

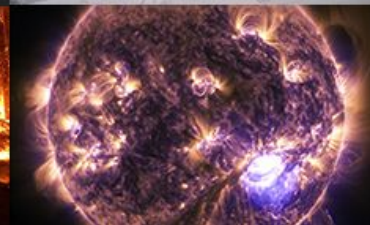
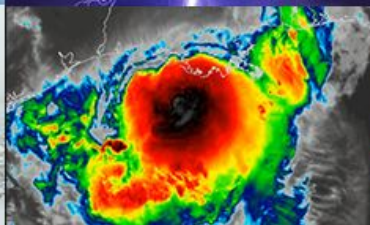
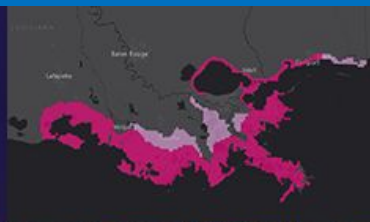


**NATIONAL
WEATHER
SERVICE**

National Weather Service: Building a Weather, Water, and Climate Ready Nation

April 6, 2022

Presenters: Mary Erickson, Acting Director, National Weather Service





Challenges and Needs



2021 Extreme Events

20 weather/
climate disasters
with losses
exceeding
\$1 Billion each

Annual Average for
Extreme Natural
Events Increasing

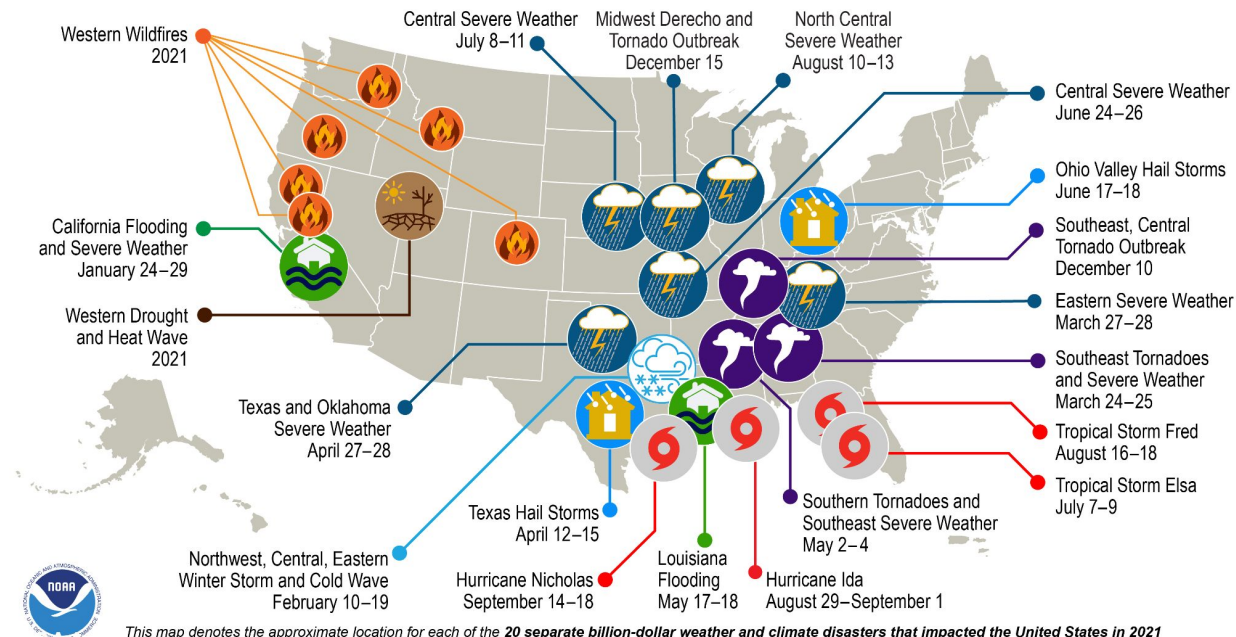
1980-
2021

7.4
Events

2017-
2021

17.2
Events

U.S. 2021 Billion-Dollar Weather and Climate Disasters



Source: <https://www.ncdc.noaa.gov/billions/>



Societal Challenges & Needs

Challenges

- **Extreme Events and Cascading Hazards:** Communities, particularly underserved, face enduring, compounding risks
- **Coastal Resilience:** Impacts of accelerating changes to the coast
- **Water Availability, Quality and Risk:** Competing demands for limited and stressed water supply
- **Our Changing Ocean:** Atmosphere-ocean variability impacting climate
- **Monitoring and Modeling for Climate Change Mitigation and Adaptation:** Information needed to make well-informed mitigation decisions
- **Effects of Space Weather:** Societal, economic, national security, and health risks

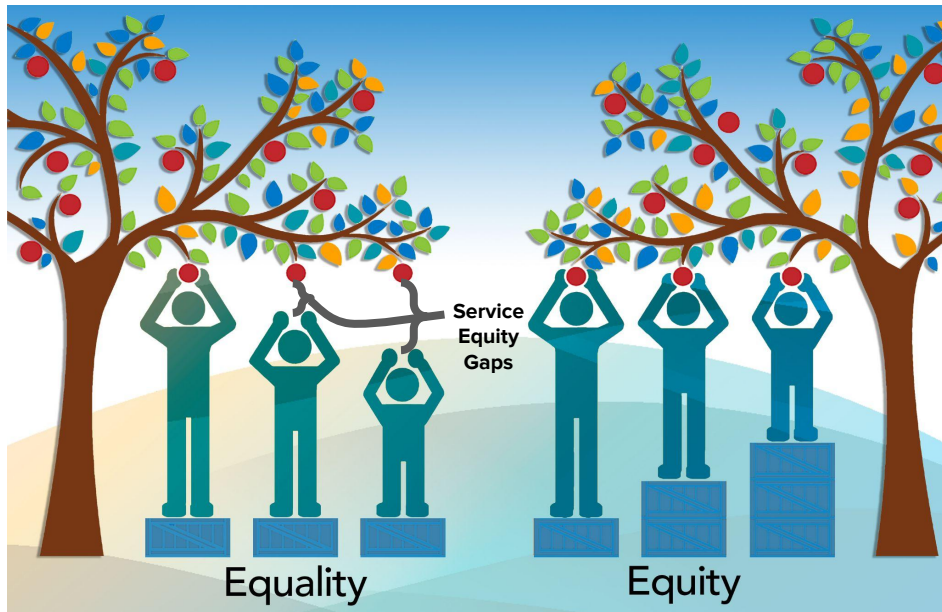
Decision Makers





Equitable Services for a Weather-Ready Nation

"Building a Weather-Ready Nation, One Community at a Time"



