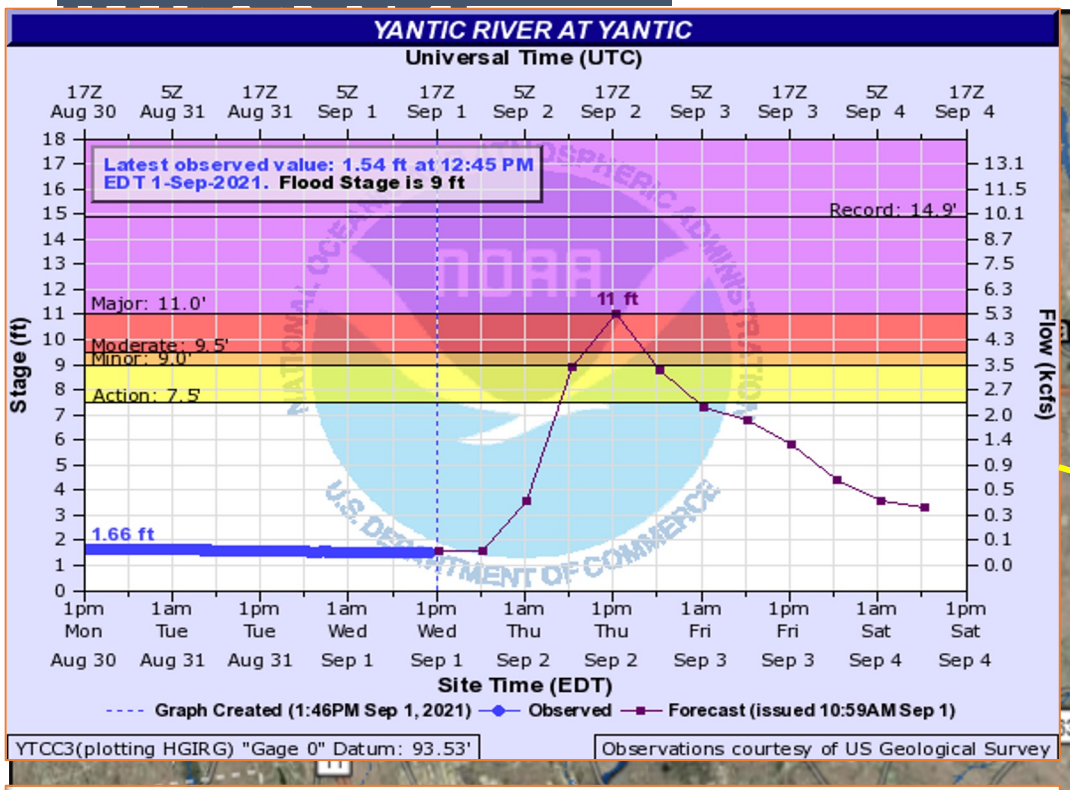


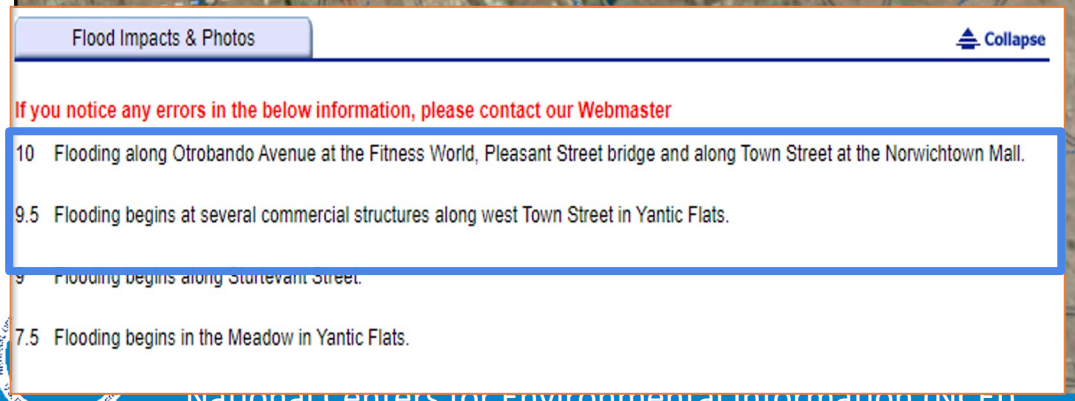
https://sealevel.nasa.gov/flooding-days-projection

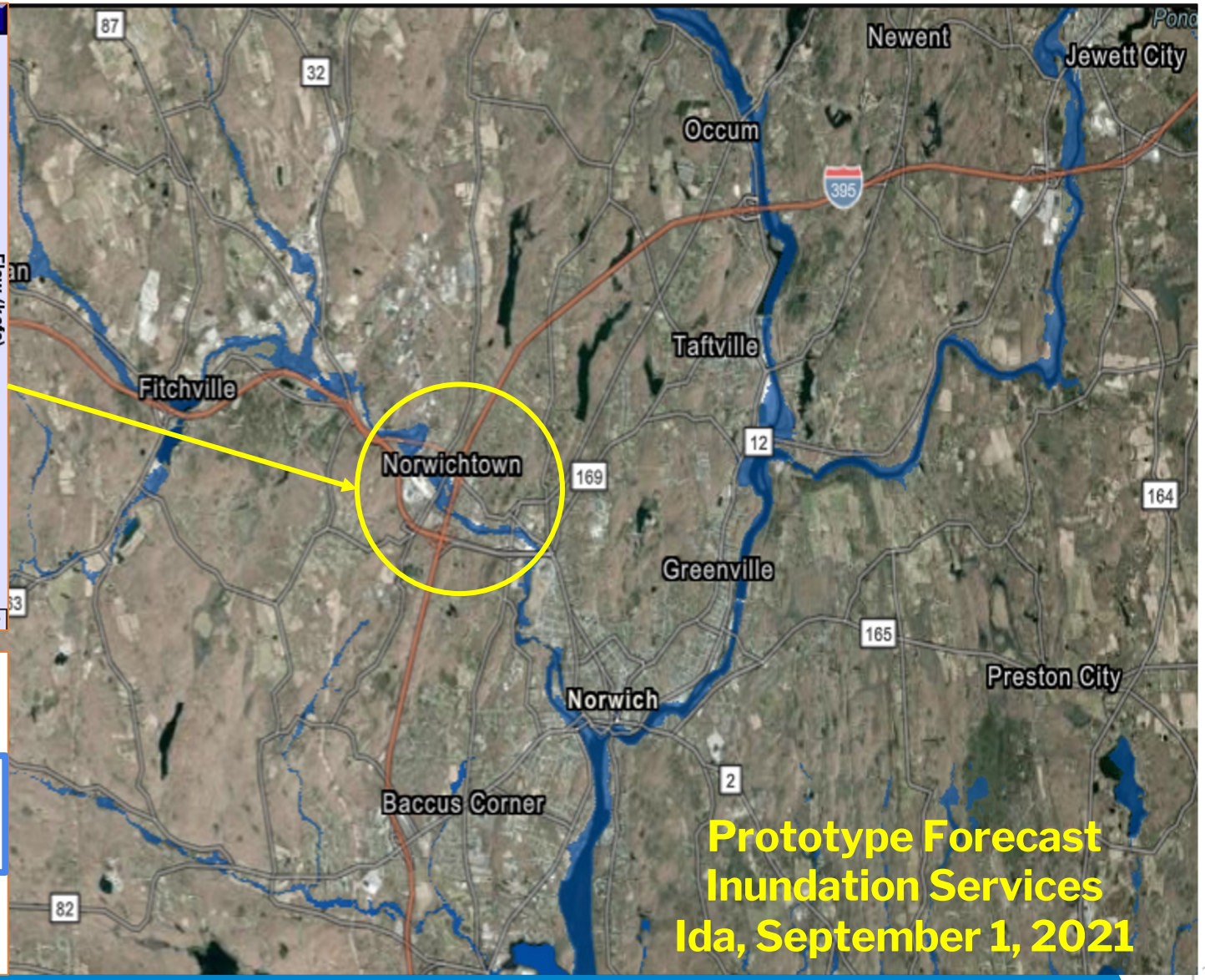
NOAA Context: BIL Flood and Inundation Mapping and Forecasting Tasks

- Real-time Coastal and Inland Forecast Flood Inundation Mapping (CIFIM)
- Improve Overall Forecasting Skill and Services through the Next-Generation of NOAA's National Water Model (NG)
- Update and Revise Precipitation Frequency Atlases for the U.S. including Probable Maximum Precipitation (PF/PMP)
- **Build out Subseasonal to Annual Integrated Water Capabilities (SA)**
- **Apply NOAA's Service Delivery Framework (SD)**

Value of FIM Services - Visualizations to depict impacts!







