PLANNING FOR AND MANAGING THE IMPACTS OF CHANGING PRECIPITATION PATTERNS ON WASTEWATER AND STORMWATER SYSTEMS

SEPTEMBER 5, 2023

UNIVERSITY OF MARYLAND ENVIRONMENTAL FINANCE CENTER

OVERVIEW

- **Welcome and background**
- **Precipitation data updates and projections**
- **Planning and decision support tools**
- **Cases and examples**
- **Q & A**

UNIVERSITY OF MARYLAND 1856
ENVIRONMENTAL FINANCE CENTER

PRESENTERS

Stephanie P. Dalke, Program Manager, Water Resources and Climate Adaptation, University of Maryland Environmental Finance Center

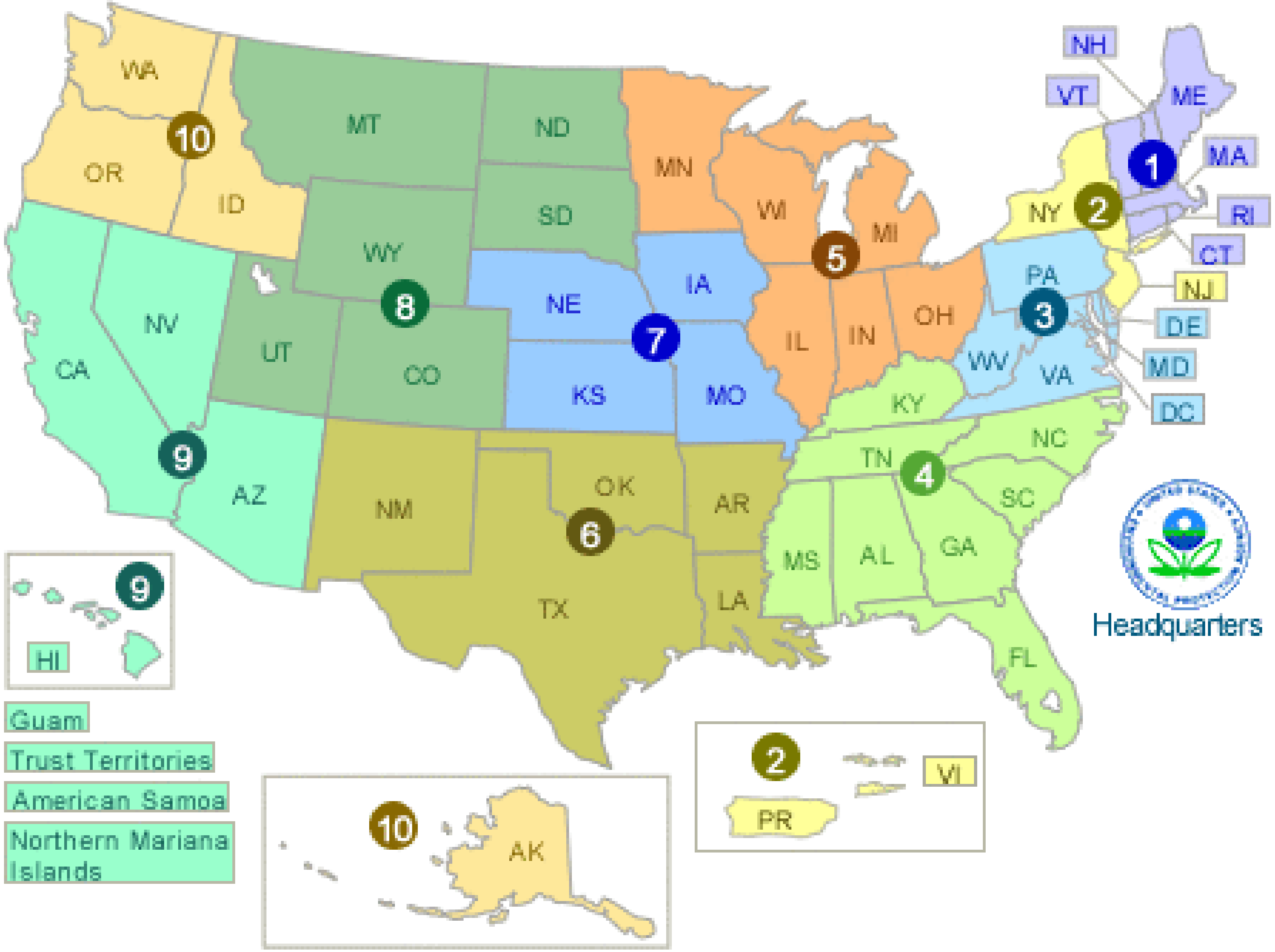
Ellen Mecray, Regional Climate Services Director, Eastern Region NOAA/NESDIS/National Centers for Environmental Information

Art DeGaetano, Professor, Earth and Atmospheric Sciences and Director, NOAA Northeast Regional Climate Center

Steve Fries, Technical Assistance Lead, Creating Resilient Water Utilities Initiative, U.S. Environmental Protection Agency

Geneva Gray, Physical Scientist, U.S. Environmental Protection Agency

POLL QUESTIONS



BACKGROUND

Generally:

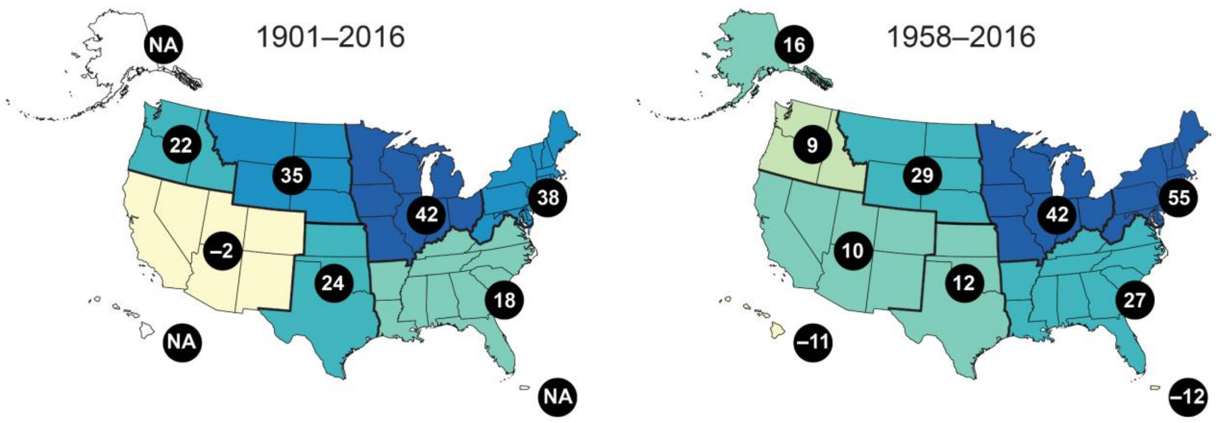
- **Precipitation patterns have changed over past century**
- **Heavy rain events have become heavier**
- **More of annual rainfall in fewer events**

Implications:

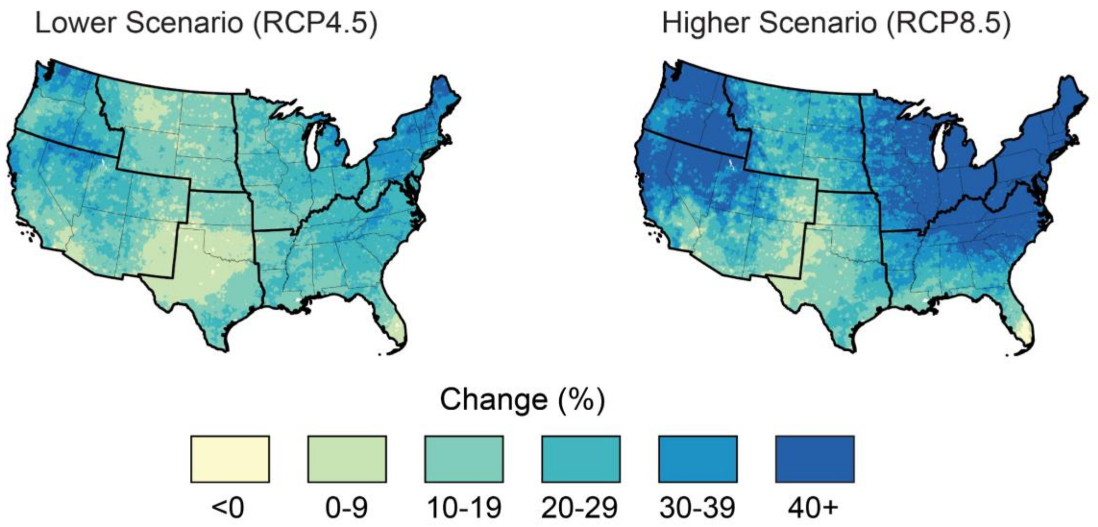
- **More water & runoff**
- **Infrastructure capacity limits**
- **Other infrastructure issues**
- **More floods & potential service disruptions**

*Source: National Climate Assessment (2018)

Observed change in total annual precipitation falling in the heaviest 1% of events*

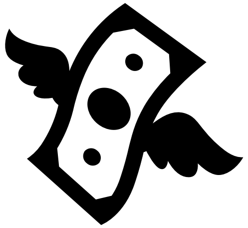


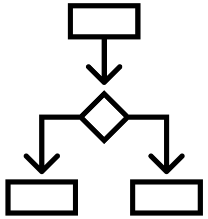
Projected change in total annual precipitation falling in the heaviest 1% of events by late 21st century*



UTILITY MANAGEMENT QUESTIONS

- **How manage these challenges cost-effectively?**
- **What should we be doing differently?**
- **What should we avoid doing?**
- **How do you plan and make decisions about this?**
- **What guidelines can you adopt vs what needs special study or design help?**
- **What resources and assistance are available to my community or system?**





"There is no consistent federal guidance or regulatory mandates that require utilities to use forward-looking climate modeling and information in their planning. As a result, each agency typically uses their own methods to prepare for future risk, based on their own analyses and available climate science, and their own leadership directives."

- 2022 Water Utility Climate Alliance report: Climate Projections for Stormwater and Wastewater Resilience Planning

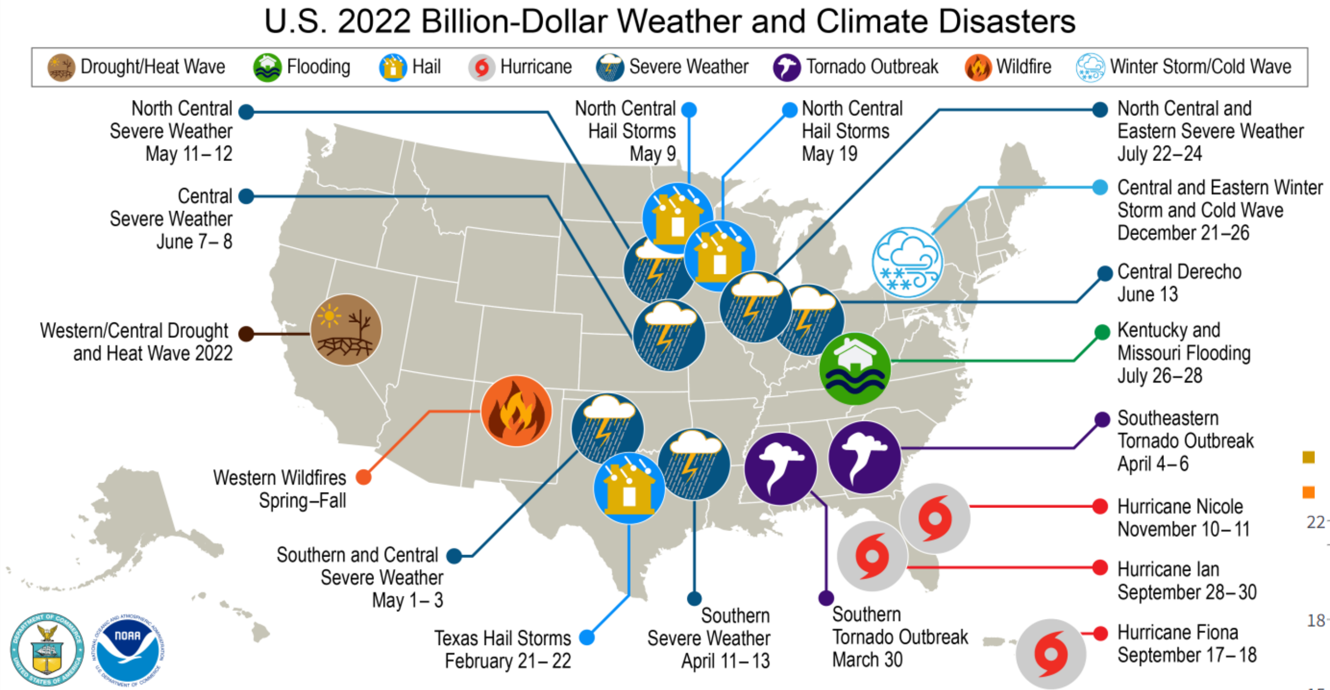
NOAA Service Delivery: Working to Meet the Needs of Water and Stormwater Managers

Ellen Mecray, NOAA Regional Climate Services Director- Eastern Region

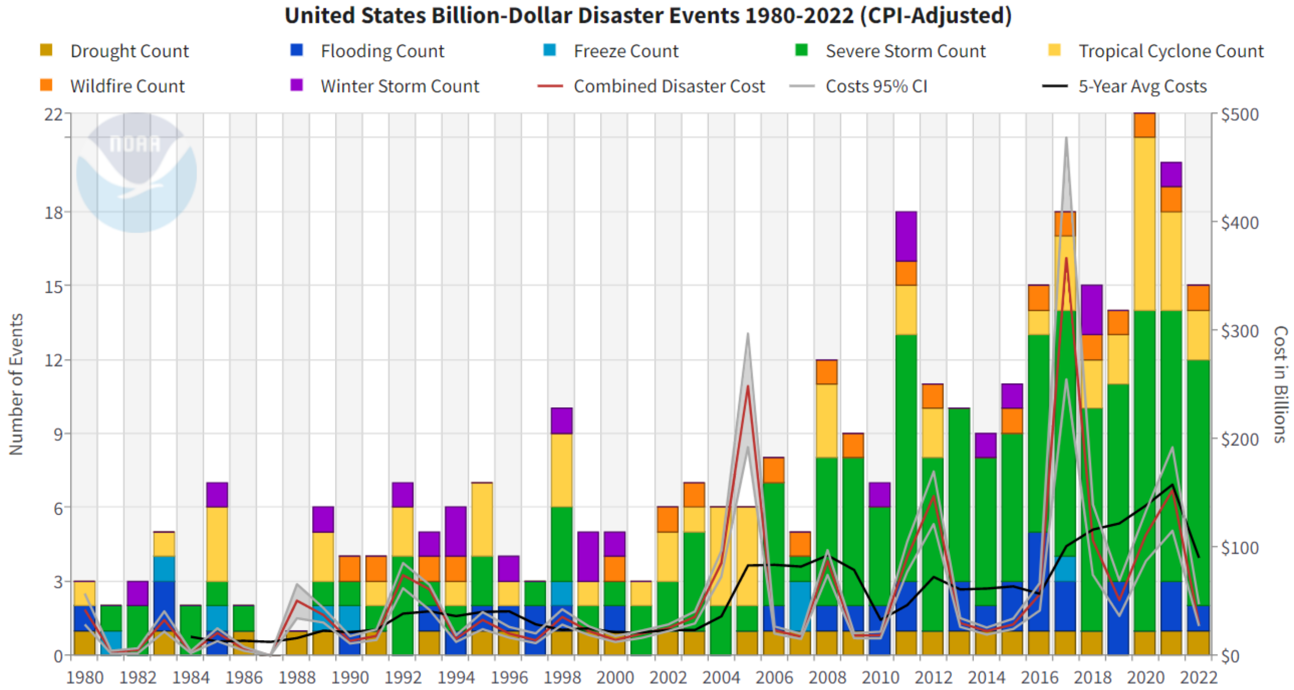
National Centers for Environmental Information (NCEI)

September 5, 2023

Disaster Trends and Why Our Work Matters



*This map denotes the approximate location for each of the **18 separate billion-dollar weather and climate disasters that impacted the United States in 2022.***