"One-Size" Services ☐
Unequal Outcomes

Equitable Services ☐
Equality of Outcomes





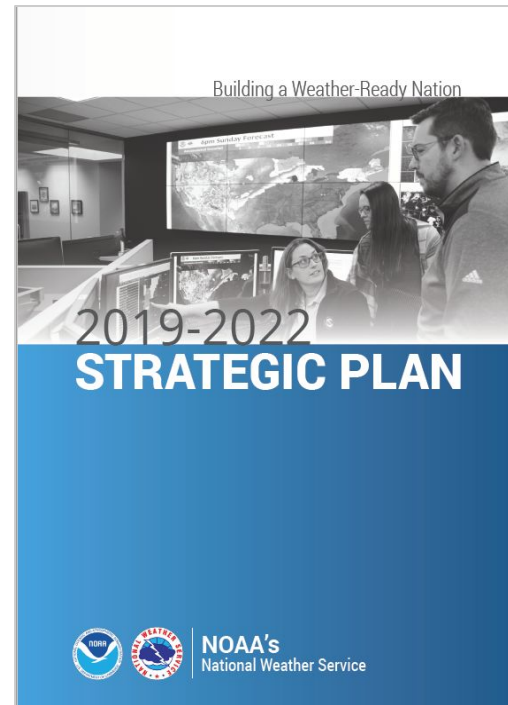
Meeting Demand



NWS Strategic Plan

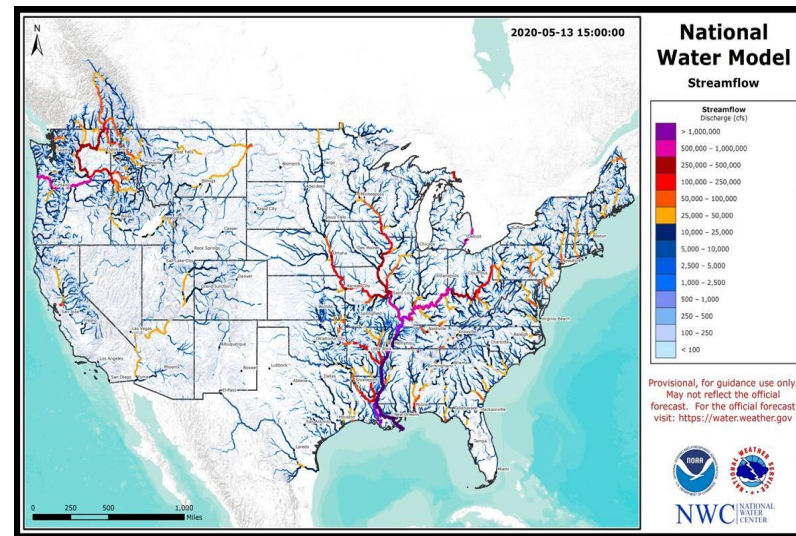
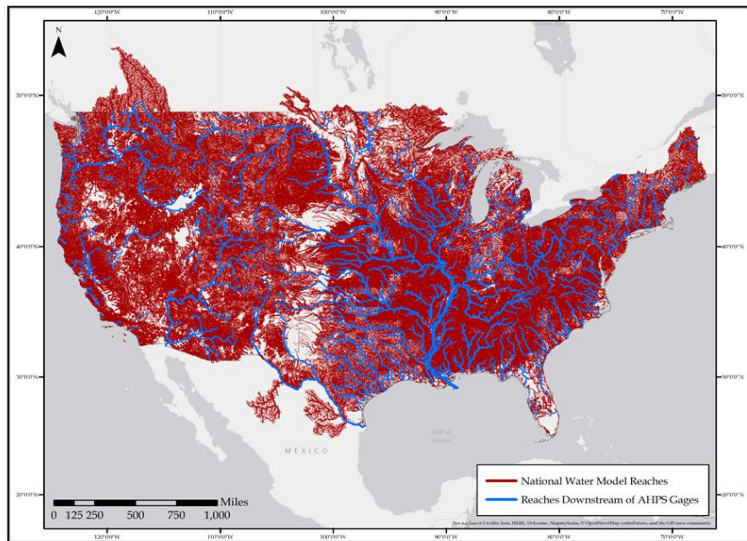
Water-Related Goals

- **Deliver actionable water resources information from national to street-level and across all time scales;**
- **Provide minutes-to-months river forecasts that quantify both atmospheric and hydrologic uncertainty;**
- **Improve forecasts of total water in the coastal zone by linking terrestrial and coastal models in partnership with the National Ocean Service; and**
- **Deliver forecasts of flood inundation linked with other geospatial information to inform life-saving decisions.**



National Water Model (NWM) Overview

- Continental-scale water resources model providing high resolution, spatially continuous estimates of major water cycle components
- Operational forecast streamflow guidance for currently underserved locations: 110,000 River miles to nearly 3,400,000 River miles



Enhancing the NWM: Development

Trajectory

v1.0

Foundation: 2016

Water resource model
2.7 million reaches

v1.1/1.2/2.0

**Upgrades:
2017/2018/2019**

Hawaii, medium range ens.,
physics upgrades, improved
modularity, MPE ingest

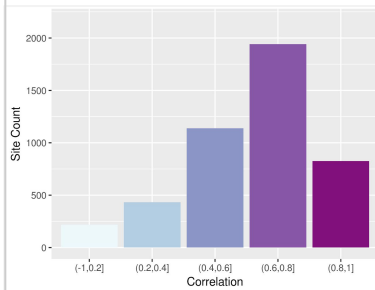
v2.1

April 20, 2021

Expansion to PR and Great
Lakes, reservoir modules,
forcing upgrades, open-loop,
and improved Hawaii forcing