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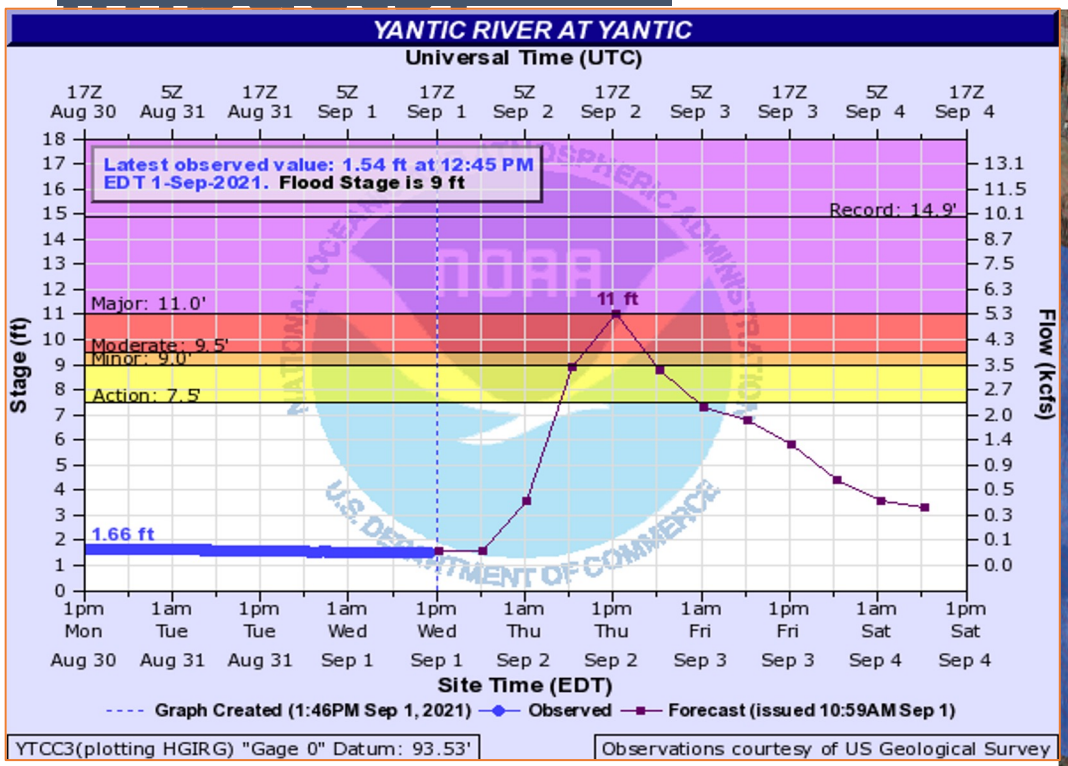
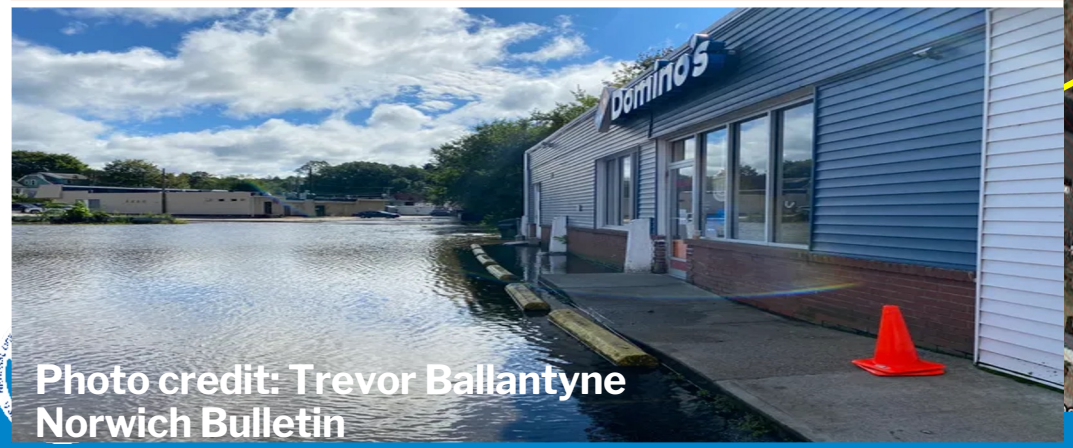
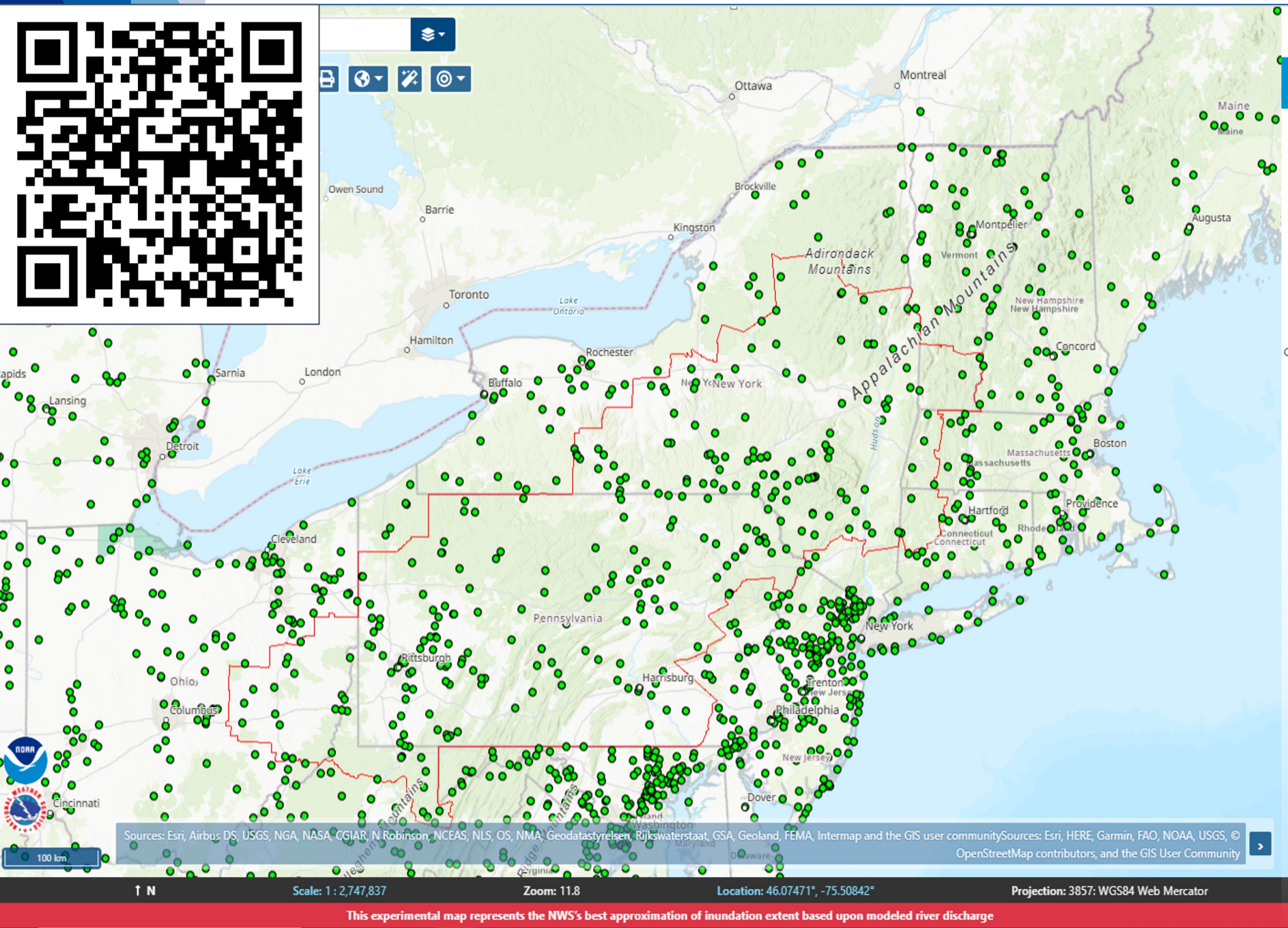