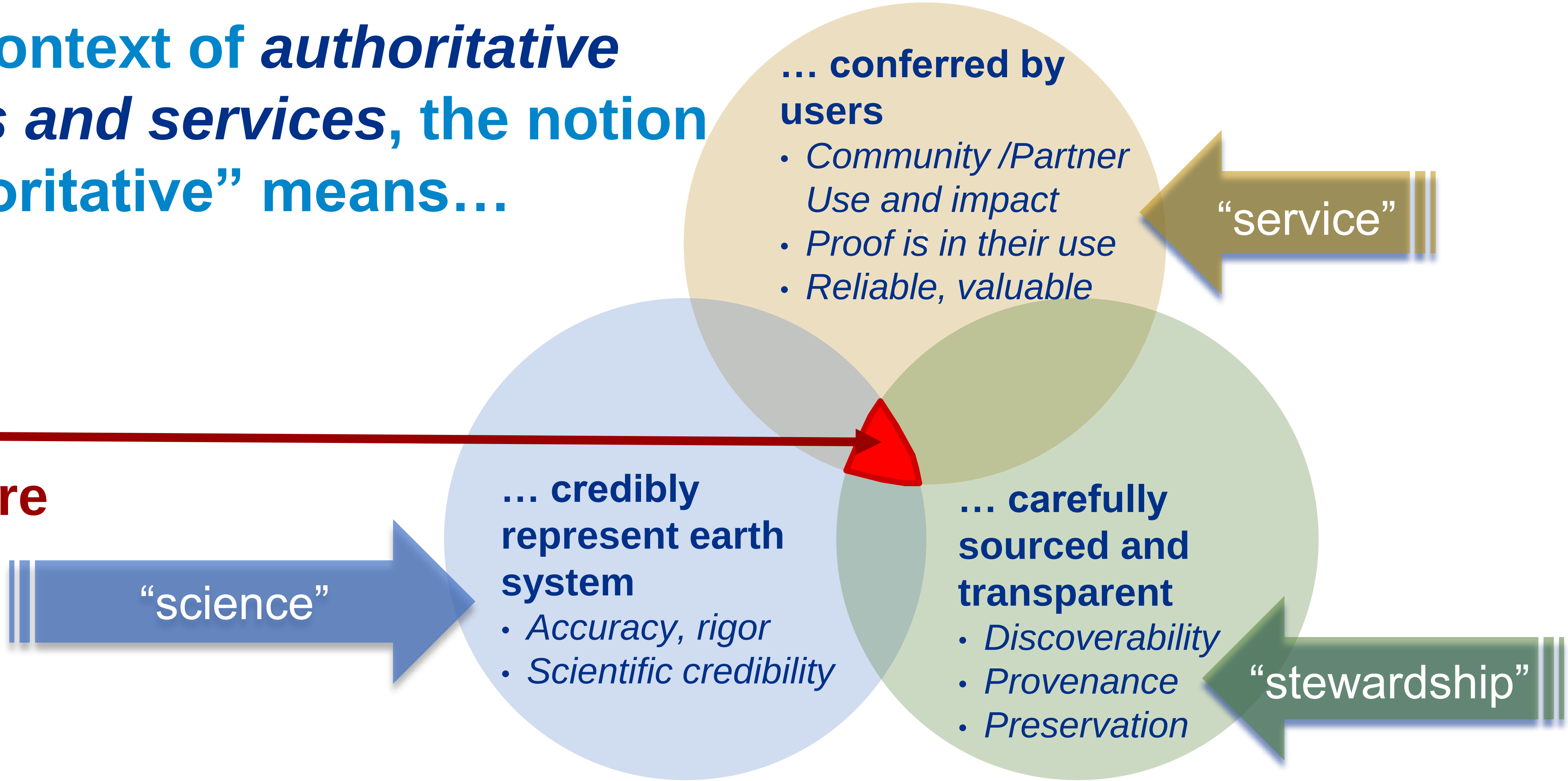


NOAA's Authoritative Products and Services

Authoritative Information and Services

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

NCEI: Aim here



The NOAA Service Delivery Framework

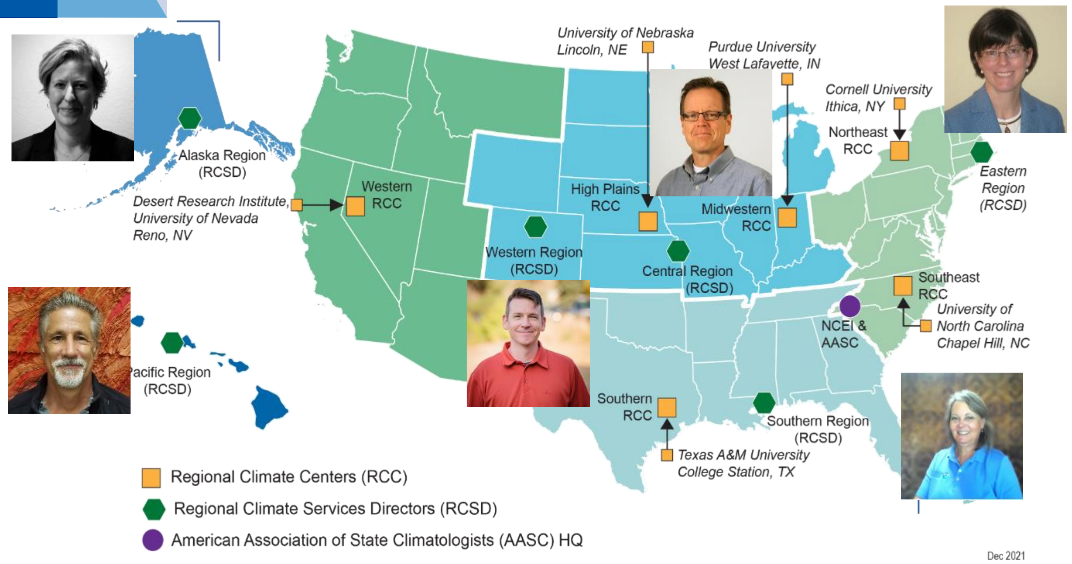
Continuous engagement is the central element for successful service delivery.

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.

NCEI National Climate Services Partnership

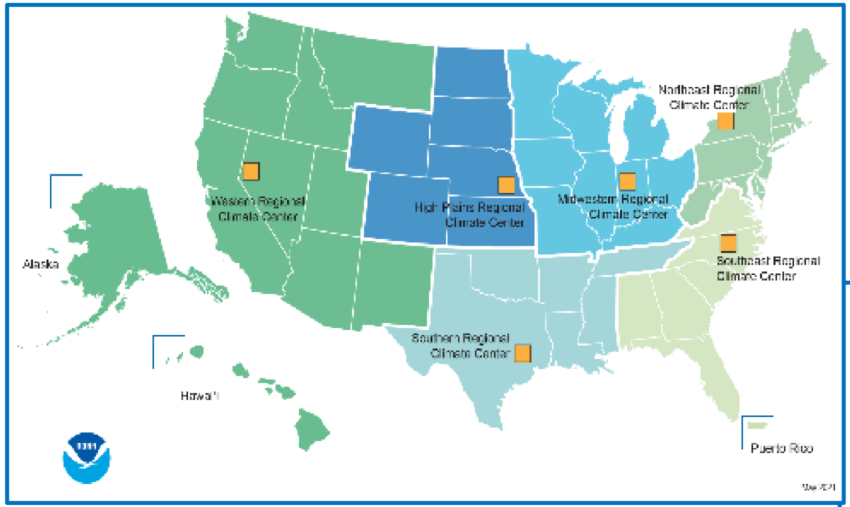


National Scope

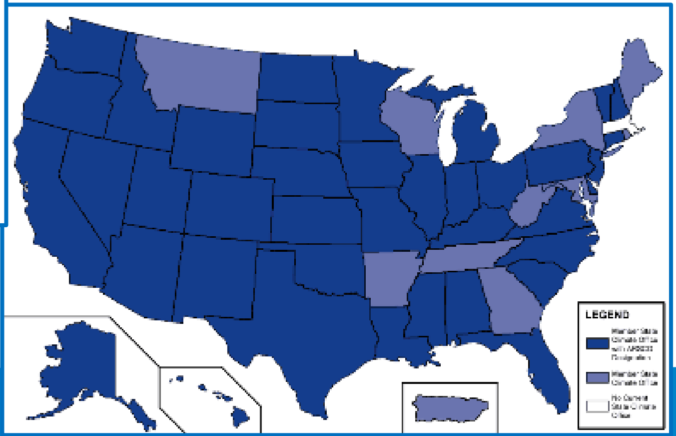
- 6 Regional Climate Service Directors
- *Voice of NOAA Climate* in each region
- NOAA and cross-Agency engagement and coordination

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

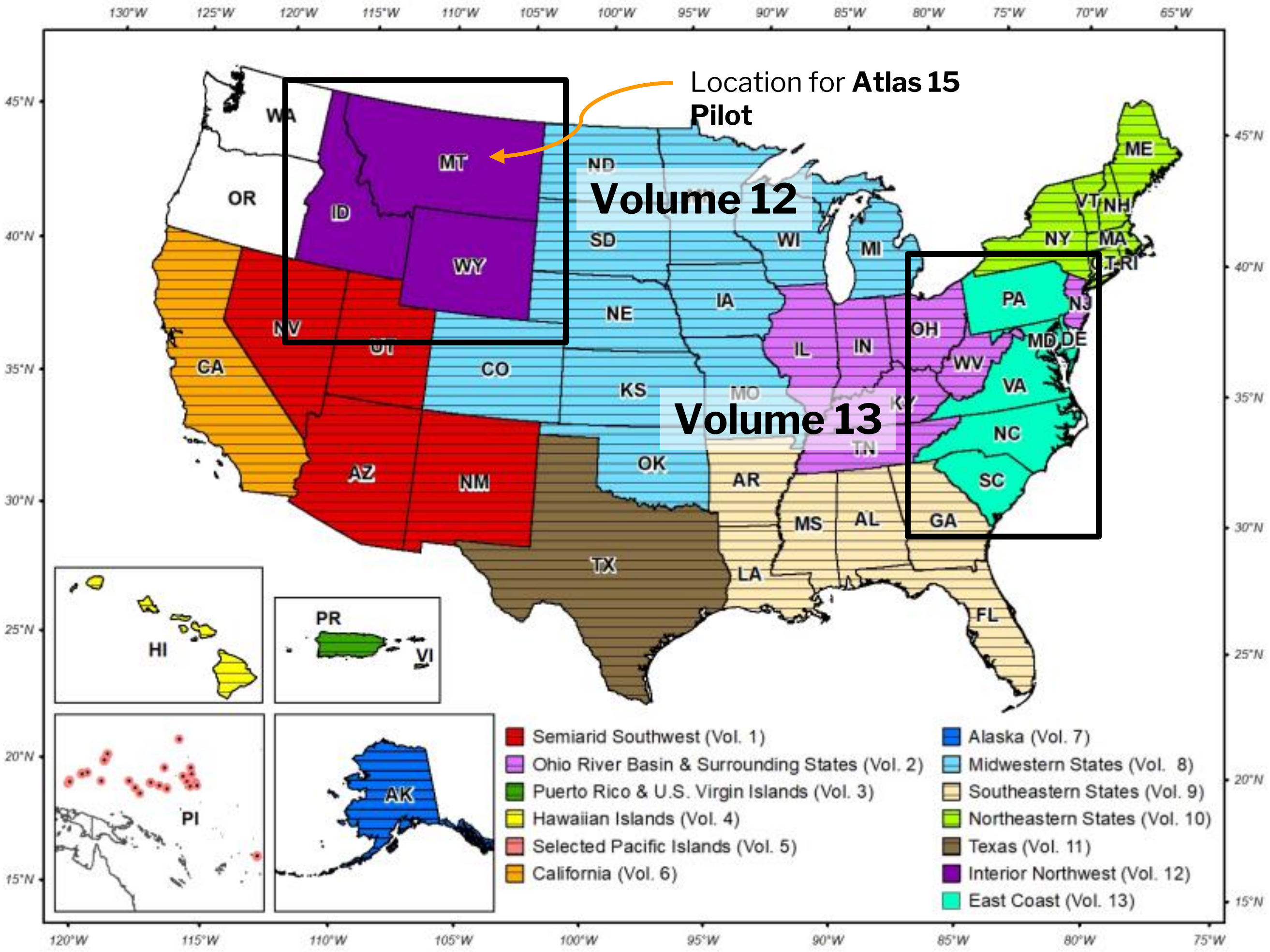


and at the

State level

- State climatologists

NOAA Atlas 14 Product Suite



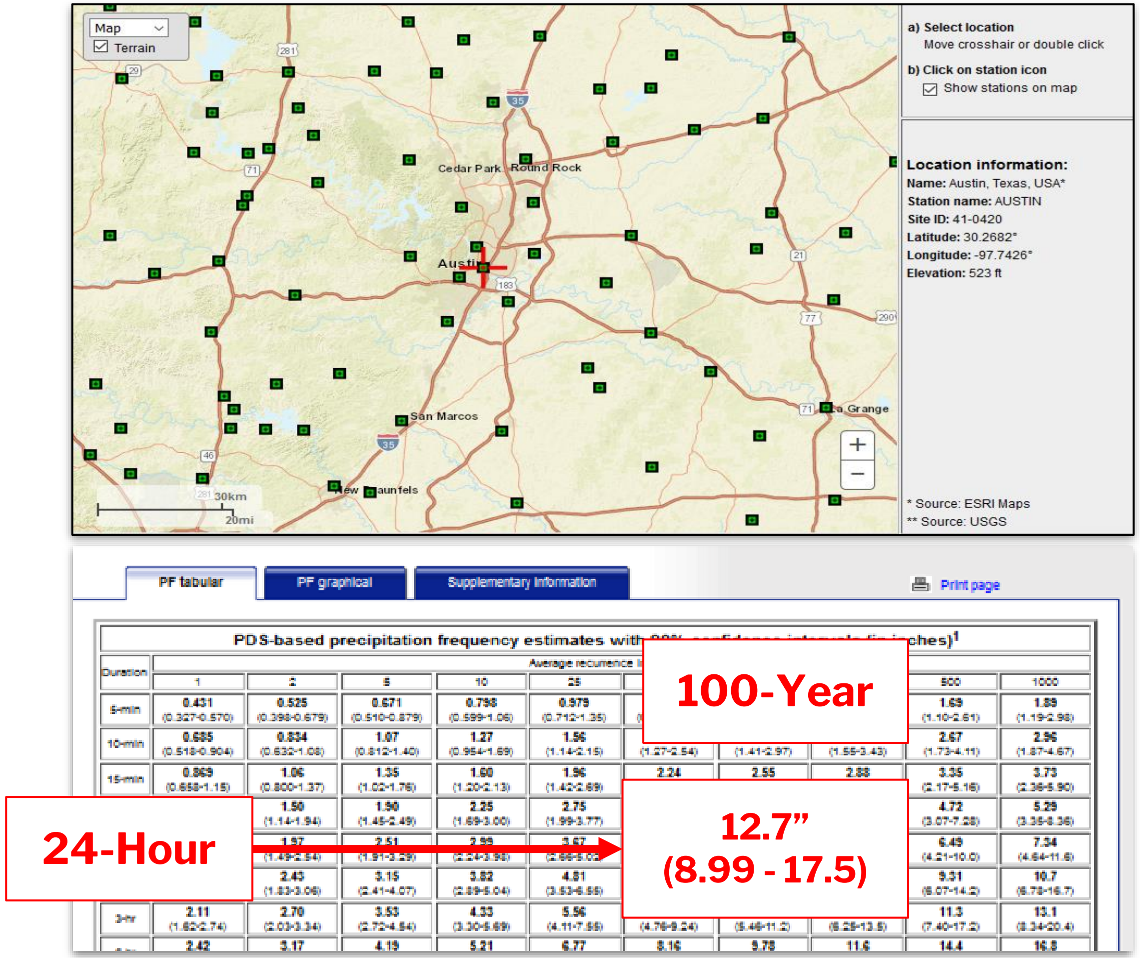
Majority of built infrastructure leverages precipitation frequency data for design and planning under federal, state and local regulations

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

NOAA Atlas 14 Features



https://www.weather.gov/owp/hdsc

Product Features

- from 5 minutes to 60 days
- recurrence intervals of 1 to 1000 years
- confidence intervals
- high spatial resolution (~800 m)
- spatial interpolation (account for terrain, coastal proximity, etc.)
- numerous internal consistency checks
- regional approach that allows for the development of rare frequency
- denser rain gauge networks with longer periods of record, and extensive quality control

Assumptions

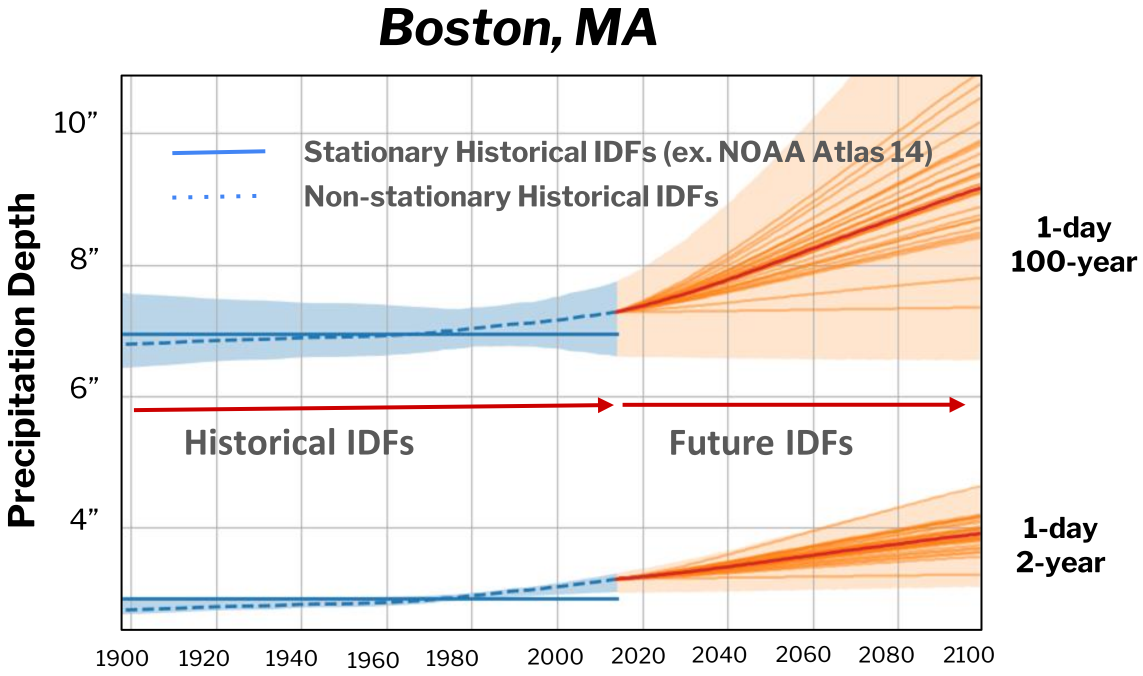
- Assumes stationarity in data and methodology; doesn’t account for climate change

Atlas 15 Methodology Developed: Accounting for Nonstationarity

"Analysis Of Impact Of Nonstationary Climate On NOAA Atlas 14 Estimates : Assessment Report"

Objective 1: Assess the suitability of state-of-the-science methodologies for nonstationary precipitation frequency analysis.