V1.0

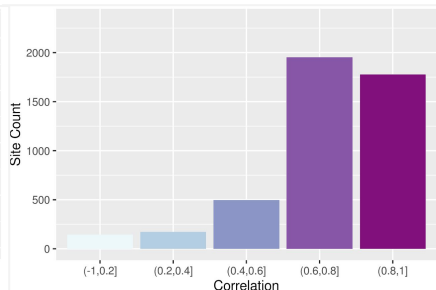
Distribution of Correlation



18% have cor >= 0.8

V2.1

Distribution of Correlation



39% have cor >= 0.8

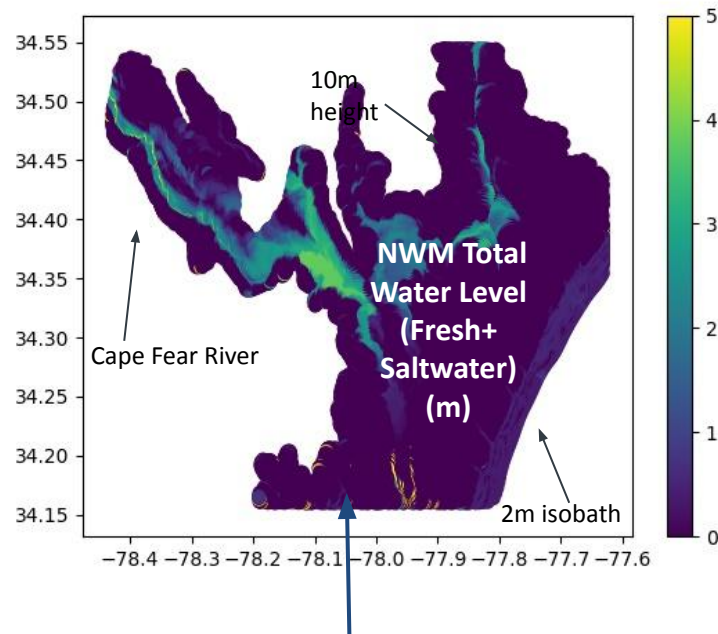
v3.0

Next Upgrade: Q3 2023

Coastal coupling, expansion to Alaska,
improved infiltration, inland hydraulic
routing, hydro-fabric upgrades

NWM v3.0 (2023): New Coupled Total Water Forecasting Capability

Over 100 million people live near the coast who don't get national total water guidance today



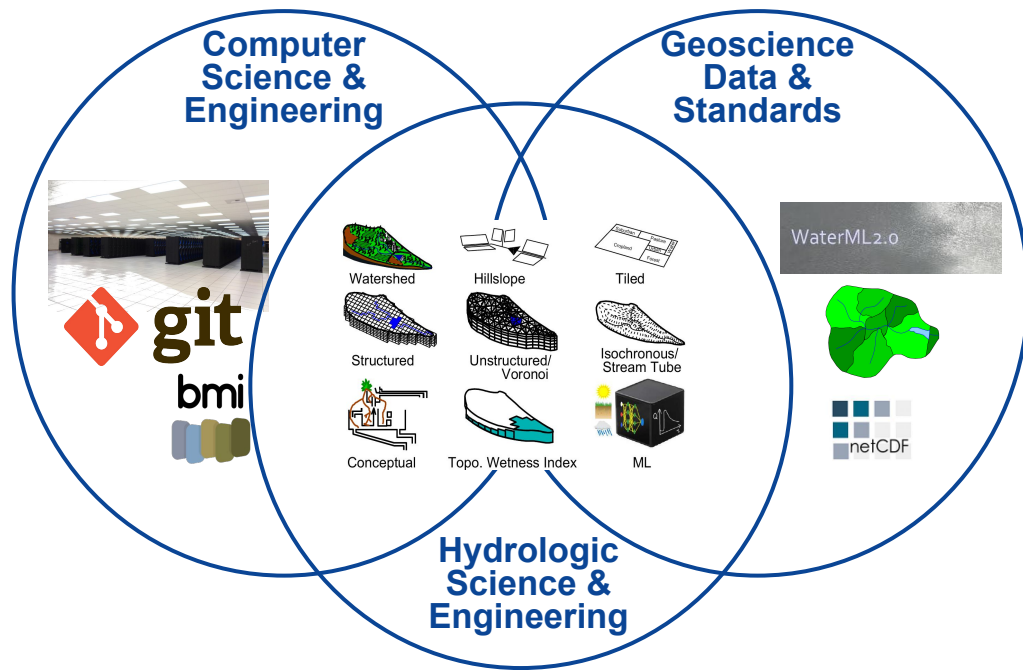
Key Goal: Fill this capability gap by coupling NWM with National Ocean Service Surge and Tide Operational Forecast System to simulate compound flooding driven by the combined effects of freshwater/surge/tides/wave action – First-ever, CONUS-wide, Hawaii, and Puerto Rico and US Virgin Islands Guidance



Key Enhancement: Next Generation Architecture

Design Principles

- **Model agnostic:** allows different methods for calculating watershed response
- **Standards based:** enables hyper-resolution and water quality modeling
- **Science driven:** allows evaluation of any formulation in any subwatershed
- **Domain science friendly:** encourages community use/involvement



NOAA led multi-agency effort with first successful demonstration at December 2021 AGU Conference



Hydrologic Ensemble Forecast Service (HEFS)



Goal to Produce Streamflow Forecasts That:

- Seamlessly span lead times from one hour to one year
- Are reliable, skillful, and account for both the meteorological and hydrologic uncertainties
- Are dependable (consistent with retrospective forecasts) and adequately verified
- Inform user's decisions (compatible with/support Decision Support Systems, e.g., NYCDEP, FIRO)

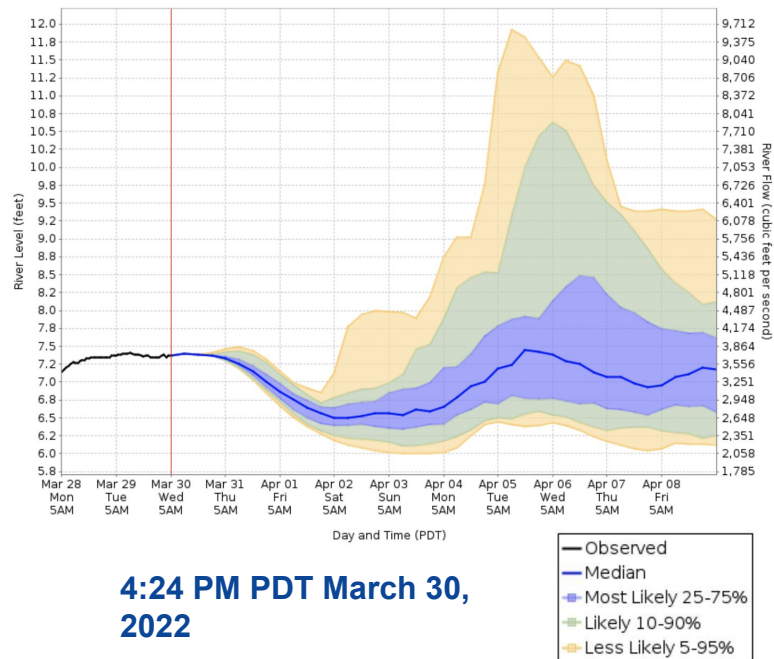


Implementation Status:

- More than 1600 river locations display HEFS experimental short and/or long-range products
- Baseline validation completed at more than 2400 river forecast locations
- Leverage GEFSv12 model forcings
- By May 2023, NWS plans to implement HEFS at more than 3400 service locations



Cowlitz River at Randle, Washington



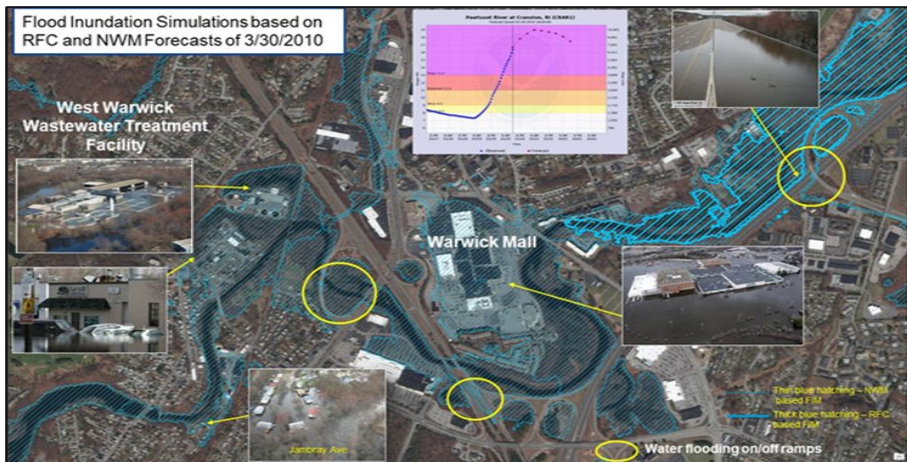
4:24 PM PDT March 30, 2022



Mitigate Flood Impacts

Demonstrating Improved Decision Support Services to Emergency Managers

National FIM Services captured as KPI in New DOC Strategic Plan



- This image shows the Flood inundation map used as part of a table top for the 2010 flood in Warwick, RI
- Locations in yellow show impacts to critical infrastructure.

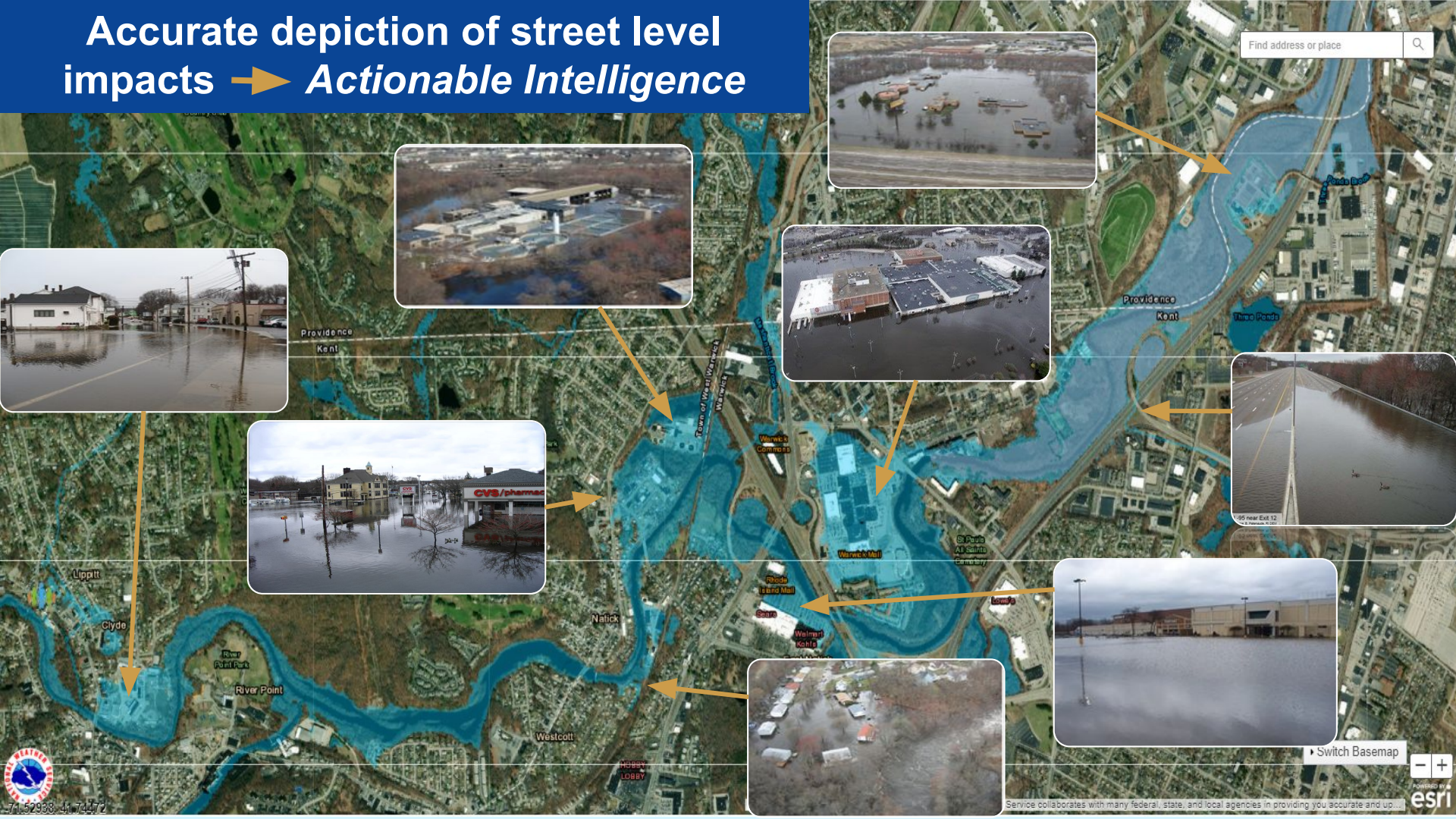


Looking Ahead

- Infrastructure Investments and Jobs Act
 - Coastal & inland flooding mapping and forecasting
 - Atlas-14 Precip Frequency updates, new techniques
 - Social and Behavioral Sciences database
 - National Water Model v3.0