National Water Model & Flood Inundation Services



NWS GIS Viewer | Water

LAYERS

LEGEND

ADD DATA

QUERY

OTHER

CHANGE SITE

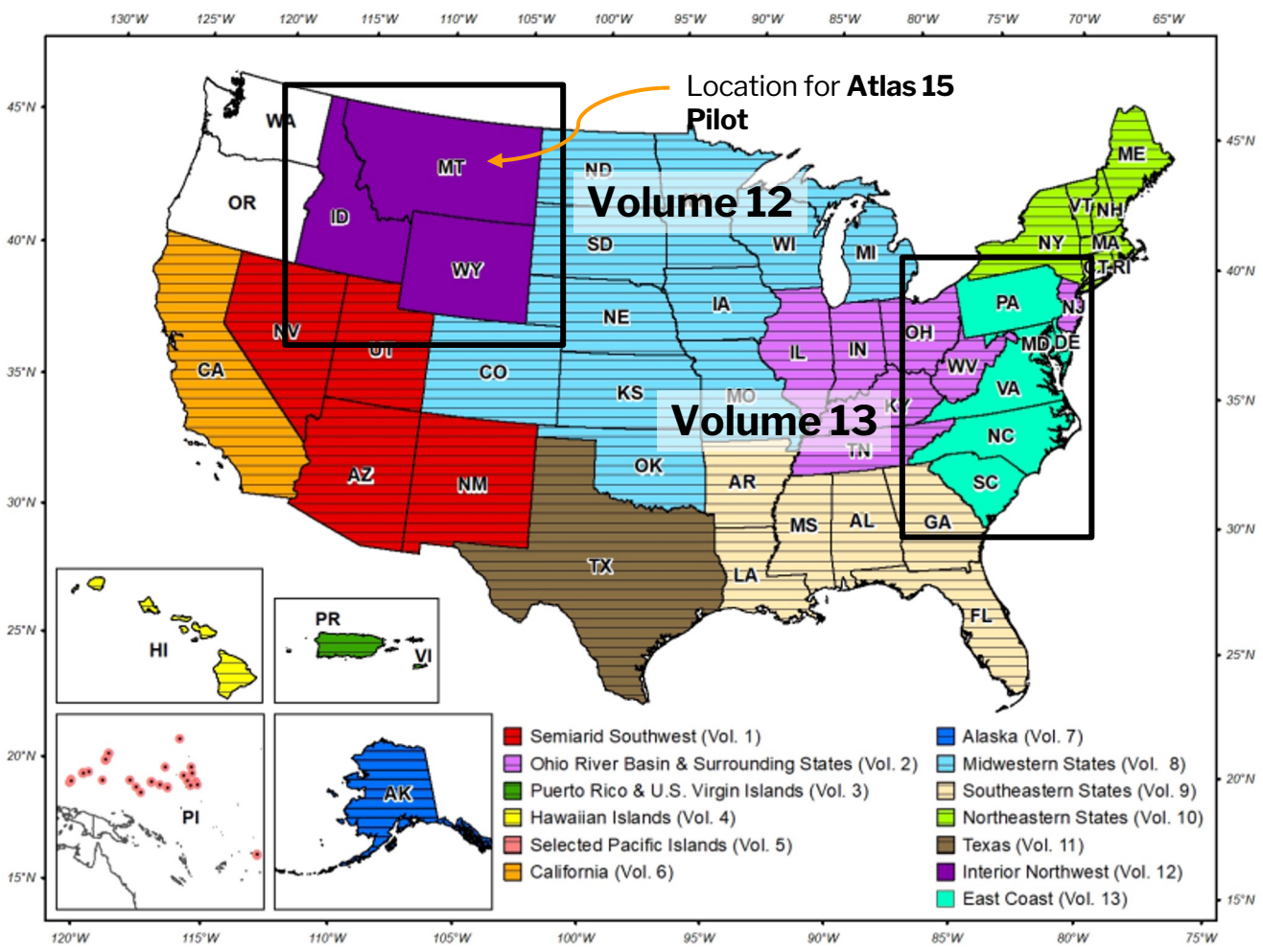
LOGIN

Clear Layers | Collapse Folders

- Watches, Warnings, Hazards, and Advisories
- Quantitative Precipitation Estimates
  - River Forecast Centers (RFC) Quantitative Precipitation Estimates (QPE)
- Radar Products
- Flood Inundation Maps (FIM) (EXPERIMENTAL)
  - [ ] NWM Latest Analysis (Zoom level 18+)
  - [ ] RFC 5-Day Max Forecast (Zoom level 18+)
  - [ ] NWM 5-Day Max Forecast (GFS) (Zoom level 18+)
  - [x] FIM Coverage Domain
    - Opacity :100%
  - [ ] FIM Coastal Exclusion Zone
- Flood Products
- River Observations and Forecasts
  - Advanced Hydrologic Prediction Service (AHPS) River Gauges
  - Land Analysis
  - National Water Model (NWM) Output
    - [ ] CONUS Precipitation (inches)
    - [ ] Hawaii Precipitation (inches)
    - [ ] Puerto Rico Precipitation (inches)
    - Streamflow Anomaly Analysis
    - High Flow Magnitude Analysis
    - Medium-Range High Water Arrival Time Forecast
    - Medium-Range High Water Probability Forecast
    - Medium-Range Max High Flow Magnitude Forecast
    - Medium-Range Rapid Onset Flooding Forecast
    - Medium-Range Rapid Onset Flooding Probability
    - Medium-Range Peak Flow Arrival Time Forecast
    - Flowlines
    - Short-Range High Water Arrival Time Forecast
    - Short-Range High Water Probability Forecast
    - Short-Range Max High Flow Magnitude Forecast
    - Short-Range Rapid Onset Flooding
    - Short-Range Rapid Onset Flooding Probability
  - River Forecast Center (RFC) Output

Bookmark Views:

NOAA Atlas 14 Product Suite



Majority of built infrastructure leverages precipitation frequency data for design and planning under federal, state and local regulations

Volumes

- Volume 1 (2004): Semi arid Southwest

  ....
- Volume 11 (2018): Texas
- **Volume 12 (2024) :** Montana, Idaho, and Wyoming
- **Volume 13 (2025):** Mid-Atlantic

Performed at request of states and funded through FHWA

National Centers for Environmental Information (NCEI)