Objective 2: Evaluate downscaled global projections' ability to mimic extreme precipitation at the temporal and spatial scales needed for the engineering application.



- Result of extensive, multi-year study conducted with Penn State University, University of Illinois Urbana-Champaign and University of Wisconsin-Madison
- Testing done for Atlas 14 Volume 10 project area (Northeastern States)
- Development of methodology conducted in coordination with, and funded by DOT FHWA

Bipartisan Infrastructure Law (BIL): First Direct Federal Funding

Bipartisan Infrastructure Law summary: *"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."*

"To support the design, development, and operation of our nation's built infrastructure, from new power plants to transportation systems, NOAA ***will update and revise precipitation frequency atlases for the United States that account for climate change***…"

For the first time, NOAA now will apply a nationwide update for precipitation frequency data – a long standing and highly sought need for the future of our nation's infrastructure

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The NOAA Atlas 15 Product

Volume 1: Based on historical gages and observed trends

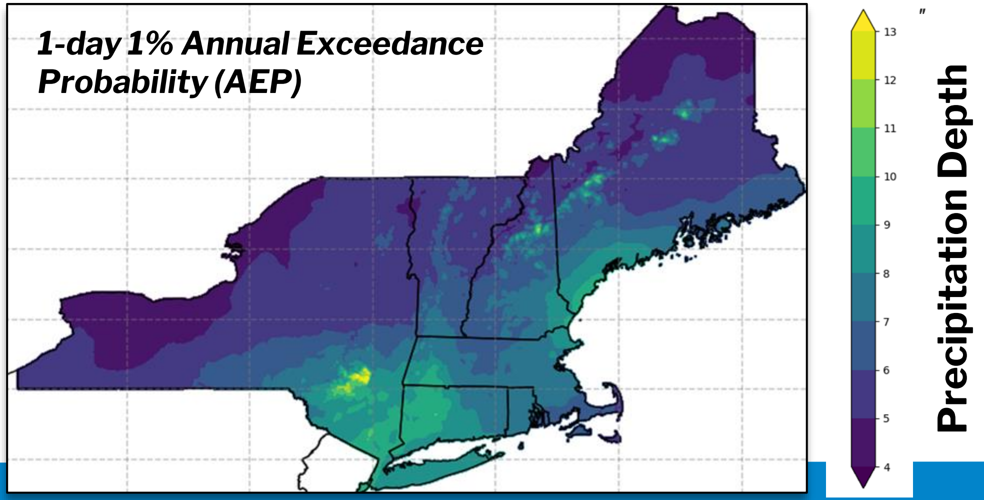
- First-ever, nationally-consistent, precip frequency data that serves as the basis for Volume 2
- Integrated terrain information
- Accounts for trends in historical observations (when it exists)
  - Non-stationary trends represents a major enhancement from Atlas 14

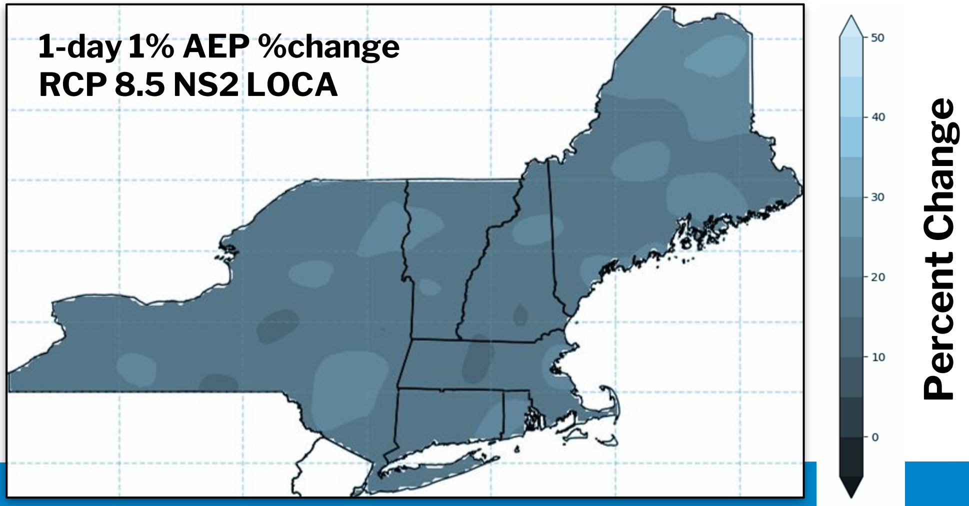
Volume 2: Incorporates climate projection adjustment factors

- 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

The NOAA Atlas 15 Road Map

2022/2023

- **Feb. - Aug. 2022** - Published methodology and briefed stakeholders
- **Sept. 2022** - Distributed Public Notification Statement (PNS) and collect public feedback.
- **Jan. 2023** - Hosted technical workshop with federal partners.
- **Apr. 2023** - Award contracts and grants and initiate product development.

2024

- **Development** - Evolve framework. Create Quality Controlled National Precipitation Database. Evaluate Climate Model Projections
- **Pilot** - Deliver Atlas 15 Vol. 1 and Vol. 2 pilot over Montana.

  Collect and adjudicate feedback on preliminary estimates and Web dissemination strategies.

2025

- **CONUS -** Publish provisional data
- **CONUS** - Initiate 60-day peer review for Atlas 15 Vol. 1 and Vol. 2 for CONUS (lower 48 states).

  Collect feedback and adjudicate comments on product.

2026

- **CONUS** - Complete Atlas 15 Vol. 1 and Vol. 2 and deliver estimates, documentation and supplementary products to stakeholders.
- **oCONUS** - Initiate peer review for oCONUS (e.g. Hawaii, Alaska, Puerto Rico, U.S. Virgin Islands, Guam).

  Collect feedback and adjudicate comments on product.

2027

- **oCONUS** - Complete Atlas 15 Vol. 1 and Vol. 2 and deliver estimates, documentation and supplementary products to stakeholders.

Summary

- NOAA is recognized by the engineering and floodplain management communities as **the authoritative** source of precipitation frequency data, and we have a long history of generating these data that serve as the foundation for **built infrastructure nationwide**
- The generation of authoritative precipitation frequency information **requires a rigorous development process and extensive quality control with significant stakeholder interaction**
- To account for a changing climate, NOAA, in coordination with FHWA and the academic community, **developed a new methodology for Atlas 15 that has undergone broad review** by stakeholders and Federal partners over the past year
    - **Atlas 15 Volume 1 is an essential first-step** to develop Atlas 15 Volume 2
- **BIL Provision 3 resources represent the first direct Federal funding** for precipitation frequency development and will support the generation of Atlas 14/15 data
- **Atlas 14 Volumes 12 and 13 are currently under development, and the Atlas 15 data will begin this fiscal year**

Questions?

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Regional Climate Services Director- Eastern Region
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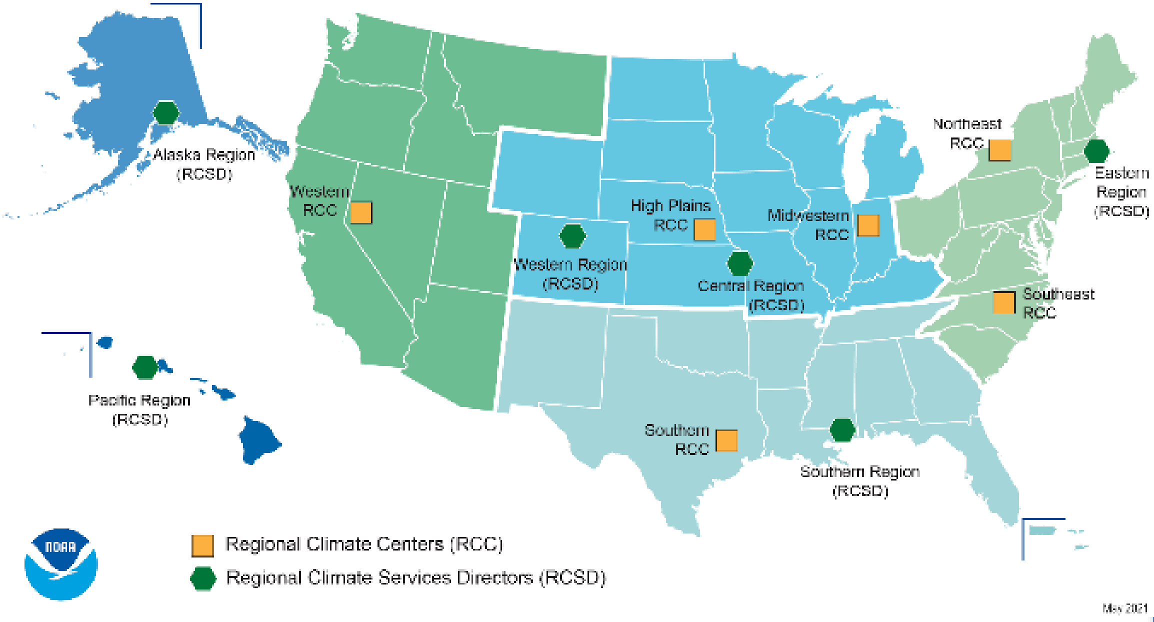
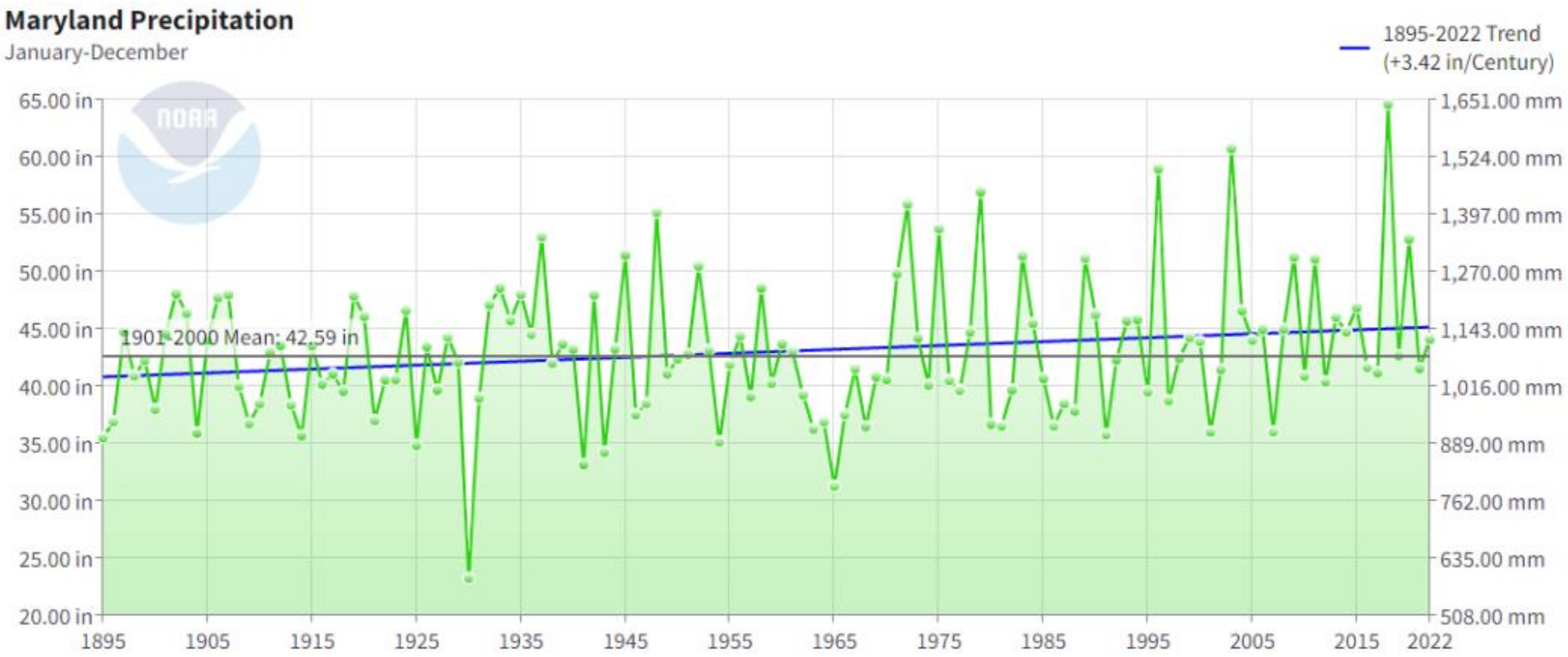
https://www.ncei.noaa.gov/regional/regional-climate-services-directors/eastern

September 5, 2023
Webinar: “Planning for and Managing the Impacts of Changing Precipitation Patterns on Wastewater and Stormwater Systems”
Syracuse U and UMaryland



Precipitation Trends

Maryland



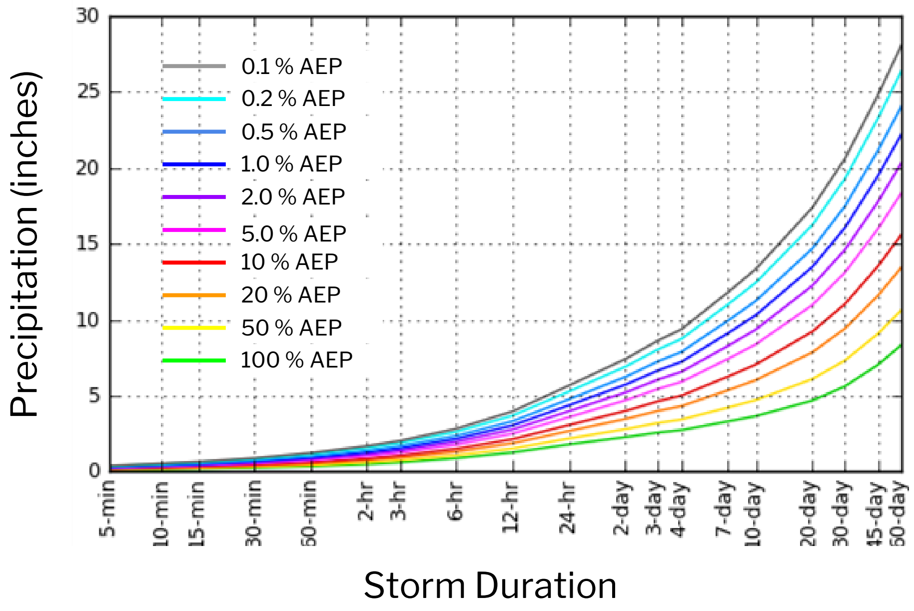
https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/

What are Precipitation Frequency Estimates?

- Precipitation amounts for a specified storm duration and an annual exceedance probability (or average annual recurrence interval).

- Precipitation **D**epth (or **I**ntensity) for a specified **D**uration and **F**requency (ARI or AEP).

DDF/IDF Curve for Specfied Location



Depth-**D**uration-**F**requency (DDF) curves

Intensity-**D**uration-**F**requency (IDF) curves

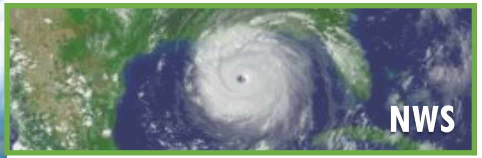
How much precipitation would be expected for a storm event that is 10 days in duration and has a 1% chance of being observed?

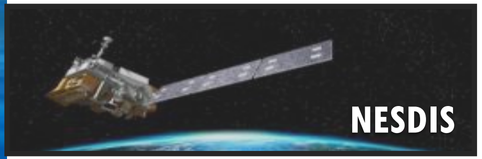
How rare is it to observe 5 inches of precipitation over 2 days?