Demonstration of flood inundation mapping capability, based on NERFC and National Water Model streamflow forecasts for the Pawtuxet River Basin in Rhode Island, March 30th, 2010

Accurate depiction of street level impacts → Actionable Intelligence





Looking Ahead



Current NOAA Budget Sources

(Enacted or Proposed)

\$345M

Disaster Relief Supplemental Appropriations Act, 2022

- **Hurricane** intensity and track forecasting
- **Precipitation and Flood prediction**, forecasting, and mitigation capabilities
- **Wildfire** research to improve prediction, detection, and forecasting
- **HPC** - Weather and Climate Research Supercomputers/ Other Infrastructure

\$4.16B

FY22 Omnibus - NWS \$1.28B

- \$77M above NWS FY21 Enacted Budget
- Provided funding increases for:
 - **Climate observations and forecasting (NWS \$24.6M)**
 - EIS: \$12.6M
 - IDP: \$12M
 - **Supports the inflationary increases (ATBs) across all Portfolios**

\$2.96B

Infrastructure Investment and Jobs Act

- **Coastal and inland flood and inundation mapping and forecasting**
- **Research Supercomputing**
- **Fire weather**
- **Ocean and coastal observing systems**
- **Coastal Zone Management**
- **Water Resources Development Act data acquisition**





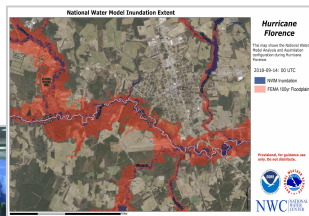
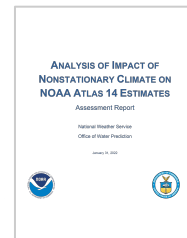
Provision 3 - A Water Focus

The Act Specifically States:

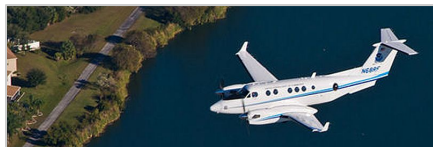
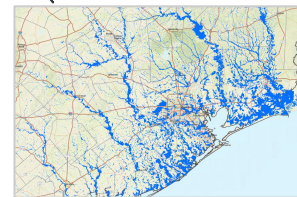
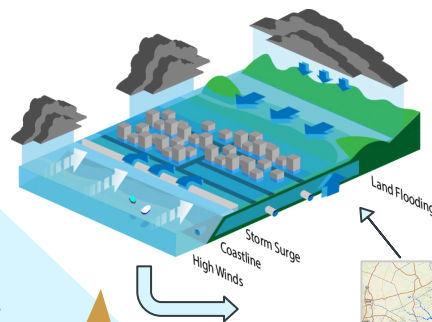
“\$492,000,000 shall be for coastal and inland flood and inundation mapping and forecasting, and next-generation water modeling activities, including modernized precipitation frequency and probable maximum studies”

- NOAA has developed spend plans for this and other provisions which have been briefed on the Hill
- Obligation of resources anticipated to begin in FY22

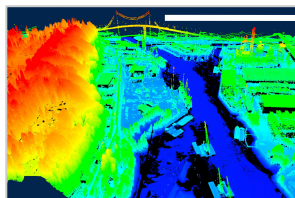
IJA: Provision 3 Activities



Transform customer experience and service delivery to provide decision makers the actionable information they need to prepare, adapt, mitigate, and respond to water-related challenges.

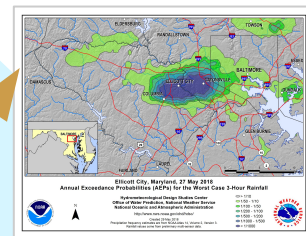


Improve Overall Forecasting Skill and Services through the Next Generation of NOAA's National Water Model Framework coupling advanced inland and coastal models used to generate total water level forecasts and flood inundation maps for rivers and coasts, and incorporate water quality.



Real-time Coastal and Inland Forecast Flood Inundation Mapping: NOAA will collect and integrate high-resolution bathymetric and topographic data by aircraft and vessel to advance and implement flood and inundation forecasting and mapping capabilities and related services.

Update and Revise Precipitation Frequency Atlases for the U.S. including Probable Maximum Precipitation: Updates and revisions will account for climate change, and these data will be publicly available. NOAA Atlas 14 precipitation frequency and probable maximum precipitation estimates are critical to design and construction all infrastructure.





New Water Resources Cooperative Institute

Addressing Basic and Applied Research Needs, and Supporting Research to Operations Activities

NOAA will establish a new NOAA Cooperative Institute [CI] in April, 2022, managed within the NWS, and focused solely on helping NOAA address the Nation's growing water challenges

- **The CI** will leverage talent and diversity from multiple universities to **lead an interdisciplinary, systems-based research approach** from mountains to tributaries, lakes and rivers, and ultimately to the coasts **that will seed new and improved operational services for the NWS**

Expand and improve
water resources
prediction capabilities

Advance and accelerate
community water
resources modeling

Research
Themes

Advance and augment
hydroinformatics

Apply social, economic
and behavioral science
to water resources



Precipitation Prediction Grand Challenge

NOAA's Response – Pushes for Improvement

1 Improve end-user products

Through continuous user engagement and social science to more effectively communicate the forecast

2 Assimilate and integrate data

Then regularly produce supporting datasets, including re-analyses and re-forecasts

3 Address global model systematic errors

4 Establish traceability of error sources

5 Change the paradigm and target regions around the globe

That host sources of prediction predictability

6 Improve global water vapor and boundary layer observations



Imperative to Improve Precipitation Forecasts

Deadly and damaging threat from too much or too little water —
exacerbated by climate change



Looking Ahead

- Progress in flood and drought forecasting largely dependent on improved precipitation forecasts
- 2022 Disaster Supplemental - Precip Social Science, Predictability, Data Assimilation, Tools & IDSS





Questions





Closing Thoughts

- **NOAA continues to develop and evolve a broad spectrum of advanced water resources prediction, data, and decision support services to address the growing number of increasingly complex, multidisciplinary water challenges that threaten lives, livelihoods, and our national security**
- **The transformation of water prediction, and the implementation and evolution of new services, requires a continued and deepened collaboration and commitment with Federal water partners, and across the broader water resources community**

Thank you!