15

The NOAA Atlas 15 Product

Volume 1: Based on historical gages and observed trends

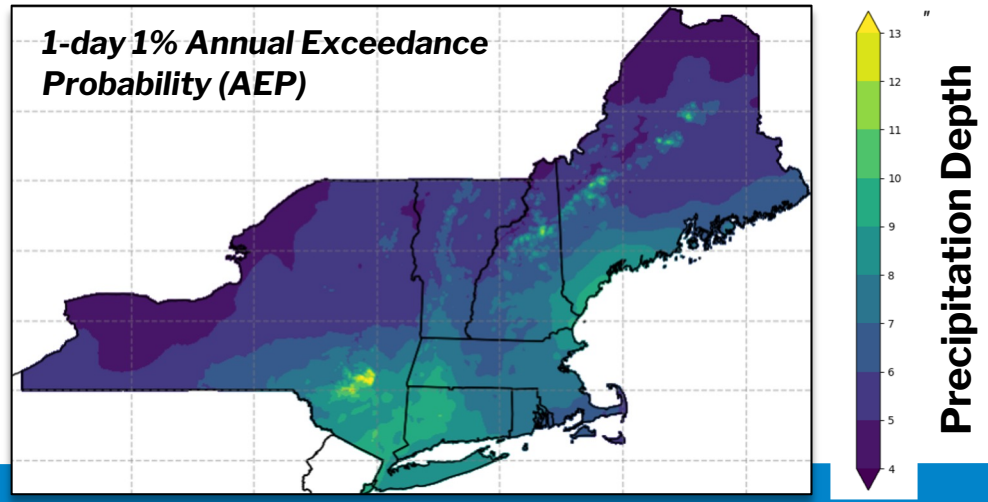
- First-ever, nationally-consistent, precip frequency data that serves as the basis for Volume 2
- Integrated terrain information
- Accounts for trends in historical observations (when it exists)
  - Non-stationary trends represents a major enhancement from Atlas 14

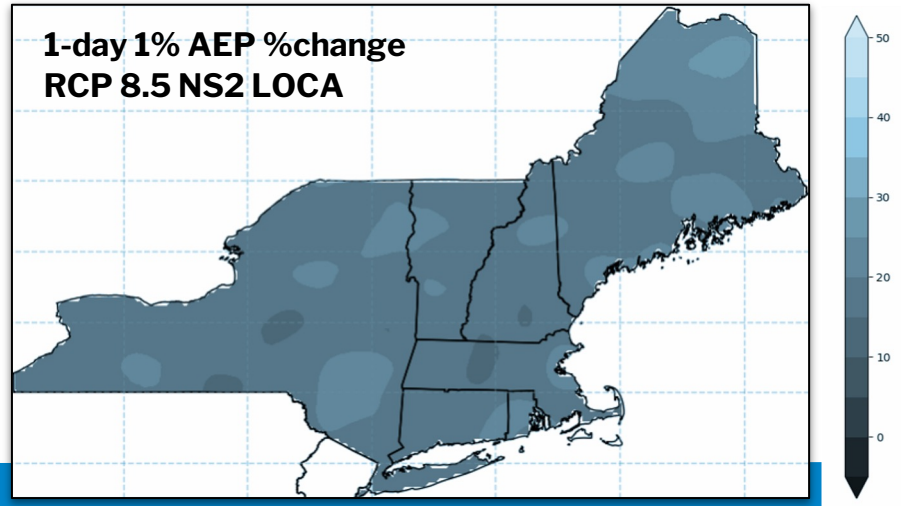
Volume 2: Incorporates climate projection adjustment factors

- Future precipitation informed by global climate models, modeled non-stationary temporal changes
- Provides adjustment factors to Volume 1 to calculate future estimates

1930 1940 1950 1960 1970 1980 1990 2000 2010 2020

2030 2040 2050 2060 2070 2080 2090 2100 2110 2120





Note: Derived from Multiple Models

Compound Flooding in Coastal-Urban Environments

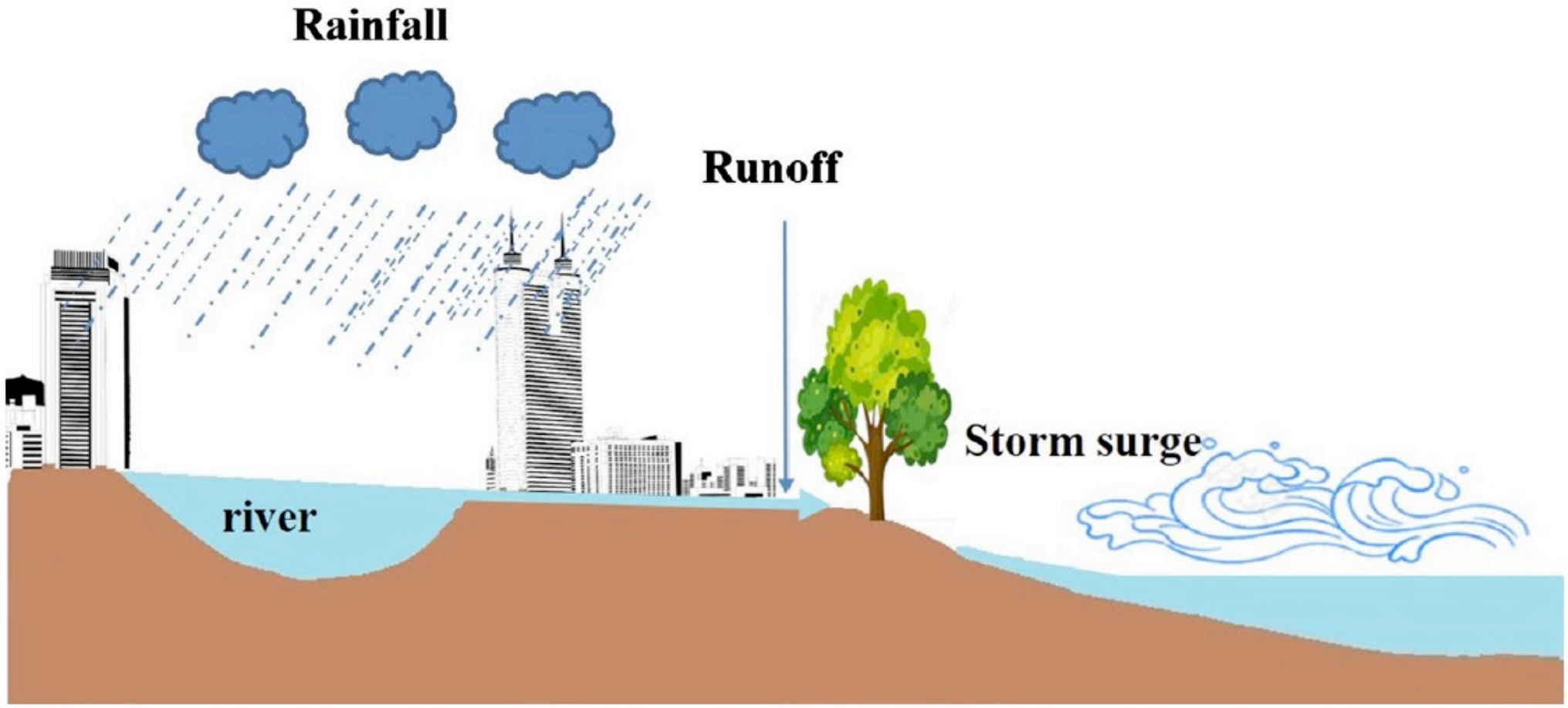


Fig. 1 Conceptual diagram of compound floods in coastal areas

(Xu et al., *Natural Hazards,* 2023)

Working together/Flooding is Local

A few things from around the region, work on compound (freshwater/saltwater) flooding:

1) From Molly Mitchell, VIMS: Joseph Zhang and Derek Loftis have done compound flood modeling for New York, Norfolk, Portsmouth, and Charleston (I think). Joseph is working with NOAA to do real-time compound flood modeling. One of our goals in the next couple of years is to expand our 36-hour Tidewatch Map to include compound flooding, based on Joseph's work.
2) From Philip Orton, Stevens Institute and CCRUN: The research is on how tropical cyclones and extratropical cyclones differ in their extreme joint rain-surge probabilities. We are focused on NYC, but I think the story is likely similar anywhere in the mid-atlantic or northeast.