22

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.





Extreme Rainfall Statistics Past, Present and Future

Art DeGaetano
Northeast Regional Climate Center
Cornell University

Cast

Coiln Evans – Cornell
Chris Castellano –Cornell
Harrison Tran – Cornell
Ben Eck – Cornell
Adrien Zheng – Cornell

Tania Lopez Cantu – CMU
Costa Samaras – CMU
Marissa Webber – CMU

Michelle Miro – Rand
Dave Robinson - Rutgers

Credits

Chesapeake Bay Trust
Virginia Transportation Research Council (VTRC)
The Commonwealth Center for Recurrent Flooding Resiliency (CCRFR)
State of New Jersey
Delaware River Basin Commission
NYS Energy Research and Development Authority (NYSERDA)

NOAA

Cornell University

NRCC

The Washington Post

Democracy Dies in Darkness

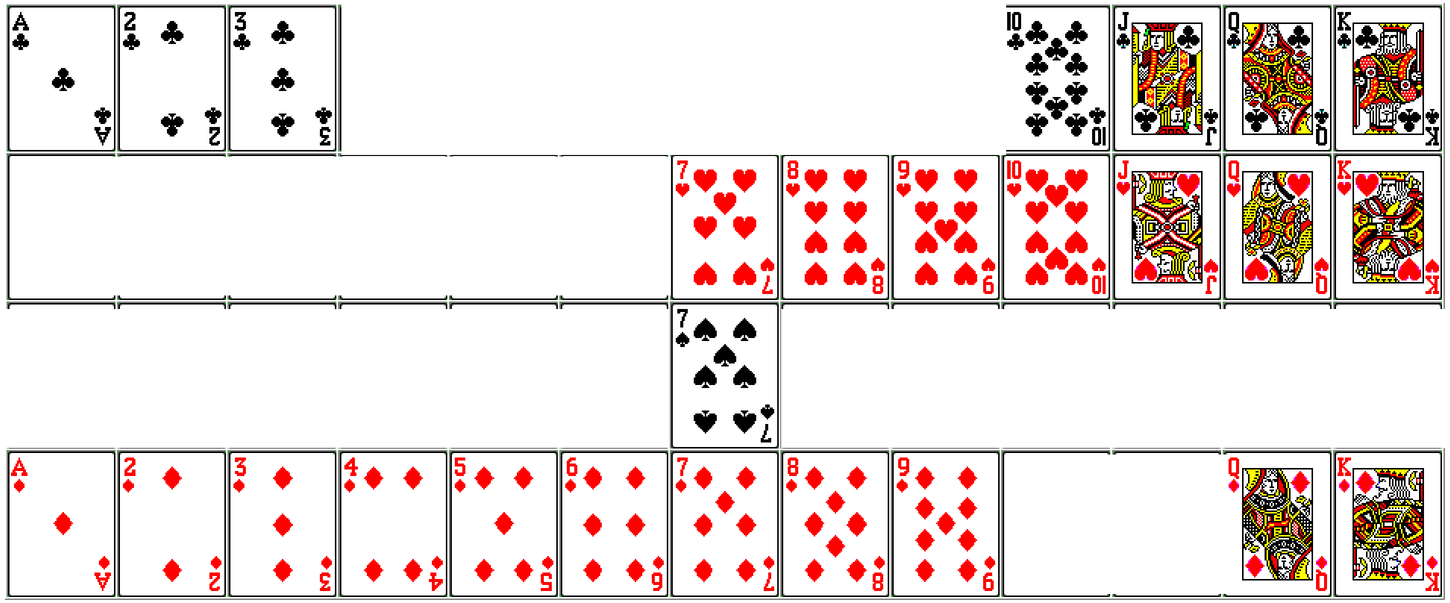
Climate and Environment

As rainstorms grow more severe and frequent, communities fail to prepare for risks

Lack of a current, national rainfall database means some states use 60-year-old statistics as they design roads, bridges and dams that are supposed to last 50 years

People walk through flood water near Interstate 10 in Houston after Hurricane Harvey hit Texas in August 2017. (Jabin Botsford/The Washington Post)

Estimating Current Rainfall Extremes is like…..



Estimating the probabilities of poker hands
Without knowing the values and suits of all the cards!

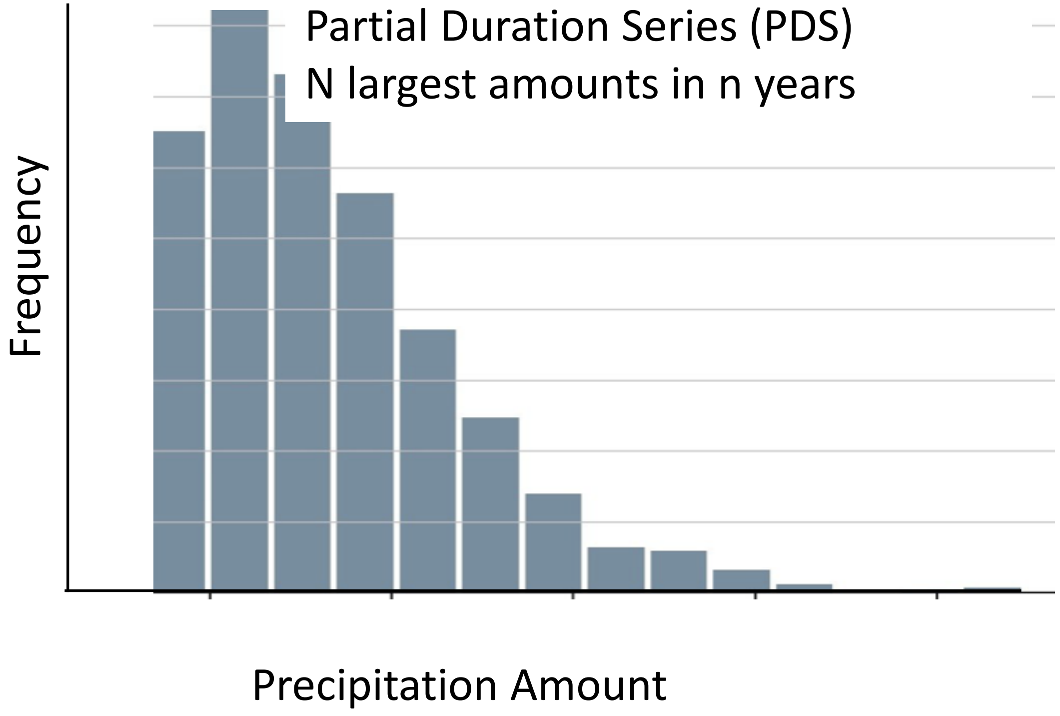
Partial Duration Series

Boston Logan Internation Airport (#190770) – 1936-2008 (72 complete years)						
7.06"	3.84"	3.11"	2.81"	2.64"	2.52"	2.42"
6.11"	3.77"	3.00"	2.80"	2.64"	2.52"	2.40"
5.69"	3.58"	2.98"	2.77"	2.63"	2.50"	2.40"
5.63"	3.51"	2.95"	2.77"	2.60"	2.50"	2.40"
4.88"	3.49"	2.94"	2.76"	2.59"	2.49"	2.39"
4.71"	3.36"	2.91"	2.76"	2.59"	2.49"	2.38"
4.47"	3.34"	2.90"	2.71"	2.58"	2.47"	
4.29"	3.32"	2.89"	2.67"	2.55"	2.46"	
4.21"	3.31"	2.89"	2.66"	2.54"	2.46"	
4.12"	3.16"	2.87"	2.64"	2.54"	2.46"	
4.00"	3.15"	2.82"	2.64"	2.53"	2.42"	

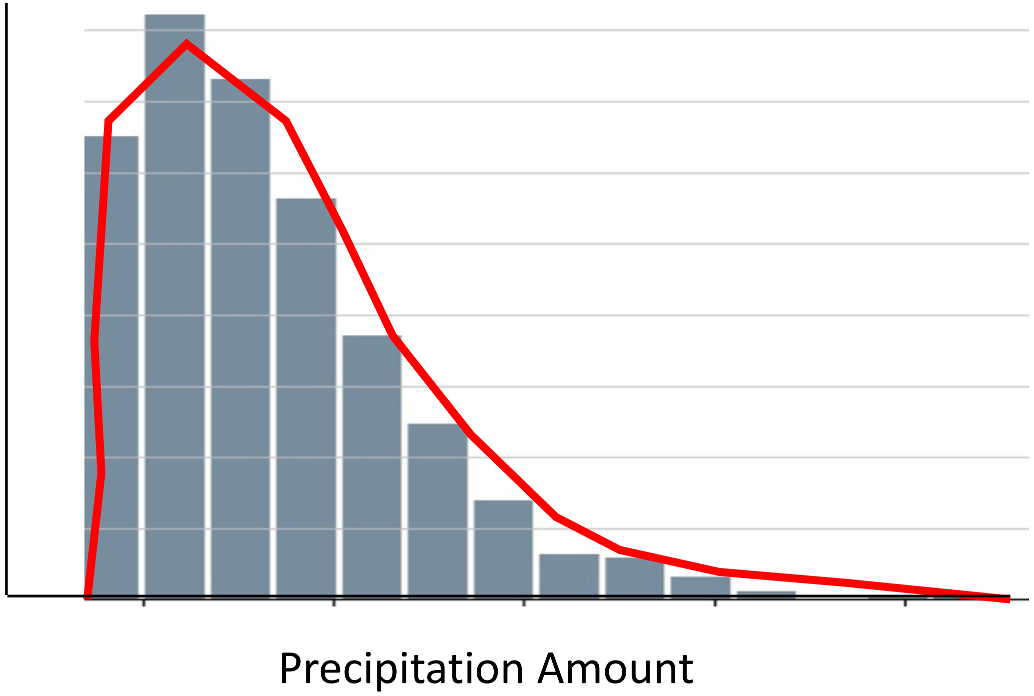
Atlas 14: The estimates are based on the analysis of annual maximum series and then converted to partial duration series results.

Methods: Partial Duration Series Fit

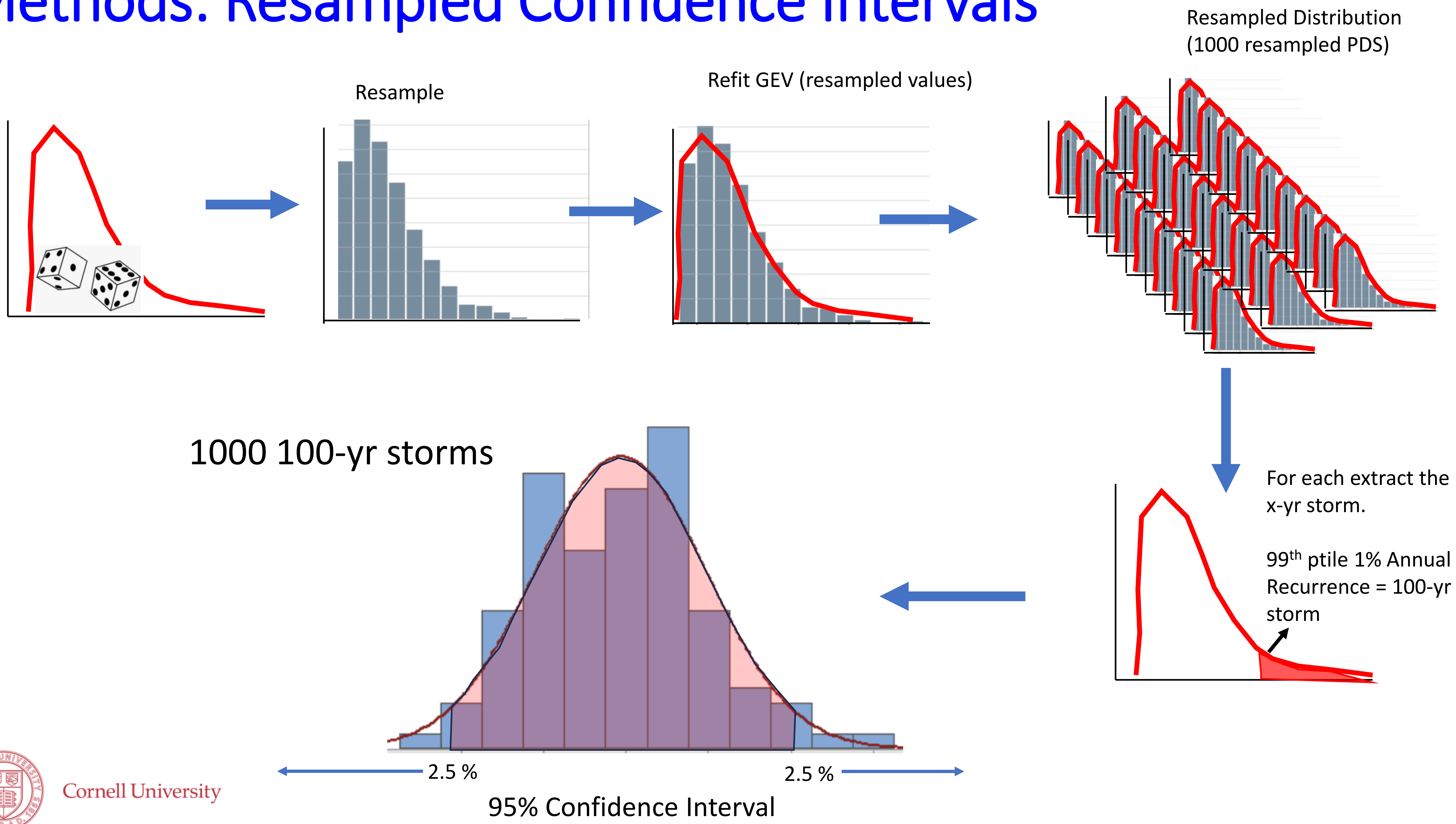
Sample (obs)



Fit GEV (obs)



Methods: Resampled Confidence Intervals



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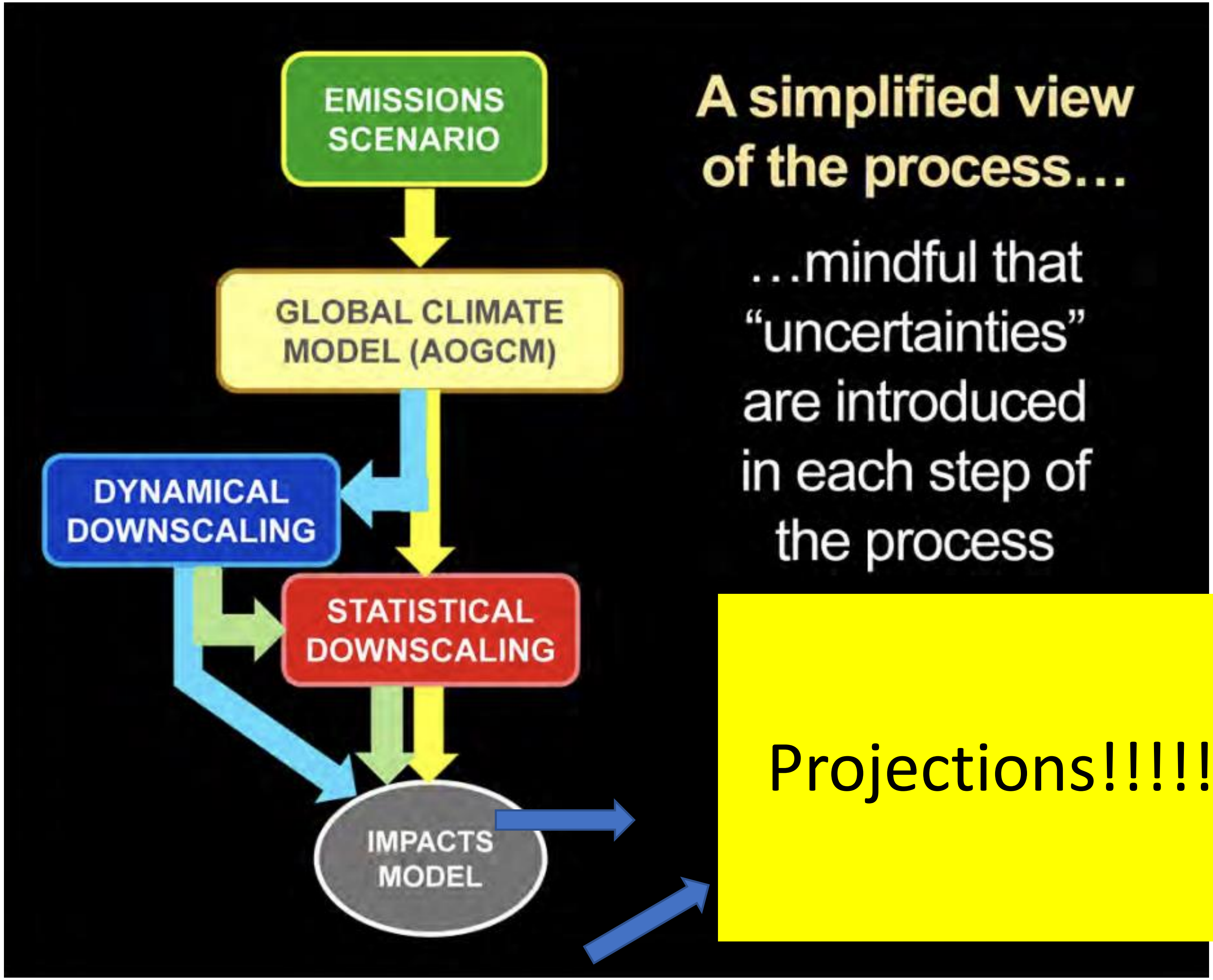
How will Design Storms Change in the Future?