NATIONAL WEATHER SERVICE

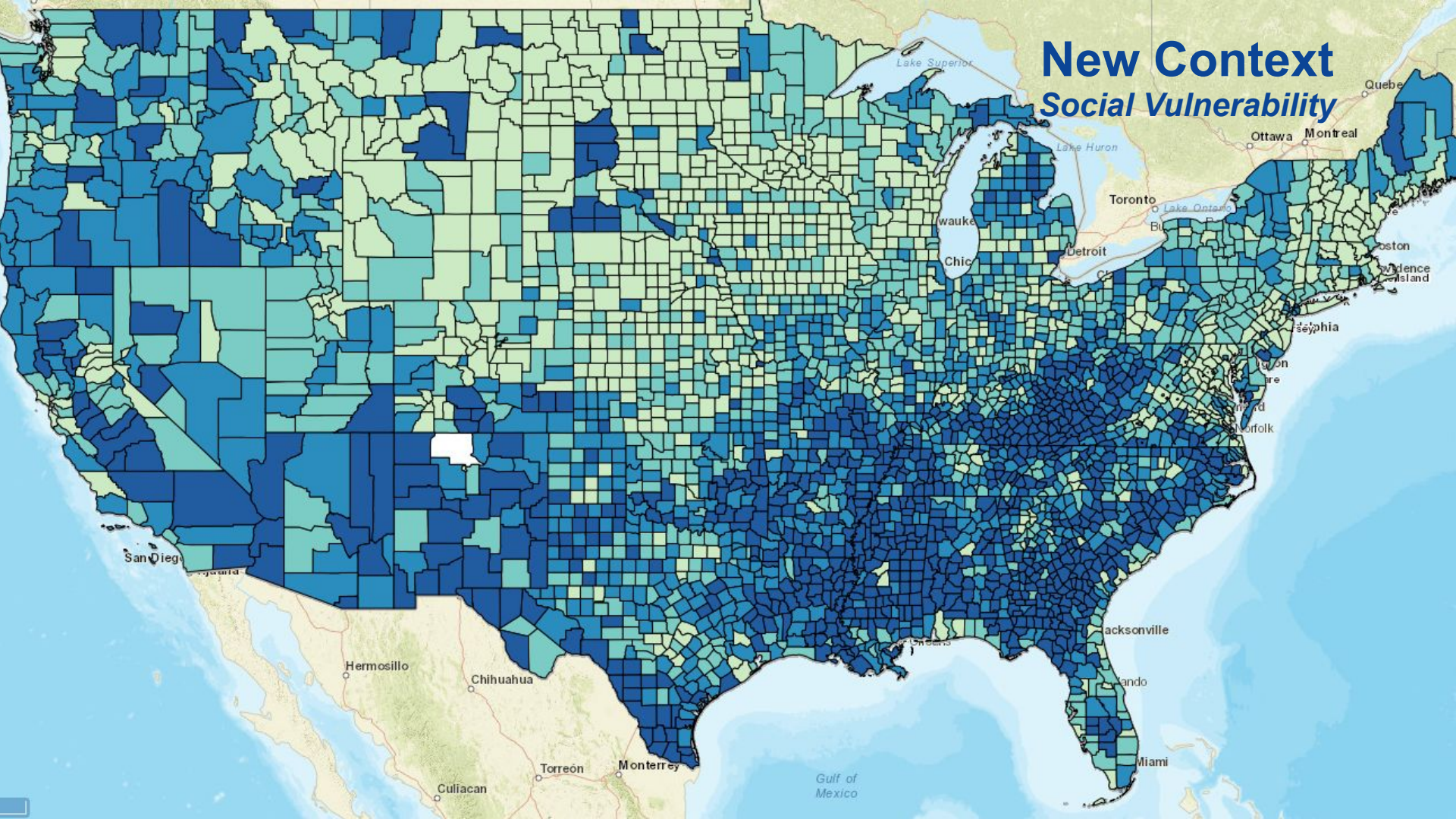
Building a Weather-Ready Nation // 24

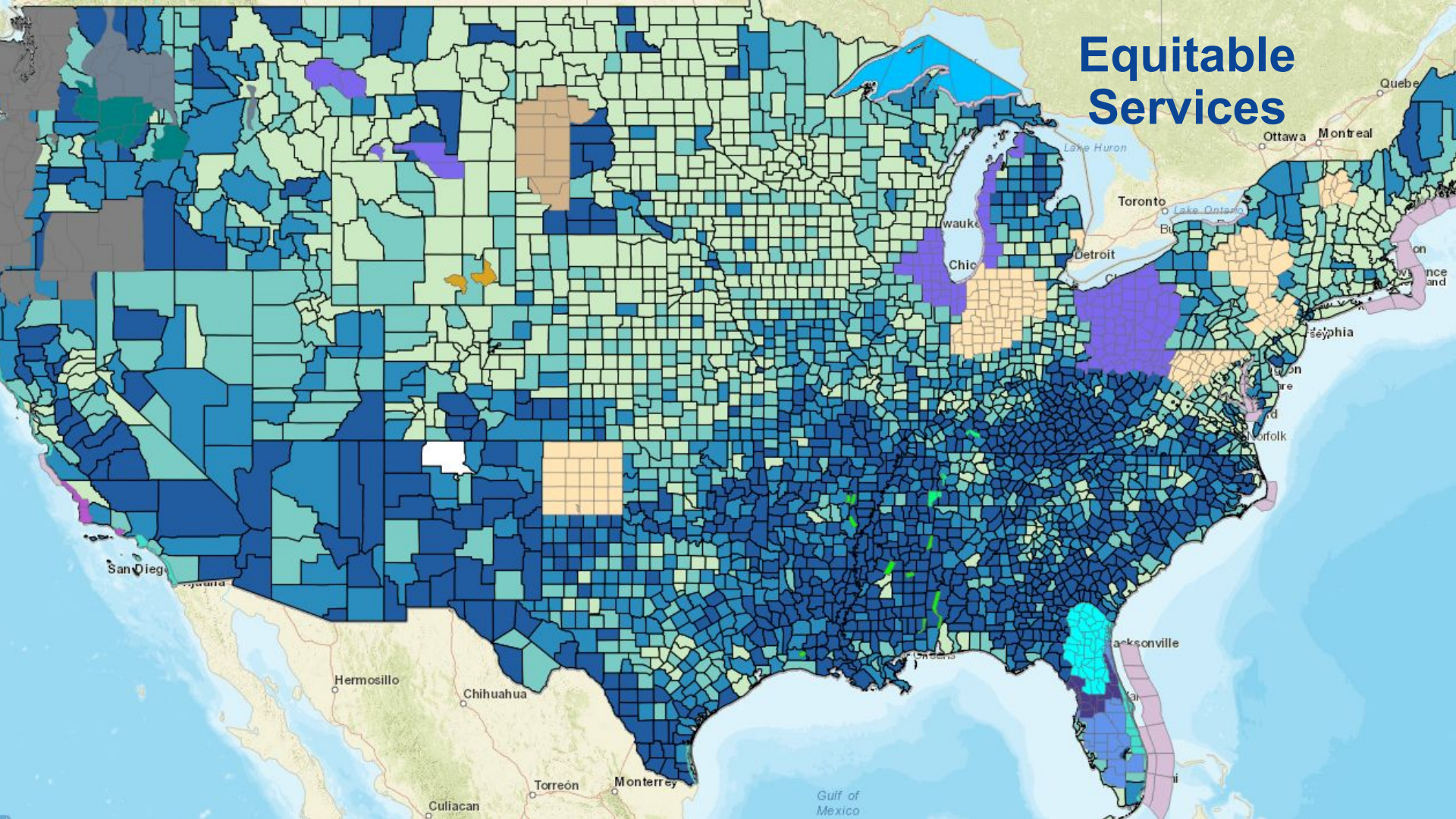
Legacy Services



New Context

Social Vulnerability



[illegible]

Priorities for Weather Research Report

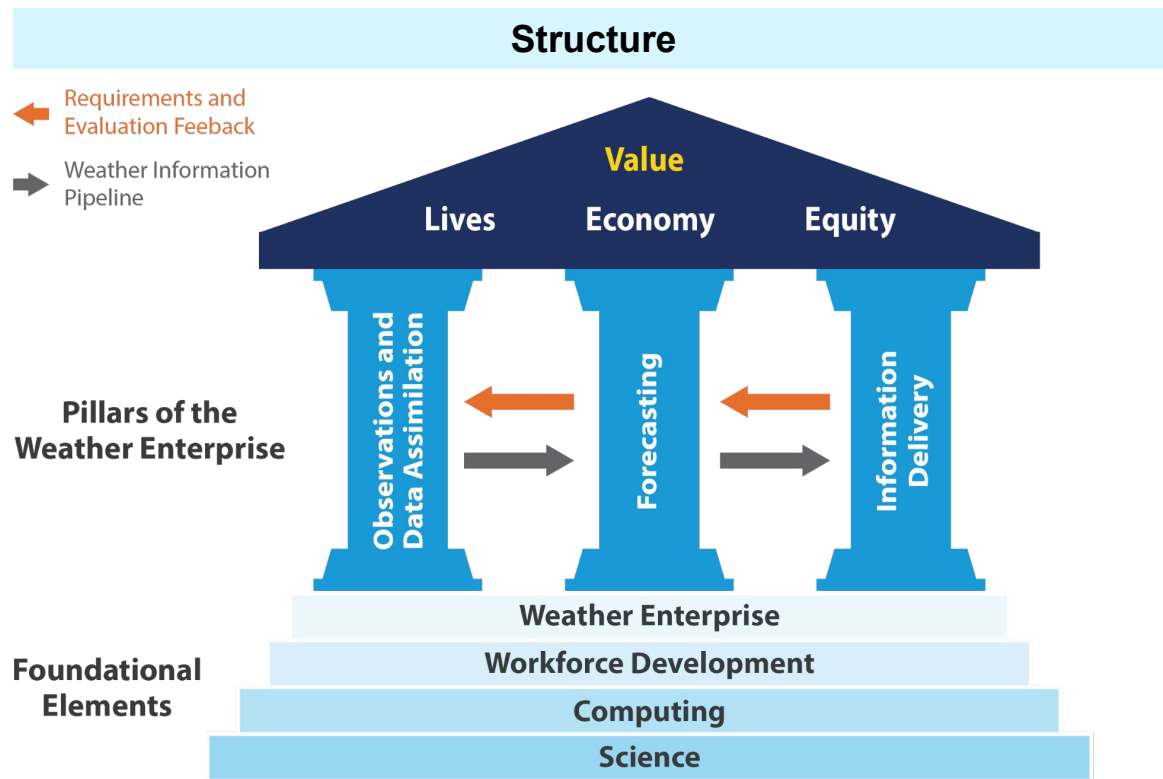


Figure 5, A Report on Priorities for Weather Research, December, 2021

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Research Themes

1

Expand and improve water resources prediction capabilities

2

Advance and accelerate community water resources modeling

3

Advance and augment hydroinformatics

4

Apply social, economic and behavioral science to water resources

New Water Resources Cooperative Institute

Addressing Basic and Applied Research Needs, and Supporting Research to Operations Activities

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Expand and improve water resources prediction capabilities -

provide expertise to support research in service equity, coastal resilience, ecosystem management, enhanced decision support services, and promote integration within NOAA's Unified Forecast System (UFS).

Advance and accelerate community water resources modeling -

support research in the development and implementation of a Next Generation (NextGen)

Research Themes

Advance and augment hydroinformatics -

support research in the development of geographic information systems and remote sensing, data assimilation, computational science and high-performance computing, and artificial intelligence and machine learning.