The NOAA Service Delivery Framework

Continuous engagement is the central element for successful service delivery.

Communication that fosters mutual learning and facilitates joint dedication to achieving agreed upon needs and goals is critical to the success of engagement.

Personal involvement in all interactions with the users and partners is critical because they are the personification of the Agency's interest and commitment.

First hand involvement of the trusted NOAA entity in all steps builds trust and streamlines processes.

Questions?

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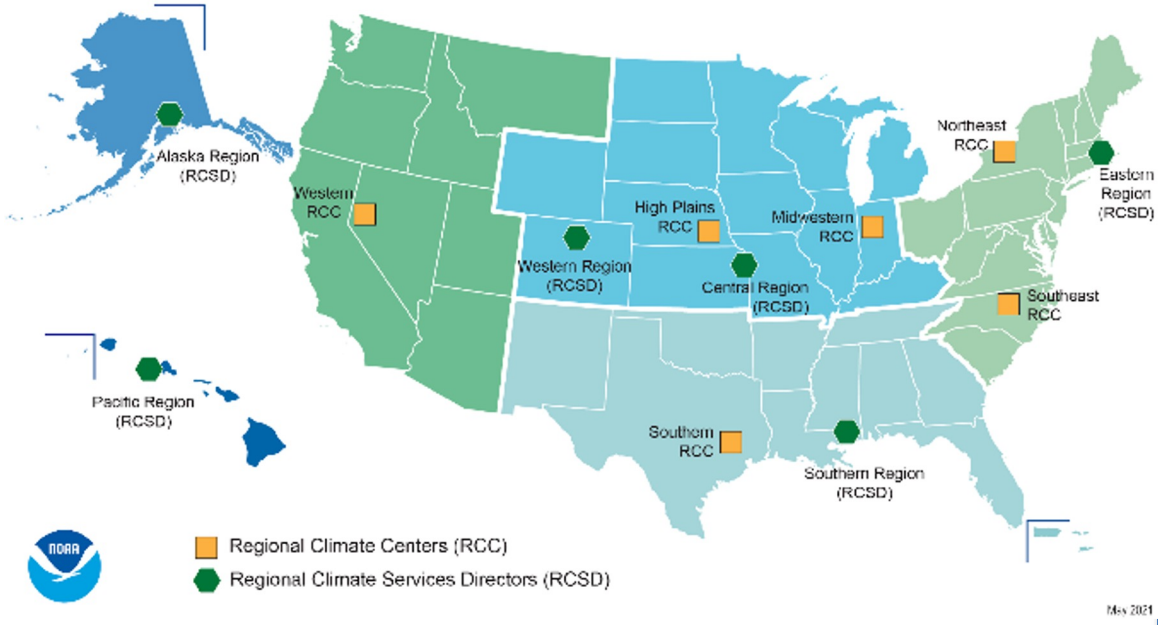
https://www.ncei.noaa.gov/regional/regional-climate-services-directors/eastern

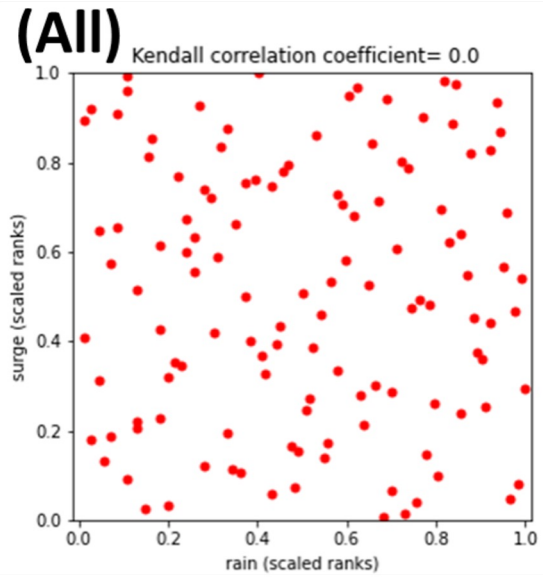
October 19, 2023
WUCA_Working Together to Better Navigate an Uncertain Future
Virtual

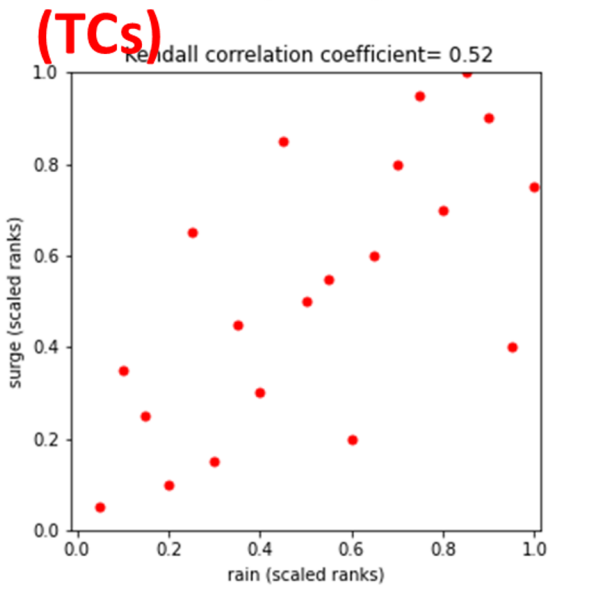


Compound rain-surge hazard: Hurricanes, while rare, are a larger threat

Normalized Rank (0 to 1) of rain and surge for top-ranked historical rain events.

- For New York City, rain and storm surge have low, but non-zero correlations ("**ALL**"). While heavy rainfall can co-occur with a large storm surge (e.g. Hurricane Irene), the combination of extreme rain and extreme surge has a very low probability
- However, the dependency of storm surge and rainfall during tropical cyclones (**TCs**) is quite different from other events, suggesting that TC events may need separate assessment
- For top-ranked TC rain and surge events, there are moderate negative correlations between rain intensity and the lag to peak surge (not shown), indicating that **the most intense TC rain and surge events (e.g. 100-year) have the most potential for compounding.**

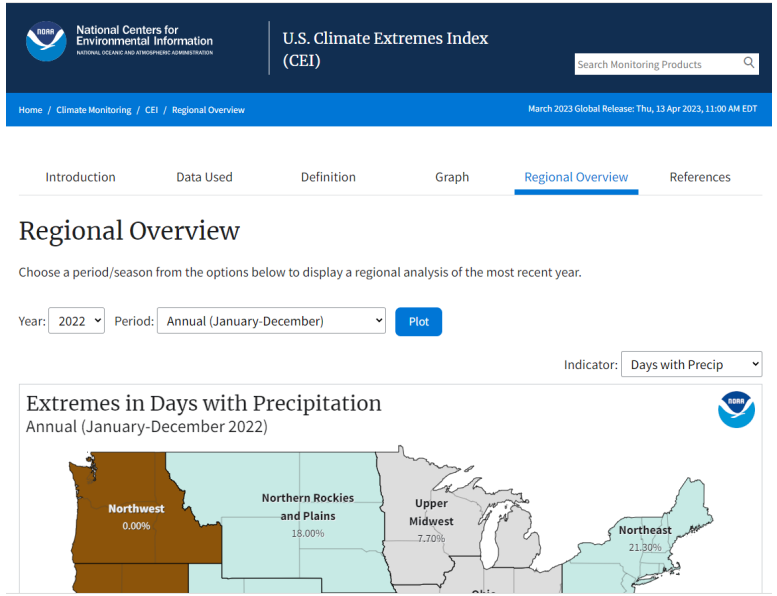




Research by post-doc Z. Chen with P. Orton and others for the New York City Panel on Climate Change