2020

1950-2020 PDS

2070

1950-2020 PDS?



Projections!!!!!

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Methods (per model and grid point)

Extract 50-yr PDS:

- 1950-1999 (model hist)
- 2020-2069
- 2050-2099

Fit GEV to PDS to obtain ARIs:

- single grid
- regional (20 grids)

Compute Change Factor CF_{ARI}:

$$\frac{ARI\ Future}{ARI\ Historical}$$

For each LOCA grid (31 x 1000) CF_{ARI} values
For each CORDEX grid (16 x 1000) CF_{ARI} values

Interpolate to common 0.1° grid
Compute median and percentiles

Resample (1000 x):

- select PDS from original future fit GEV
- fit new GEV and obtain ARI
- compute

$$\frac{ARI\ Future\ (resampled)}{ARI\ Historical}$$

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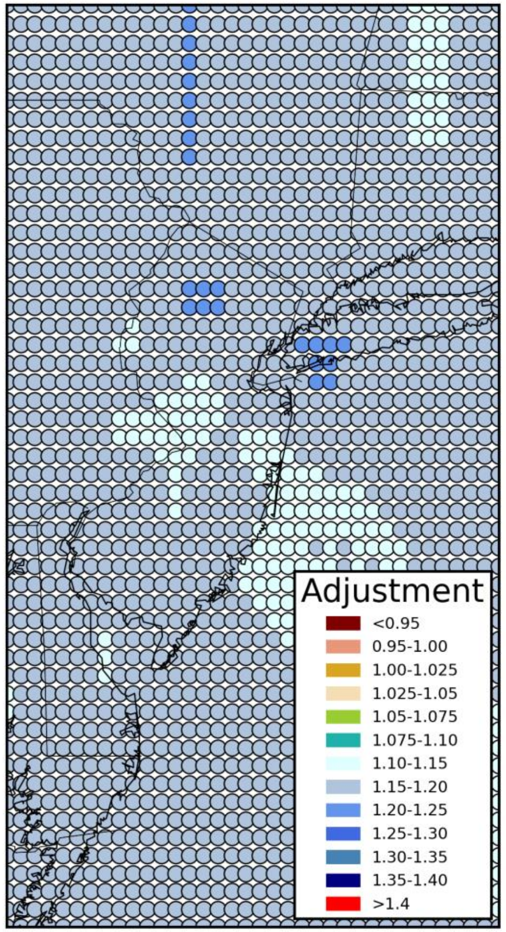
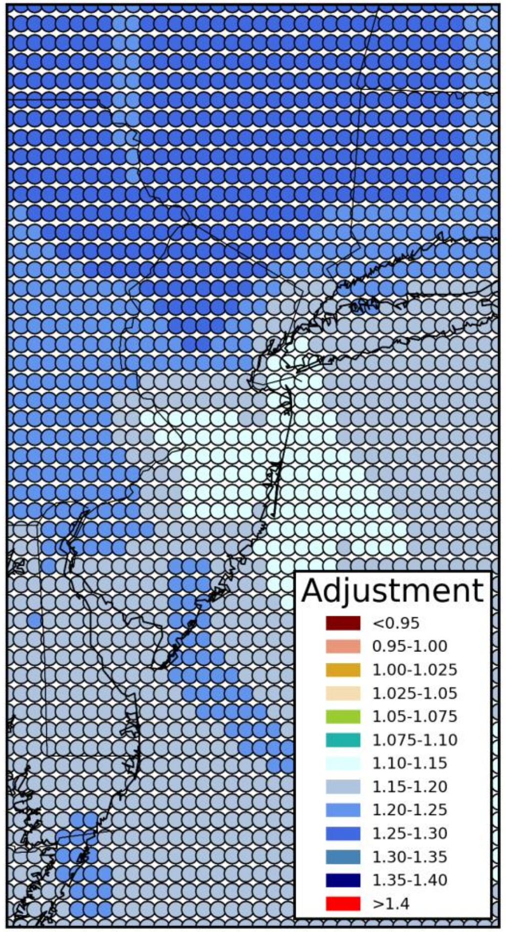
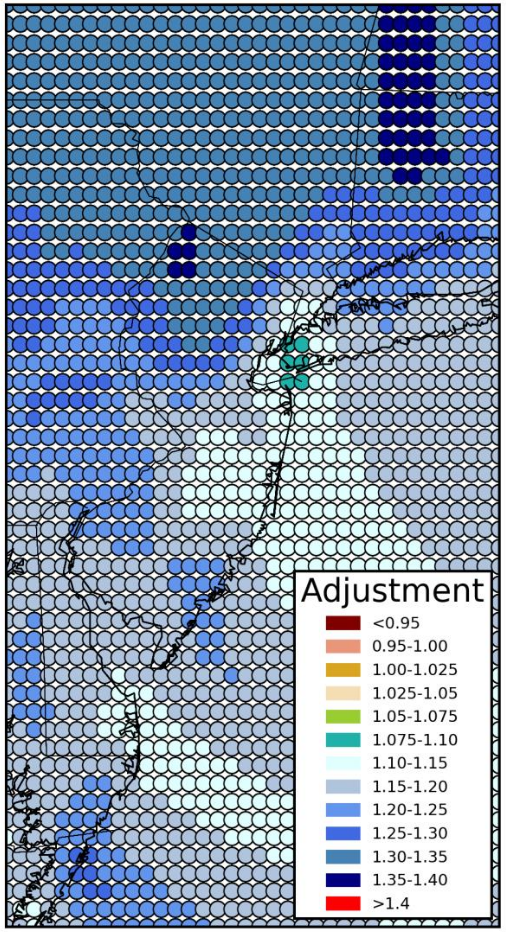
Ensemble Median Change Factor (RCP8.5 2050-2099)



2-yr



25-yr



100-yr

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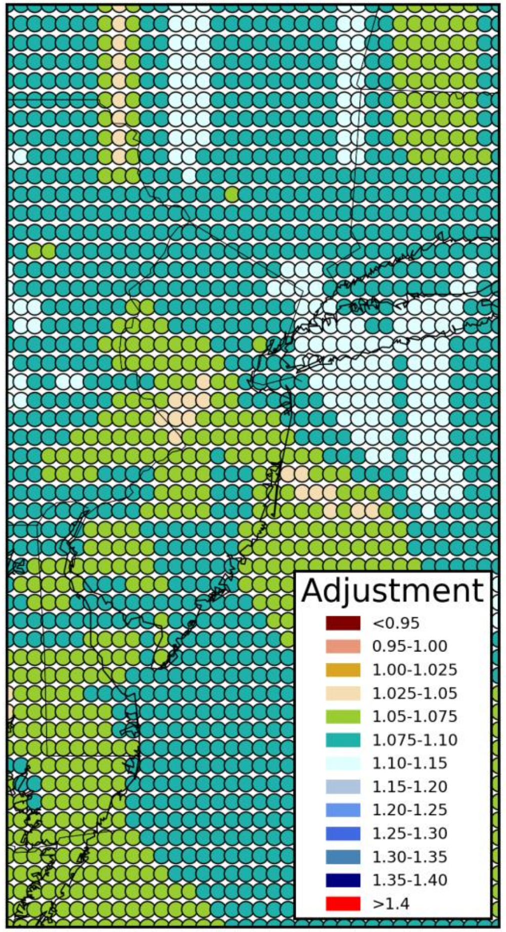
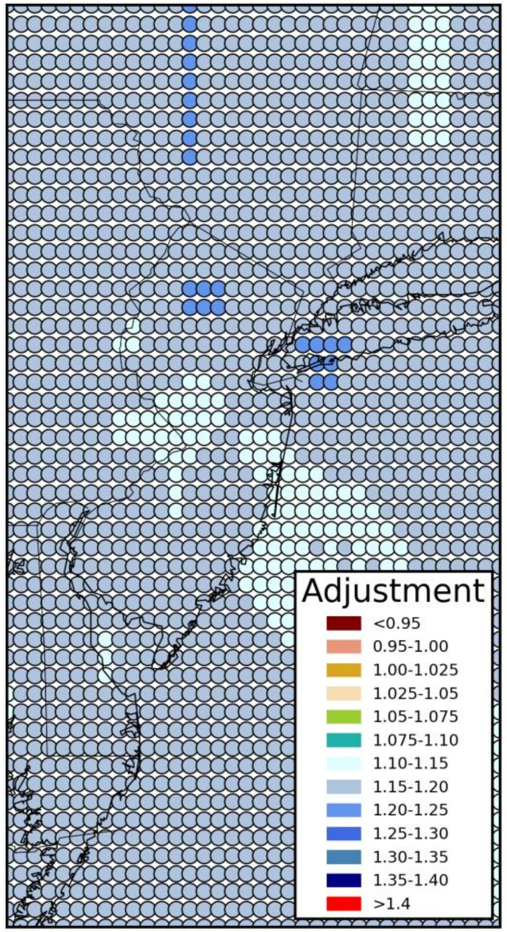
Ensemble Change Factor 17^{th}-83^{rd} percentile range

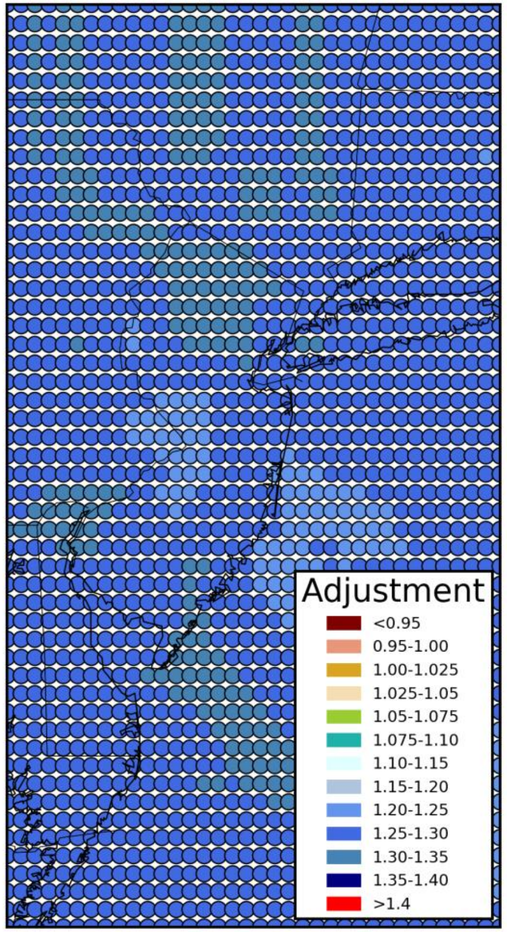
2-year ARI



17th



median



83rd

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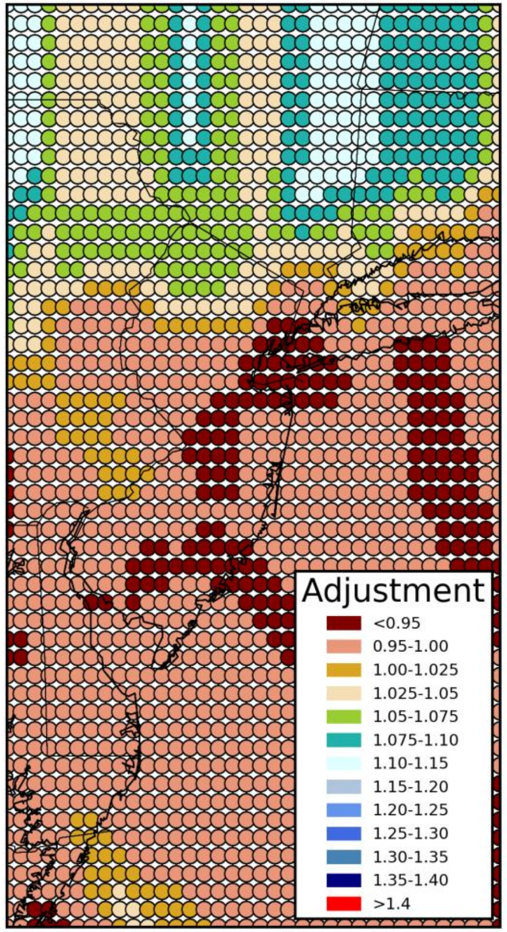
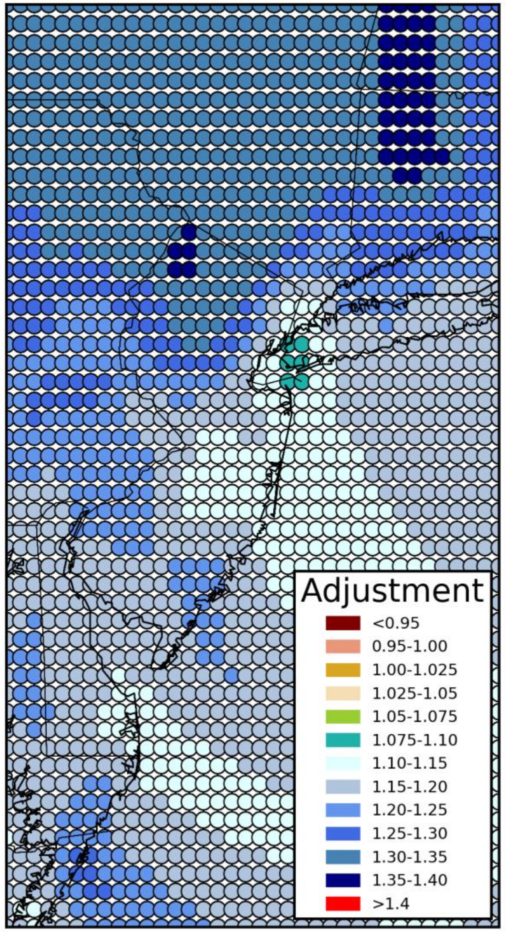
Ensemble Change Factor 17th-83rd percentile range

100-year ARI

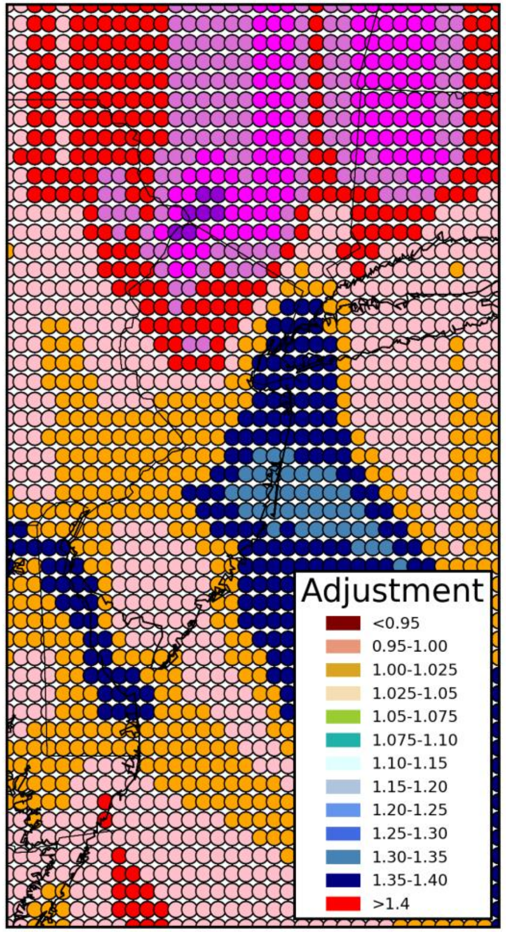
Orange 1.40-1.45
Pink 1.45-1.5
Red 1.5-1.55