Apply social, economic and behavioral science to water resources -

support research in water-related operations and outreach to improve decision support services based on the needs and comprehension of the public



New Water Resources Cooperative Institute

Addressing Basic and Applied Research Needs, and Supporting Research to Operations Activities



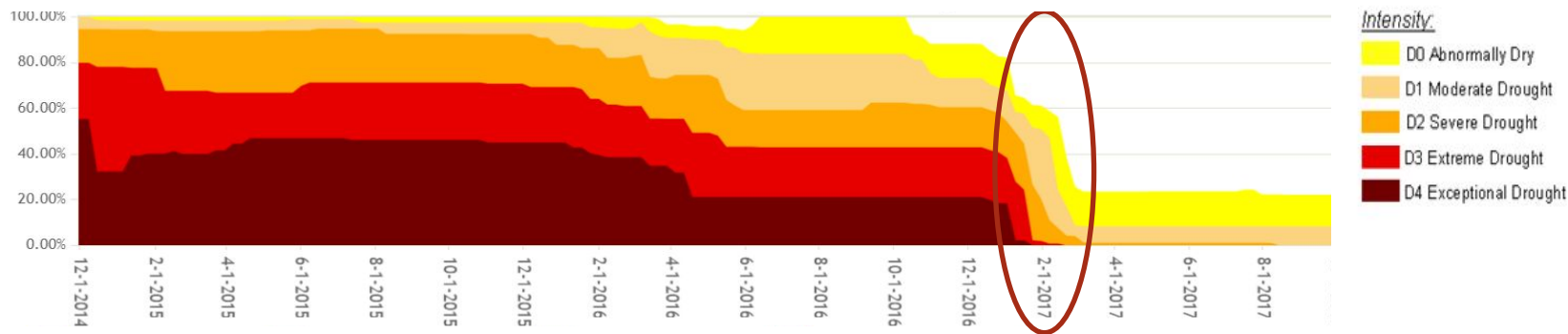
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- **Will be focused on 4 major research themes:**
 - **Expand and improve water resources prediction capabilities** - provide expertise to support research in service equity, coastal resilience, ecosystem management, enhanced decision support services, and promote integration within NOAA's Unified Forecast System (UFS).
 - **Advance and accelerate community water resources modeling** - support research in the development and implementation of a Next Generation (NextGen), community-based, open source, water resources modeling framework
 - **Advance and augment hydroinformatics** - support research in the development of geographic information systems and remote sensing, data assimilation, computational science and high-performance computing, and artificial intelligence and machine learning.
 - **Apply social, economic and behavioral science to water resources** - provide expertise to support research in water-related operations and outreach to improve the delivery and efficacy of decision support services based on the expressed needs and comprehension of the public that NOAA serves.



Can Prediction Meet Demand?

Failure to Predict Drought Amelioration

California Percent Area in U.S. Drought Monitor Categories



Transitioned from multi-year severe drought to near-normal conditions with record flooding over ~60 days

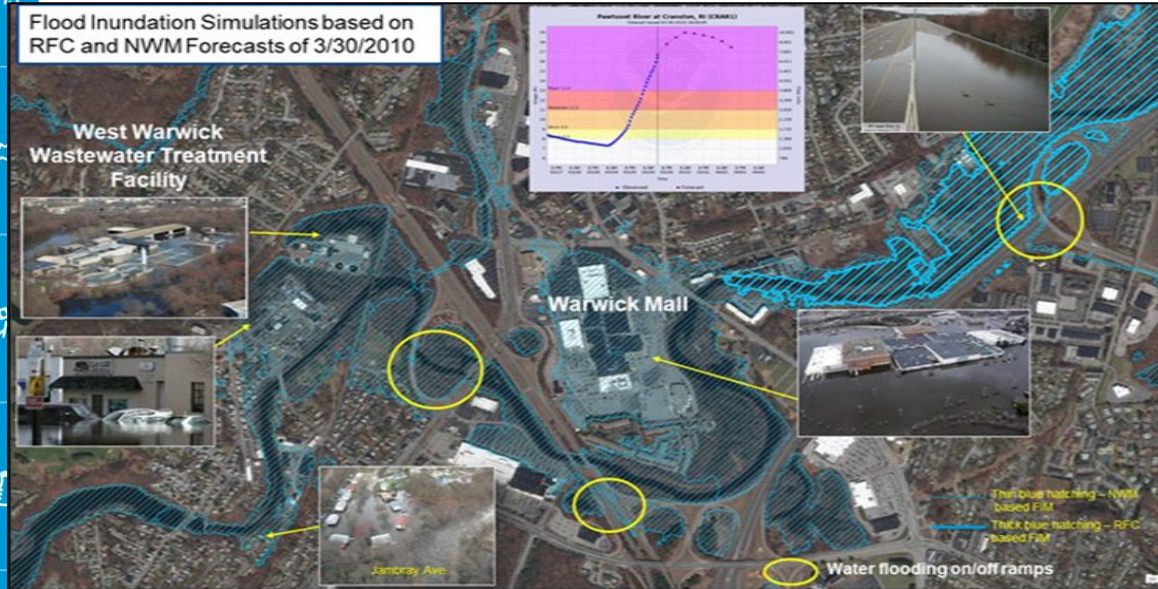
Science challenges for improved winter precipitation in this case for the southwest US include:

- Understanding why the persistent west coast ridge broke down despite La Nina conditions
- Potential role of other tropically-forced teleconnections.

All models failed to predict this transition of the large scale atmospheric state and subsequent heavy rains beyond about two weeks lead.

Mitigate Flood Impacts

Demonstrating Improved Decision Support Services to Emergency Managers



- This image shows the Flood inundation map used as part of a table top for the 2010 flood in Warwick, RI
- Locations in yellow show impacts to critical infrastructure.



Looking Ahead

- New Water Resources Cooperative Institute (Q3)
- National Water Model v3.0

Demonstration of flood inundation mapping capability, based on NERFC and National Water Model streamflow forecasts for the Pawtuxet River Basin in Rhode Island, March 30th, 2010





Outline

- **Challenges and Needs (1-2 slides)**
 - Increasing frequency of extreme events
 - Societal Challenges and Needs
- **Meeting the Demand (3-5 slides)**
 - Water-related goals in the NWS Strategic Plan
 - Budget Sources
 - Transforming Water Prediction
 - NWM upgrades
 - Flood inundation mapping
- **Looking Ahead (2-3 slides)**
 - Priorities for Weather Research Report
 - Precipitation Prediction Grand Challenge
 - Serving the traditionally underserved