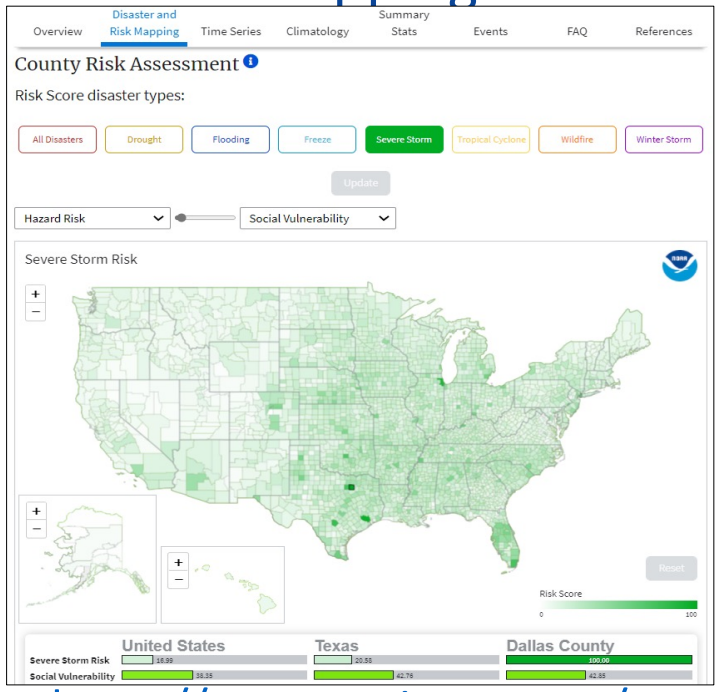
NCEI - Authoritative Climate Products & Services

US Extremes Index



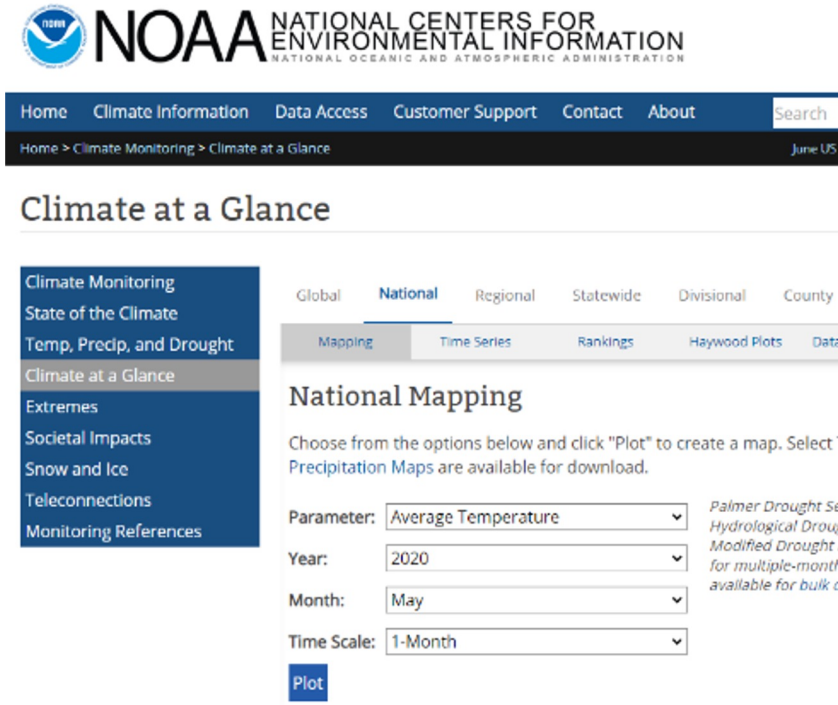
https://www.ncei.noaa.gov/access/monitoring/cei/

B$D County Hazard Mapping



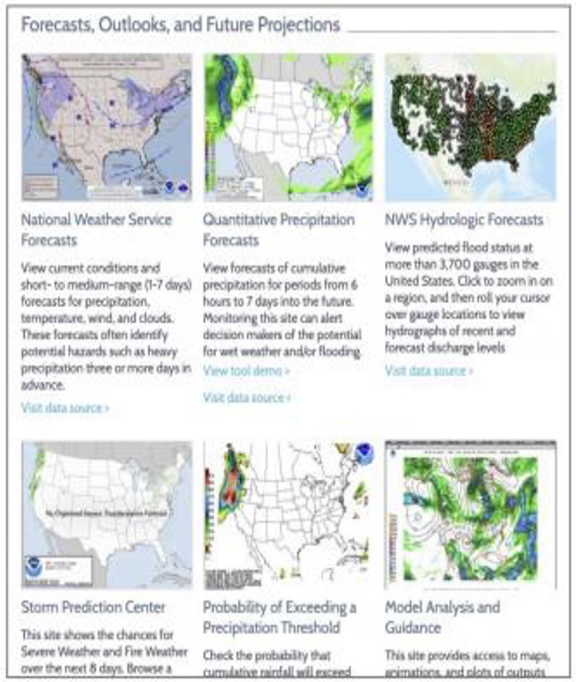
https://www.ncei.noaa.gov/access/billions/

Climate at a Glance

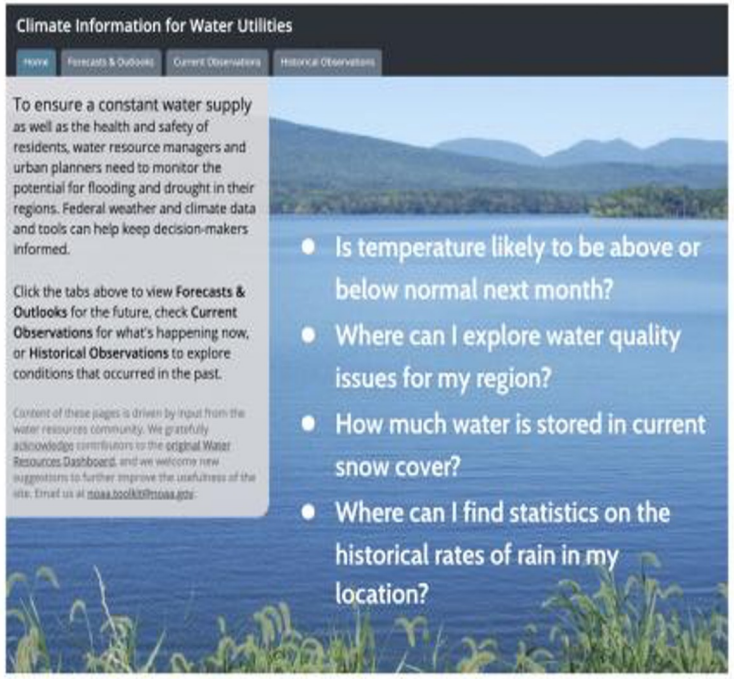


https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/

NOAA's Water Resources Dashboard (WRD) – part of US Climate Resilience Toolkit



The original Water Resources Dashboard displays sample graphics and brief dataset descriptions. Links take you directly to each data site.