17th



median



83rd

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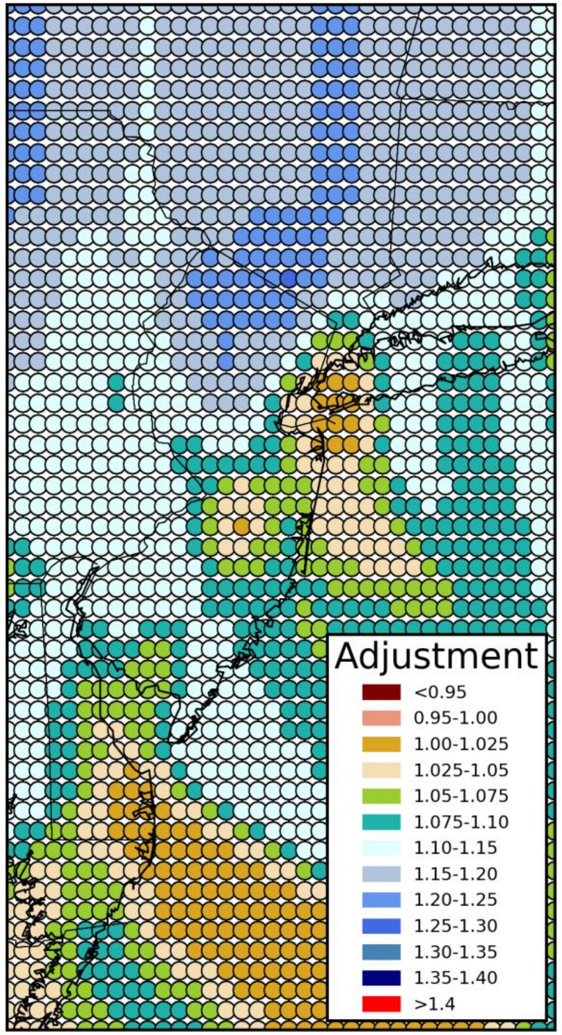
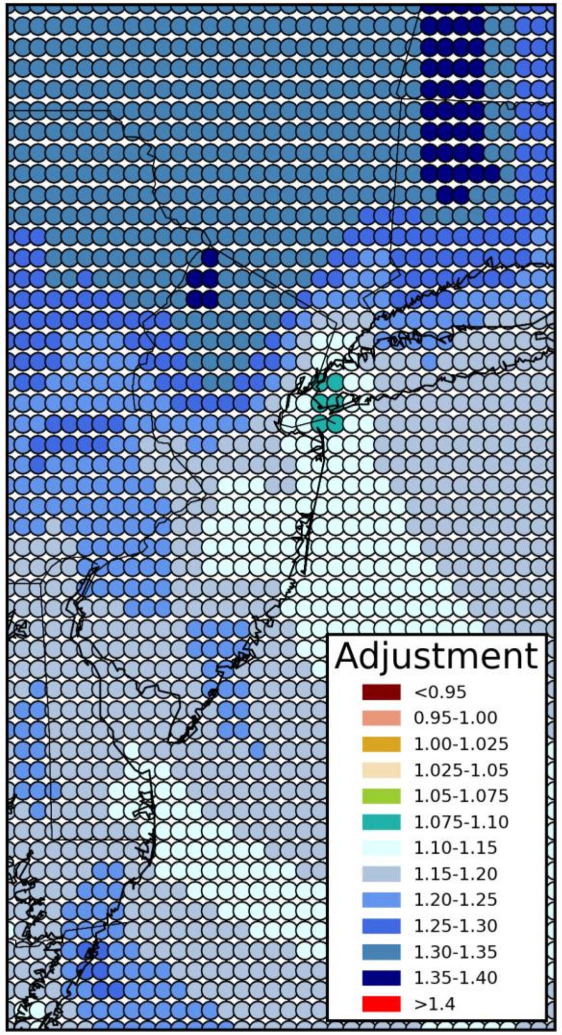
Median Ensemble Change Factors RCP 4.5 vs RCP 8.5

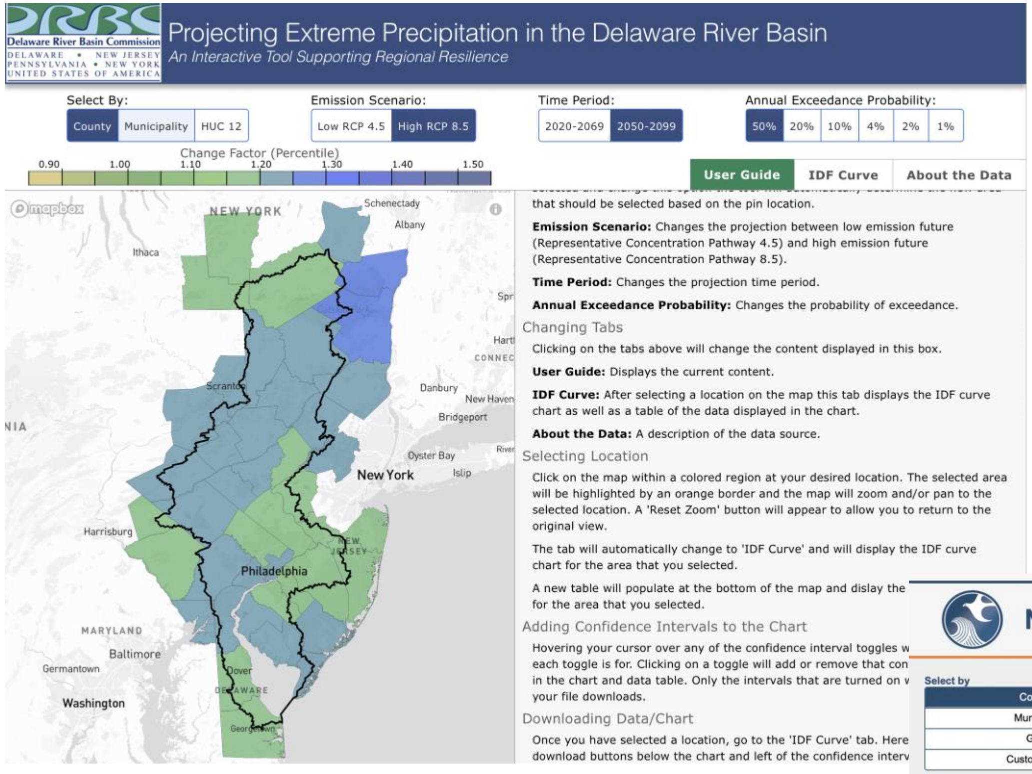
100-yr RCP 4.5. 2050-2099

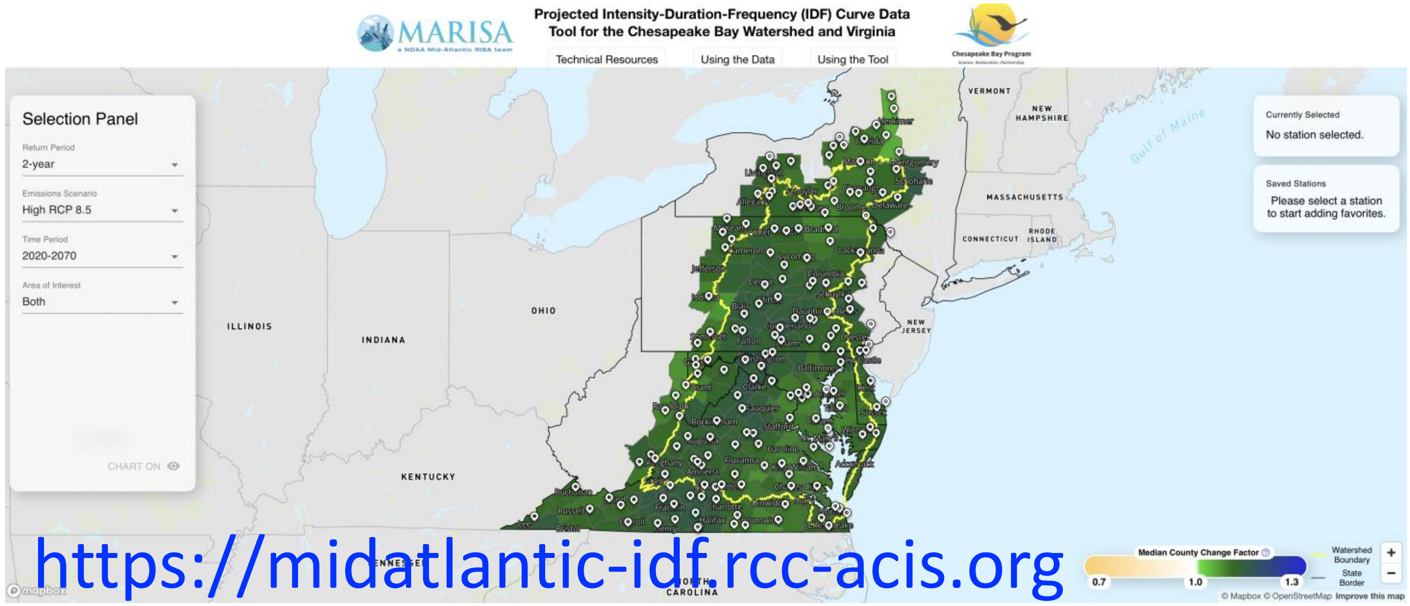


100-yr RCP 8.5. 2050-2099

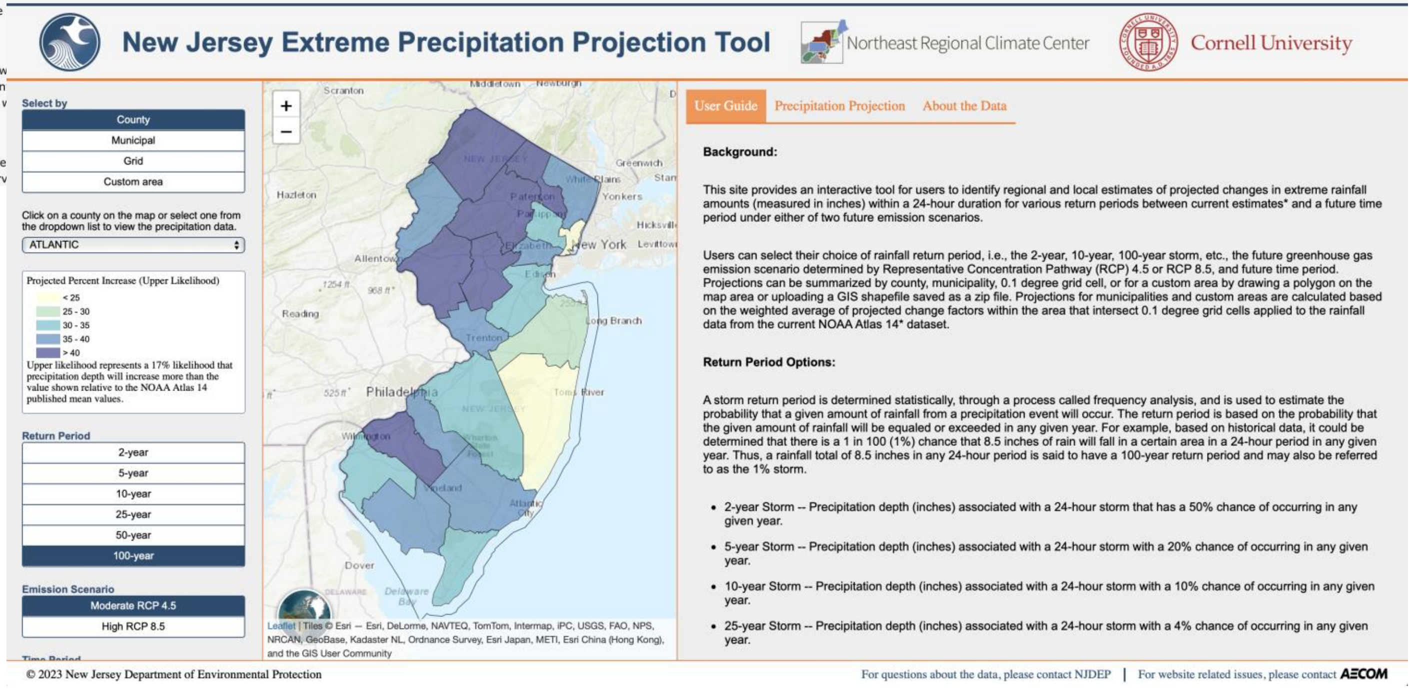


Final Products





https://midatlantic-idf.rcc-acis.org



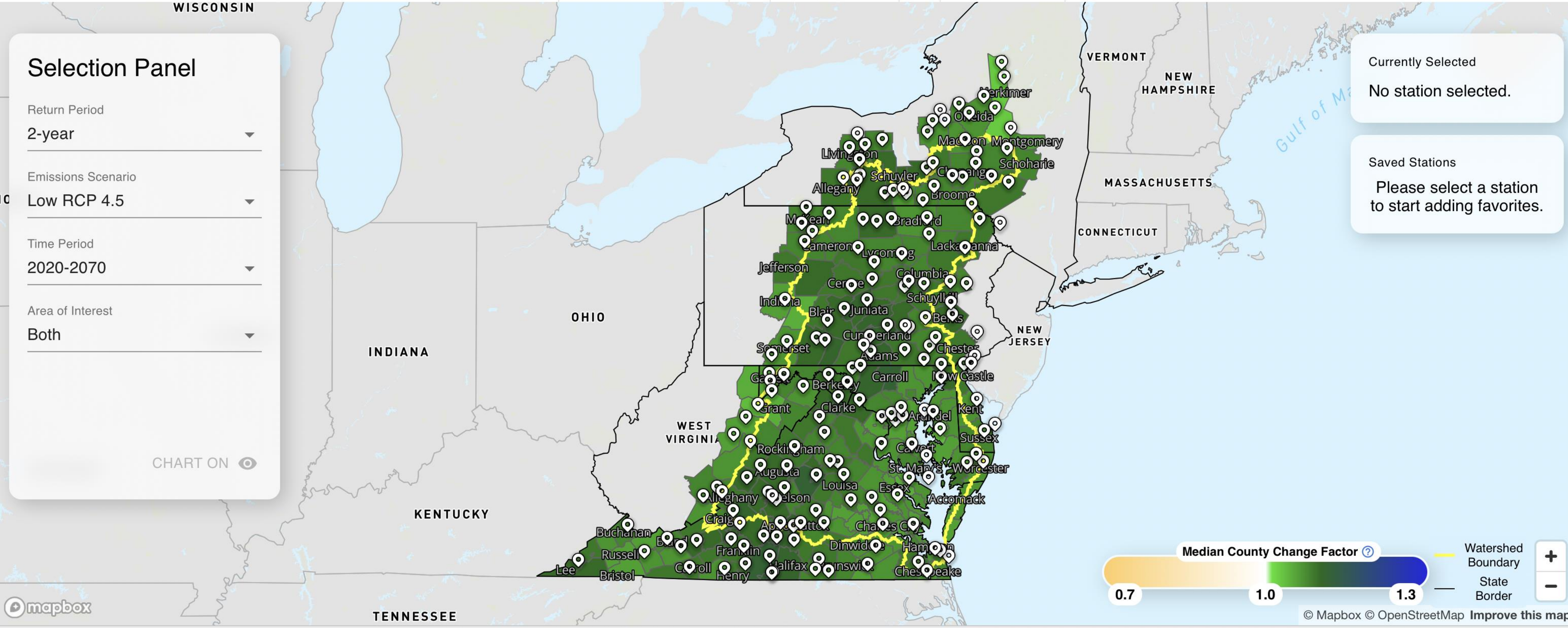
https://njprojectedprecipitationchanges.com

Projected Intensity-Duration-Frequency (IDF) Curve Data Tool for the Chesapeake Bay Watershed and Virginia

MARISA — a NOAA Mid-Atlantic RISA team

Chesapeake Bay Program — Science. Restoration. Partnership.