Plain-language questions in the Water Data Web App direct you to relevant data tools. You'll see information about how to use each tool, displayed directly next to the embedded data site in most cases.

https://toolkit.climate.gov/topics/water/water-resources-dashboard

- 2016 launched
- Created via partnership with NGOs and NOAA
- ~50 NOAA data/info sets for water managers

Categories

- Weather Forecasts and Outlooks
- Current Observations
- Historical Observations
- Climate Change
- Socioeconomic and Equity Resources
- Other Planning Resources
- Region-specific Tools and Case Studies

“Filling the Gaps” Study Objectives

- **Understand the information needs of small and medium size water utilities**
- **Identify gaps to expand and improve climate and weather-related tools and information resources for water managers’ decision making**
- **Raise awareness of weather and climate information and approaches focused in seven study regions**
- **Build regional connections that support small-scale utility decision making**
- **Enhance the Water Resources Dashboard and develop improved communication materials**

https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study

Our Changing Precipitation Webinar Series

Participants in our recent study want to better understand the science of precipitation to better plan for the future. They:

- often use IDF curves for infrastructure design decisions
- know that NOAA provides IDF curves based on historical observations
- understand that projecting precipitation for the future is difficult; they see that scientists, researchers and engineering firms are developing new methods

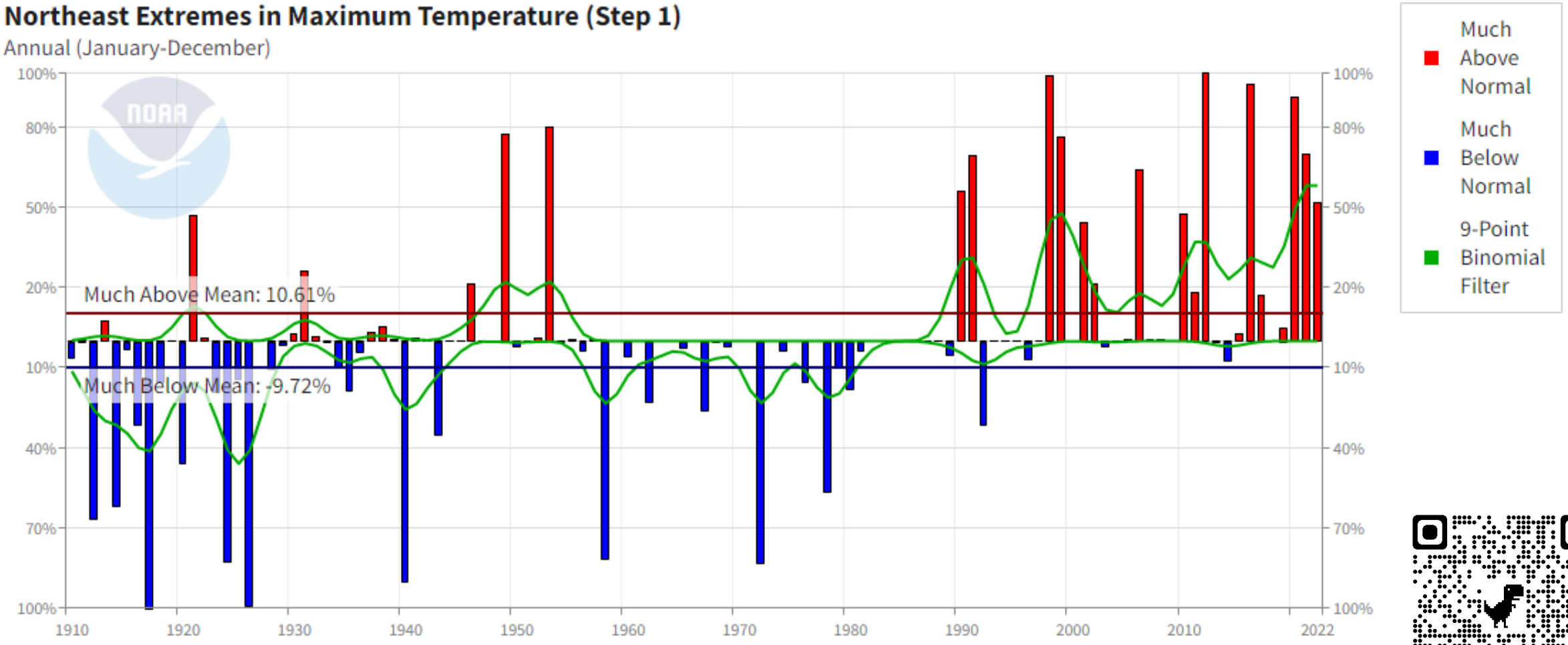
These decision makers also know that:

- they are always under pressure to deal with current impacts as well as how to design new infrastructure
- they must make decisions now that will impact their communities for up to a century
- they are constrained by their community's financial status
- every method requires assumptions about the uncertainty inherent in modeling the future

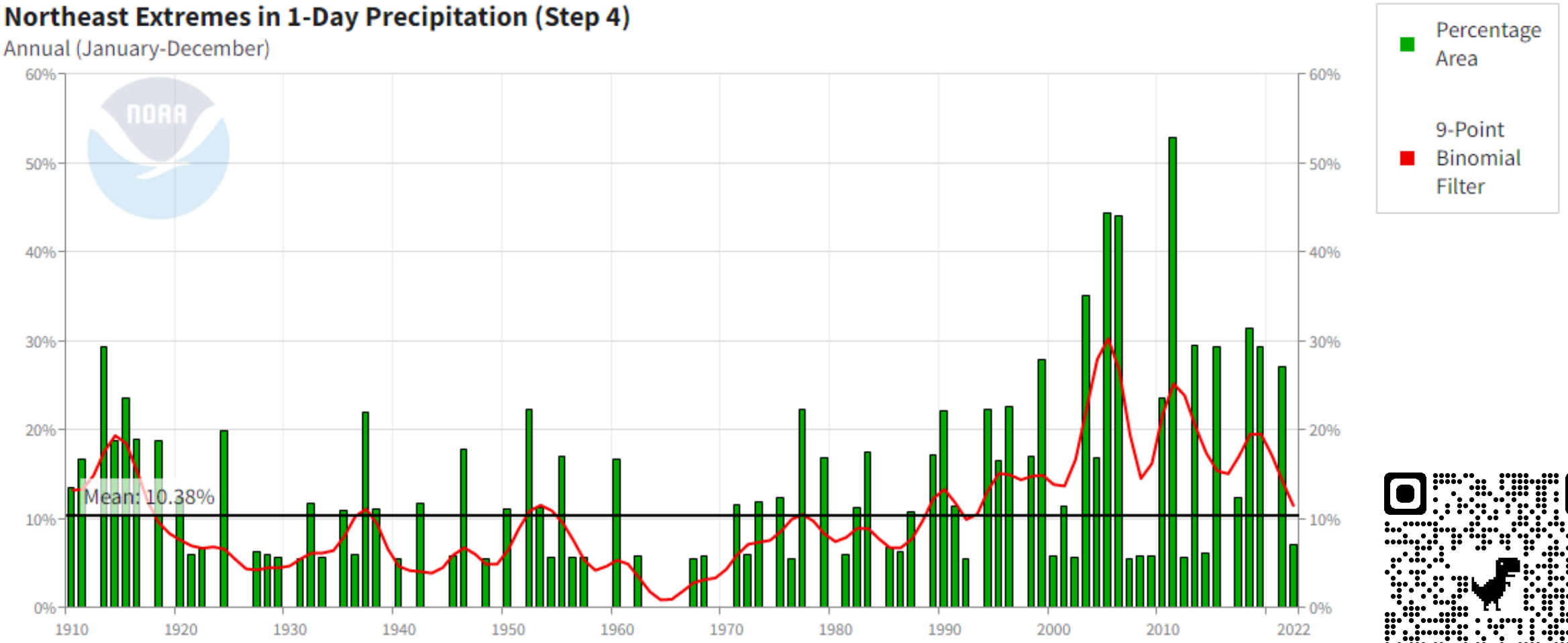
They are asking:

- How do we need to understand uncertainty inherent in precipitation prediction modeling?
- How do we select one method for making decisions over another when there is no national consensus on how to do it?
- Should communities wait until there is a national consensus?
- Is something better than nothing?

Temperature Extremes for the Northeast



Precipitation Extremes for the Northeast

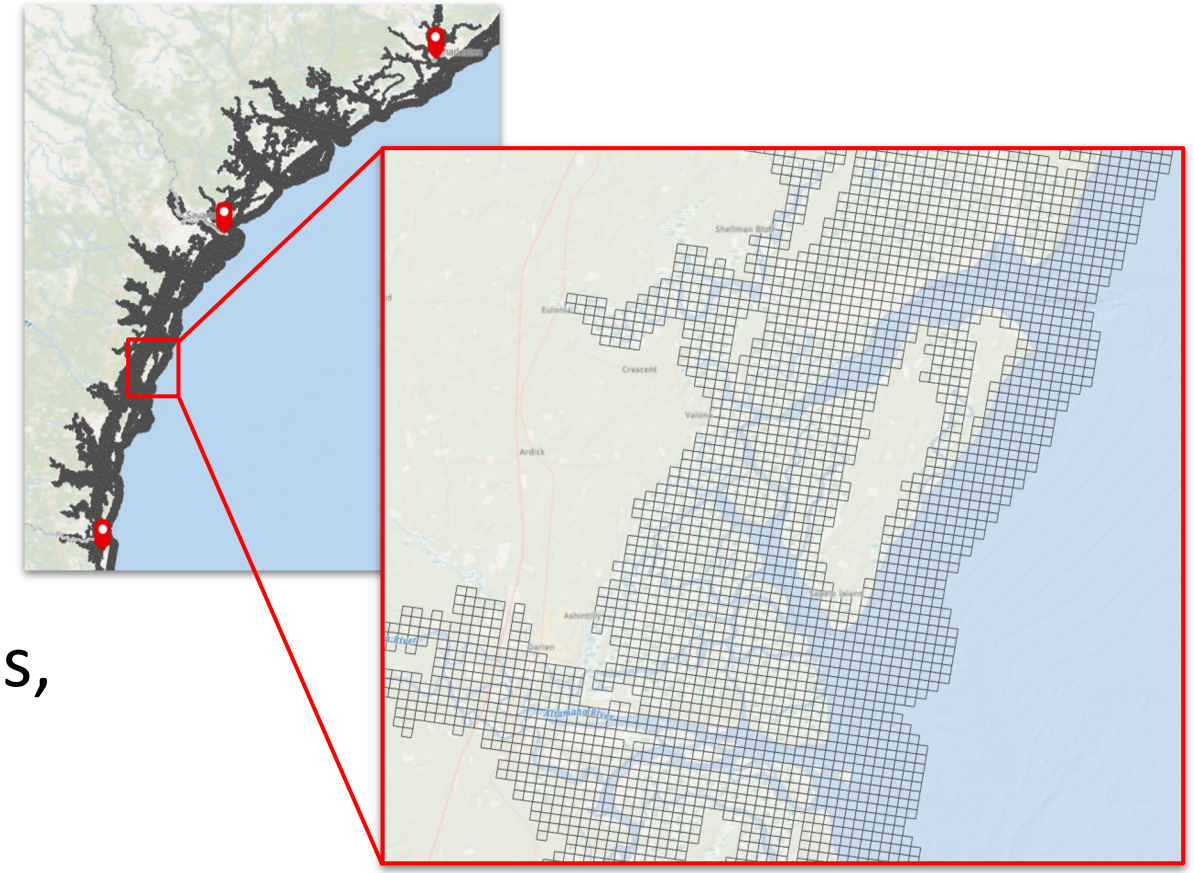


Sea Level Calculator - Version 1

- Engage and develop with users:
  - Resilience officials, planners, managers
  - Engineers
- Existing data via services:
  - Historical water levels, scenarios/projections, extrapolations, high tide flooding, extreme water levels
- Functionality:
  - Click on a tide station - data, visualizations, reports, context
  - View inundation extents on a map
  - Threshold analysis - both agency and user-defined

Sea Level Calculator - Version 2

- Build on version 1 users, data, functionality
- Integrate gridded information:
  - Scenarios
  - Extreme water levels
  - Reanalysis outputs
  - Datum conversions
- Functionality:
  - Click anywhere on the map, virtual stations
  - More advanced data analytics, including spatial



NWS Flood Inundation Mapping Services Implementation

Map Legend

10% Population served by **October 2023**.

30% Population served by **October 2024**.

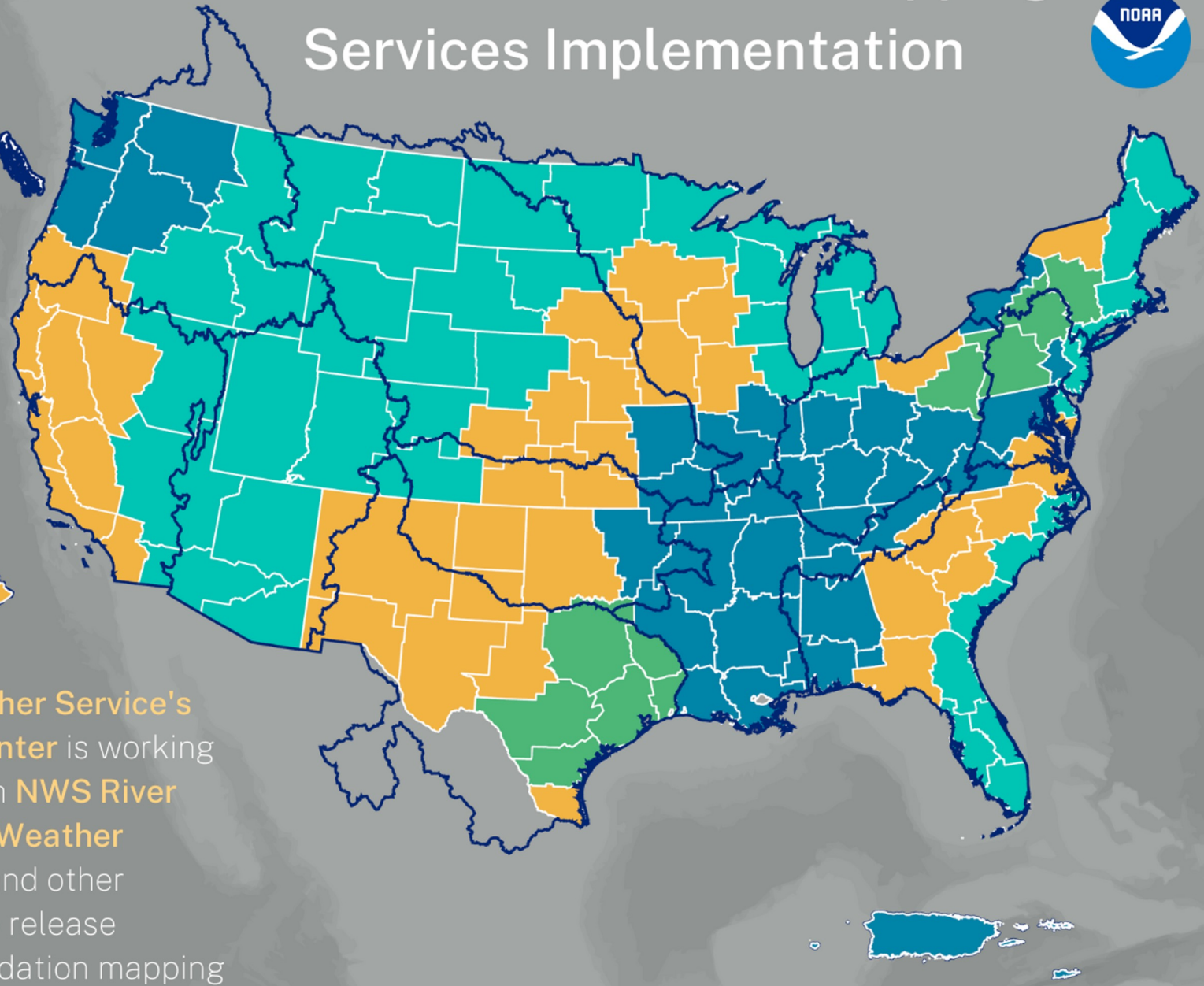
60% Population served by **October 2025**.

100% Population served by **October 2026**.

NWS County Warning Areas

NWS River Forecast Center Boundaries

*100% is approximate. Does not include all parts of Alaska, American Samoa, and Guam. Implementation areas are subject to change.



The **National Weather Service's National Water Center** is working in coordination with **NWS River Forecast Centers, Weather Forecast Offices**, and other Federal partners to release forecast flood inundation mapping services to the Nation.

Puerto Rico & U.S Virgin Islands