Technical Resources | Using the Data | Using the Tool



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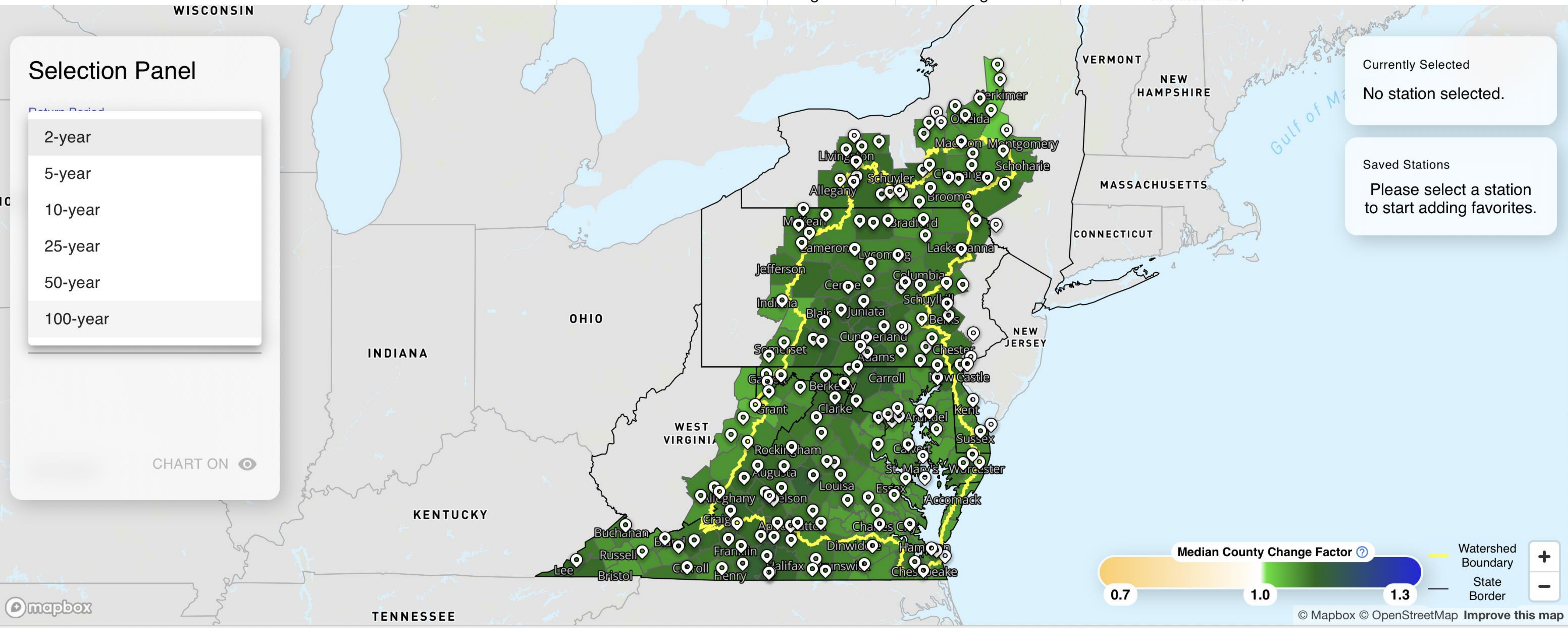

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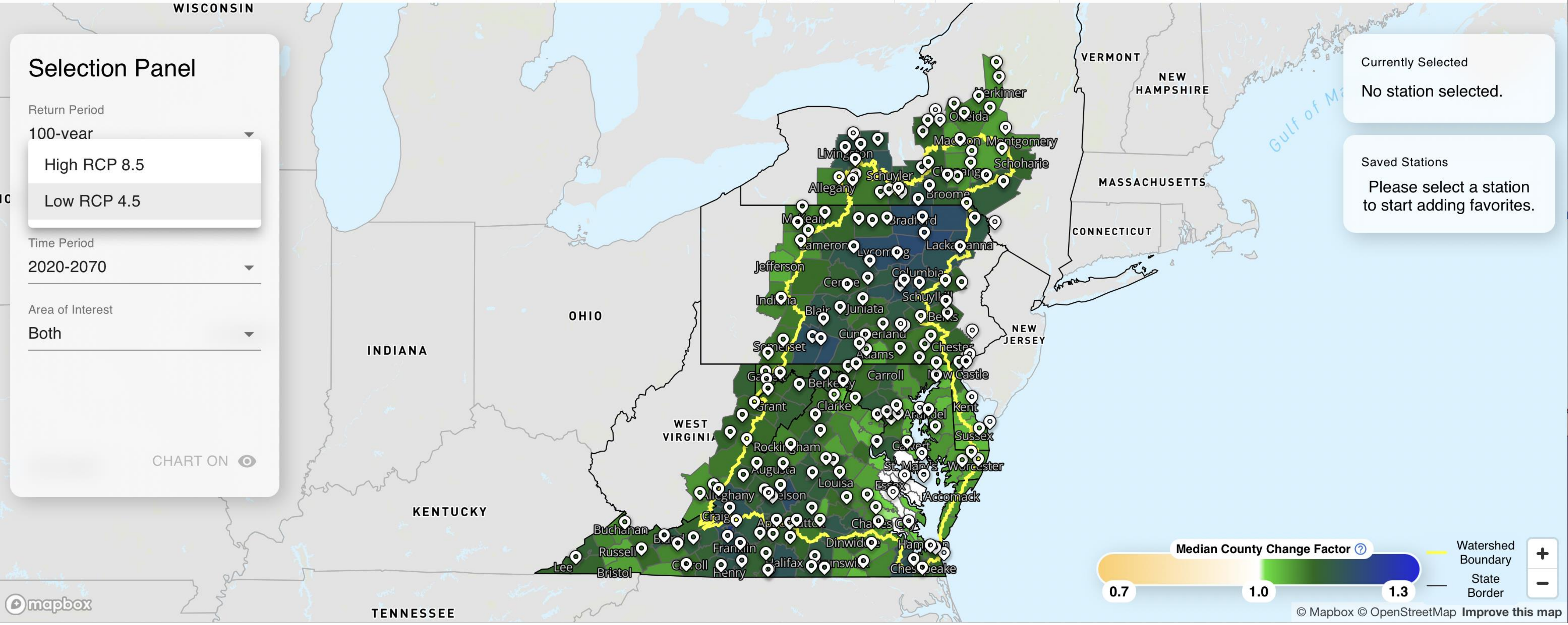

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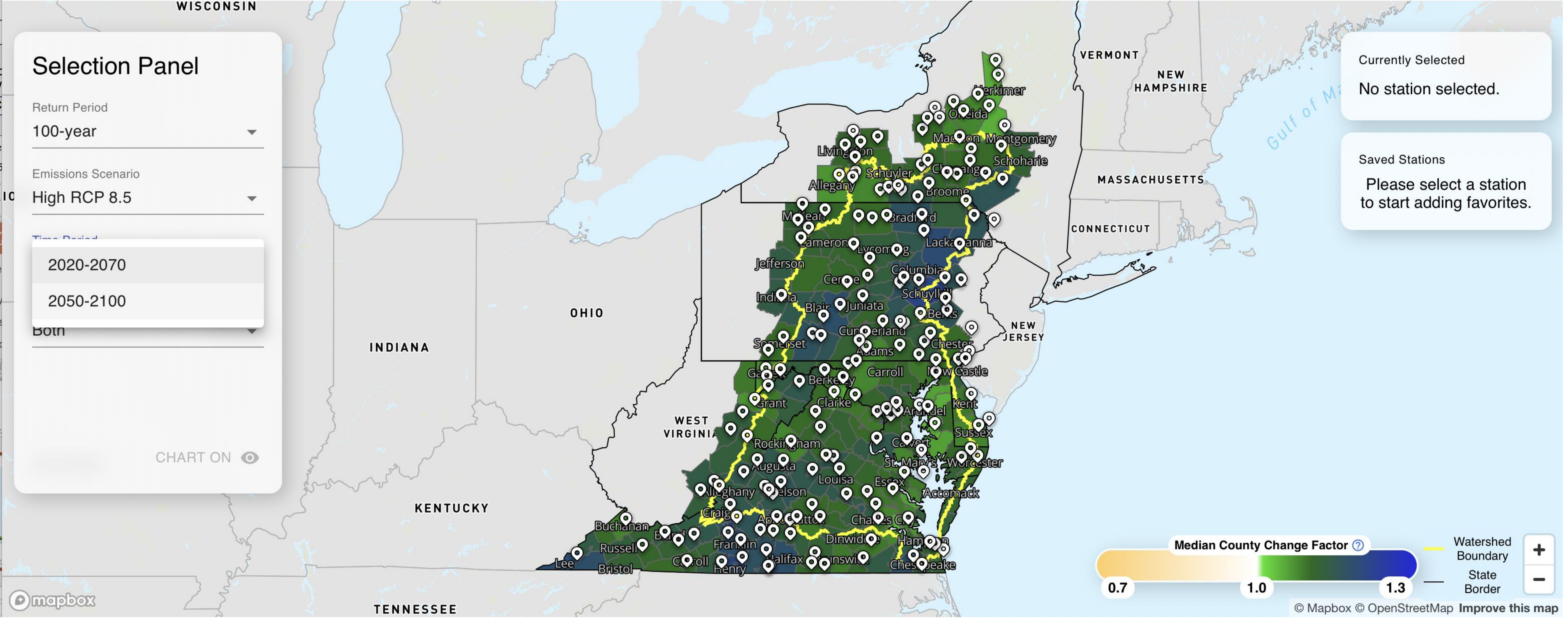

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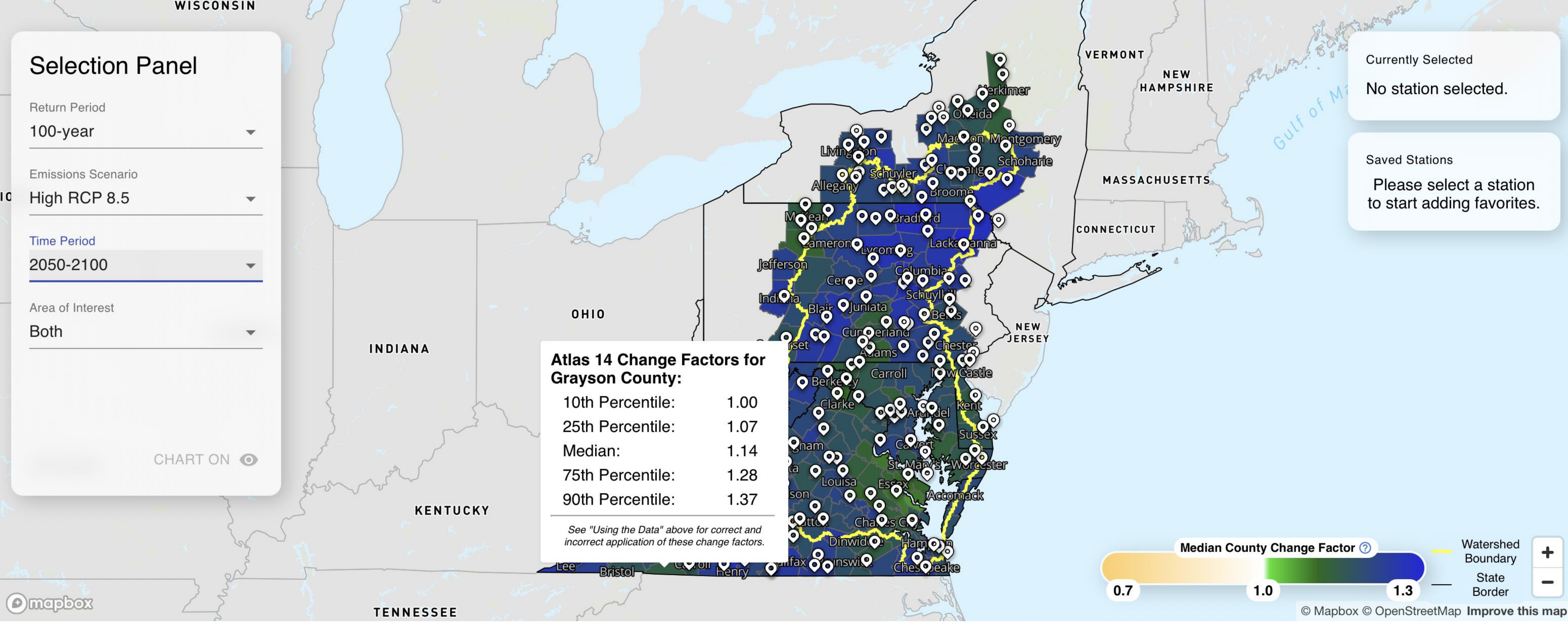

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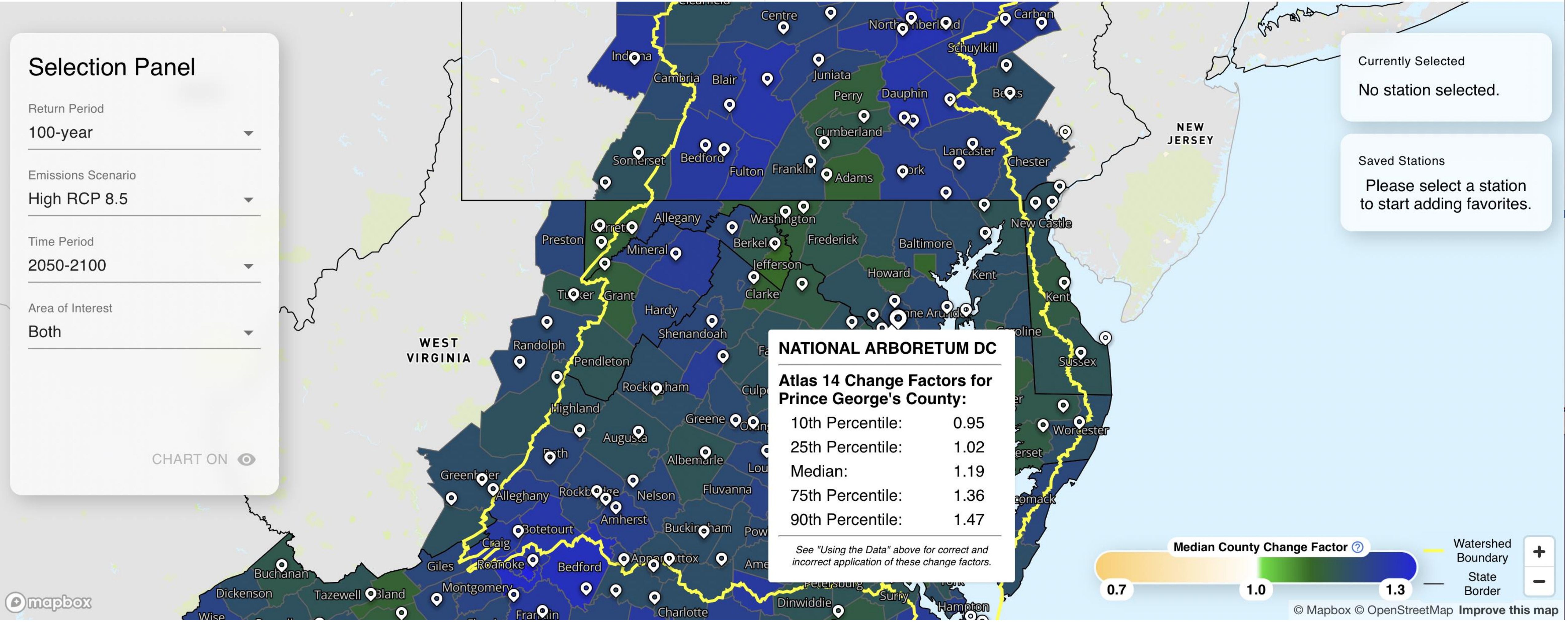

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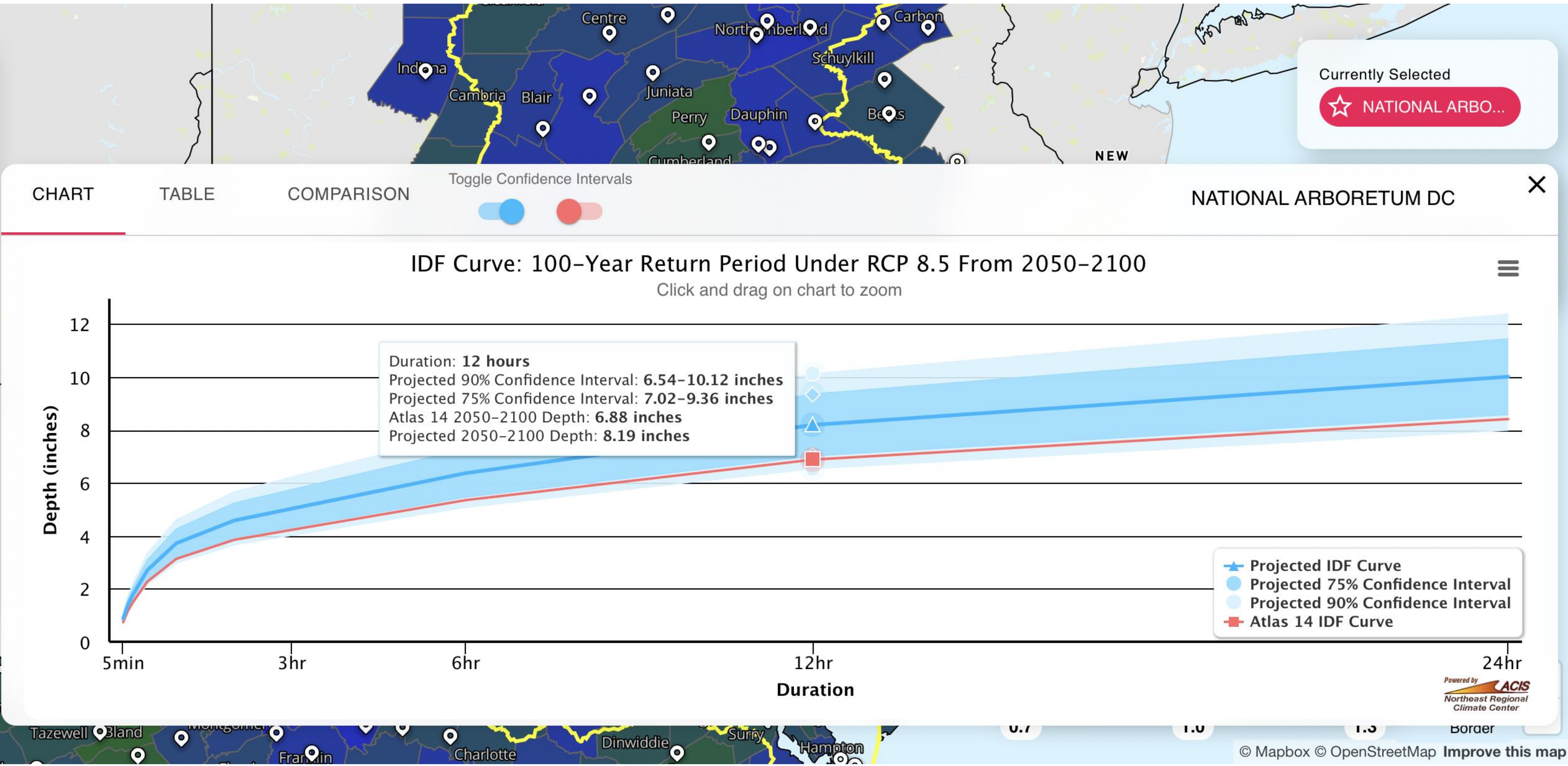

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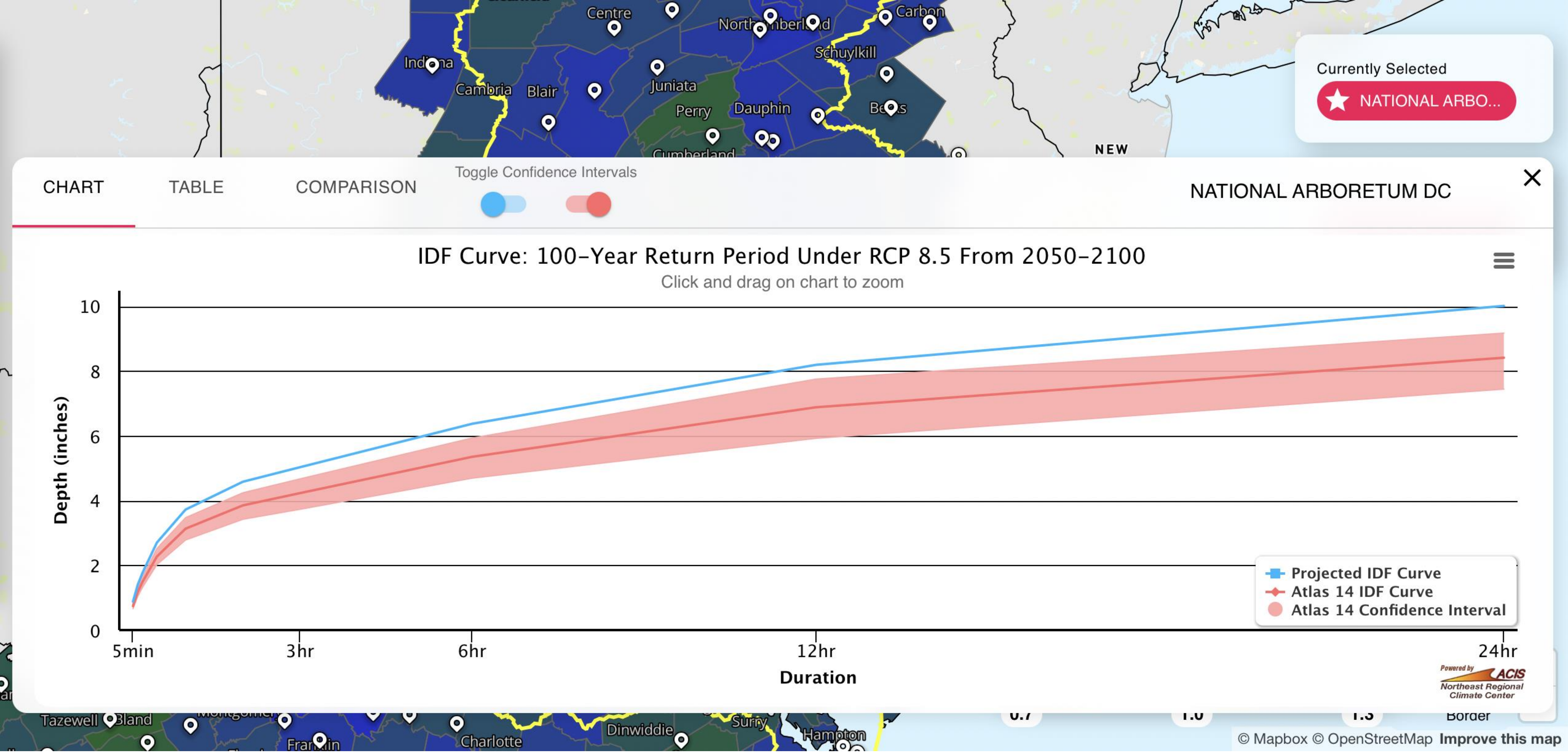

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Currently Selected

NATIONAL ARBO...

CHART | TABLE | COMPARISON | DOWNLOAD CSV

NATIONAL ARBORETUM DC

Percentile	10th	25th	Median	75th	90th	
County Change Factors:	0.95	1.02	1.19	1.36	1.471	Atlas 14 Depth (inches)
Duration	Projected 2050-2100 Depth (inches)					
5 min	0.70	0.75	0.88	1.01	1.09	0.74
10 min	1.12	1.20	1.40	1.60	1.74	1.18
15 min	1.42	1.52	1.77	2.03	2.19	1.49
30 min	2.16	2.32	2.70	3.09	3.34	2.27
60 min	2.97	3.19	3.72	4.26	4.60	3.13

Currently Selected

NATIONAL ARBO...

CHART TABLE COMPARISON

NATIONAL ARBORETUM DC

Duration	Atlas 14 Depth (inches)	Projected 2050-2100 Depth (inches)	Change (inches)
5 min	0.74	0.88	+0.14
10 min	1.18	1.40	+0.22
15 min	1.49	1.77	+0.28
30 min	2.27	2.70	+0.43
60 min	3.13	3.72	+0.59
2 hr	3.85	4.58	+0.73

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Currently Selected

WASHINGTON RE...

CHART TABLE **COMPARISON**

WASHINGTON REAGAN NATIONAL AIRPORT

Duration	Atlas 14 Depth (inches)	Projected 2050-2100 Depth (inches)	Change (inches)
5 min	0.75	0.86	+0.11
10 min	1.2	1.38	+0.18
15 min	1.51	1.74	+0.23
30 min	2.32	2.67	+0.35
60 min	3.2	3.68	+0.48
2 hr	3.86	4.44	+0.58

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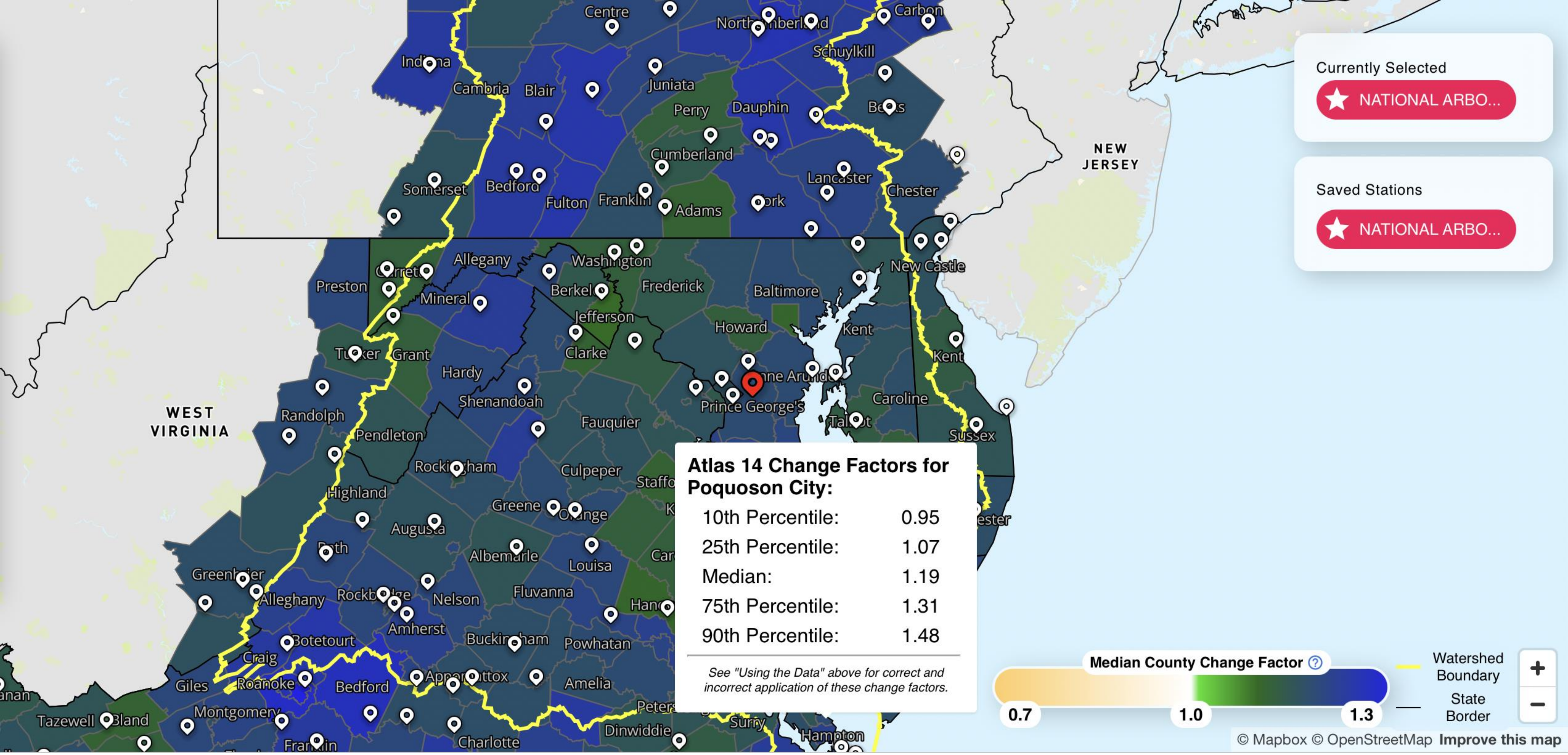

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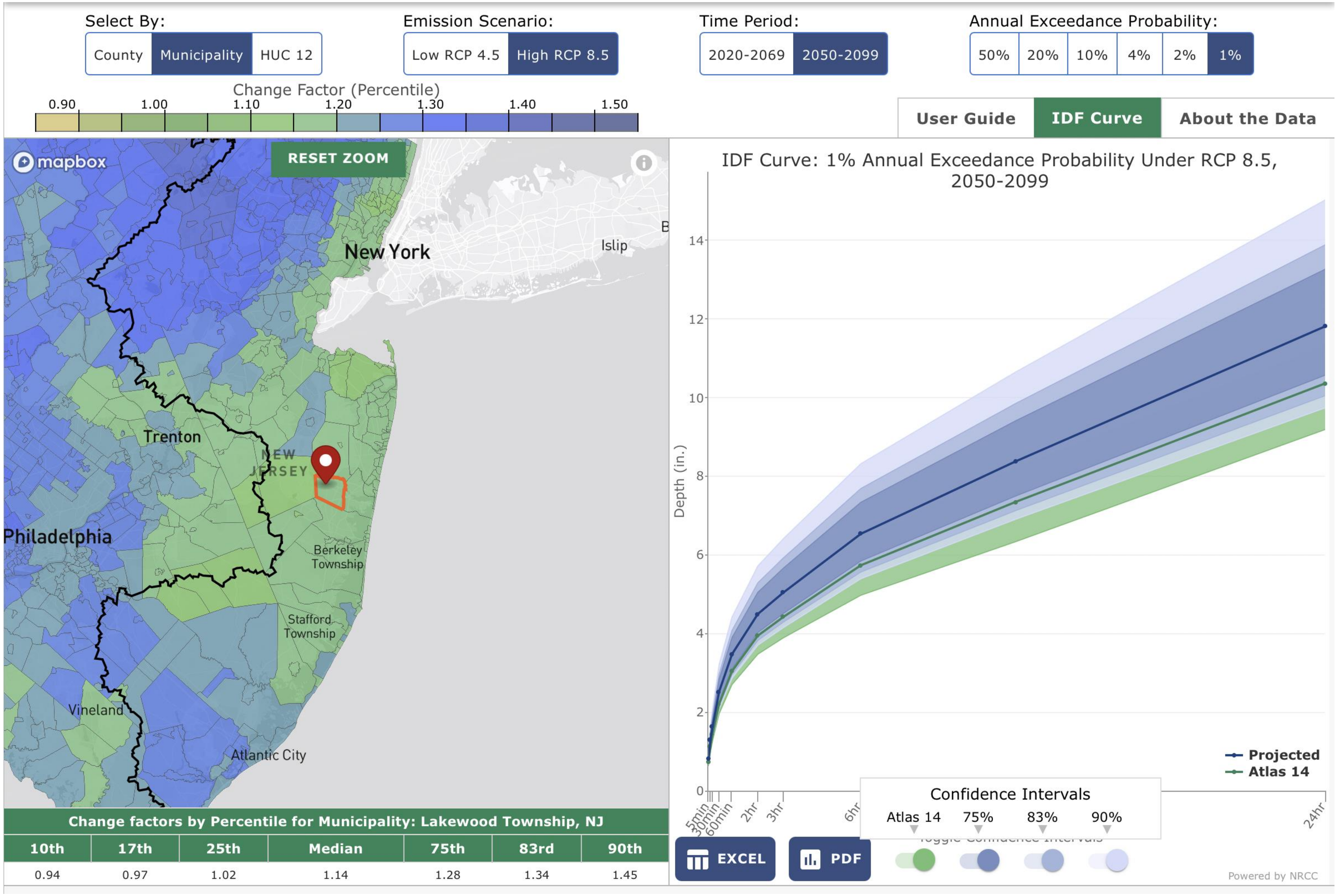
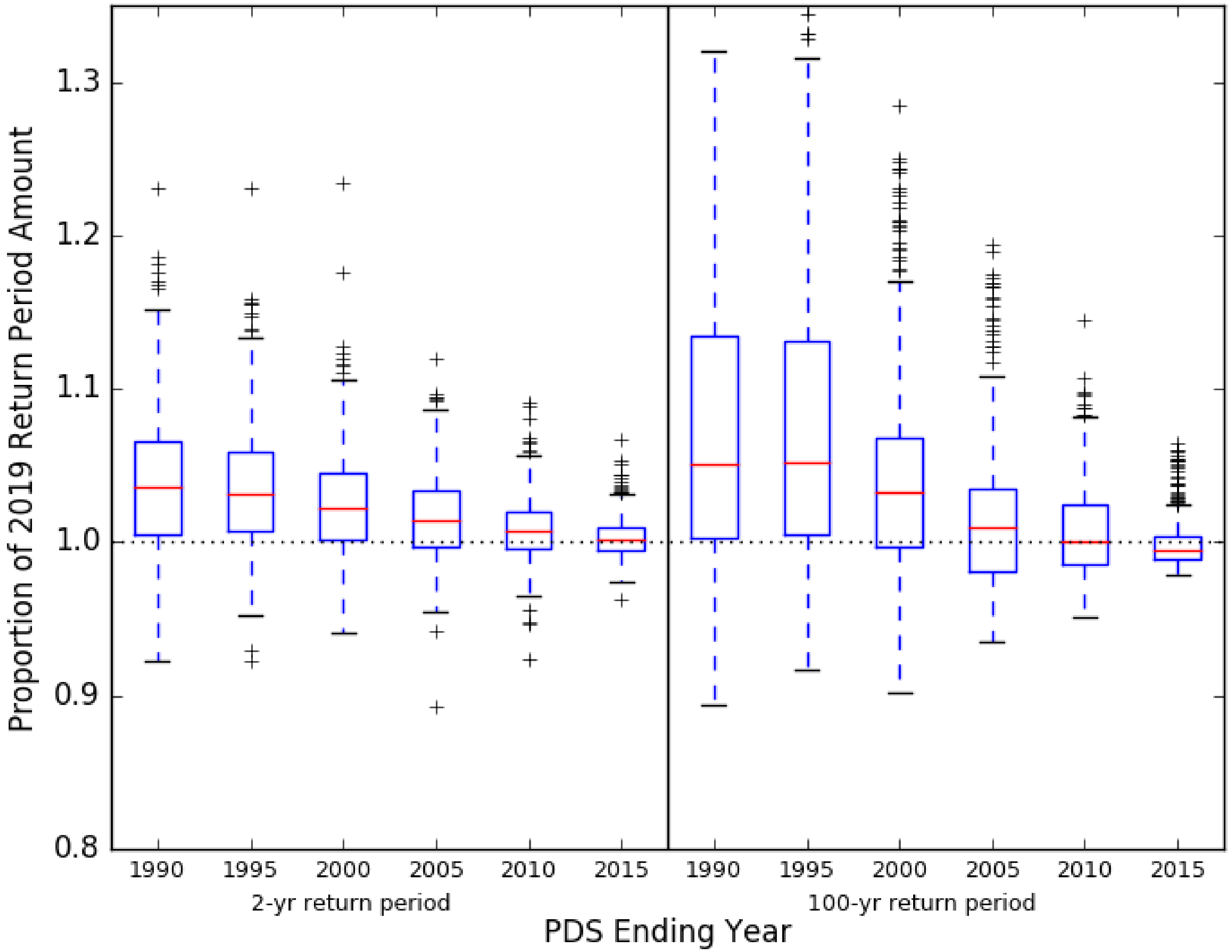
Final Product

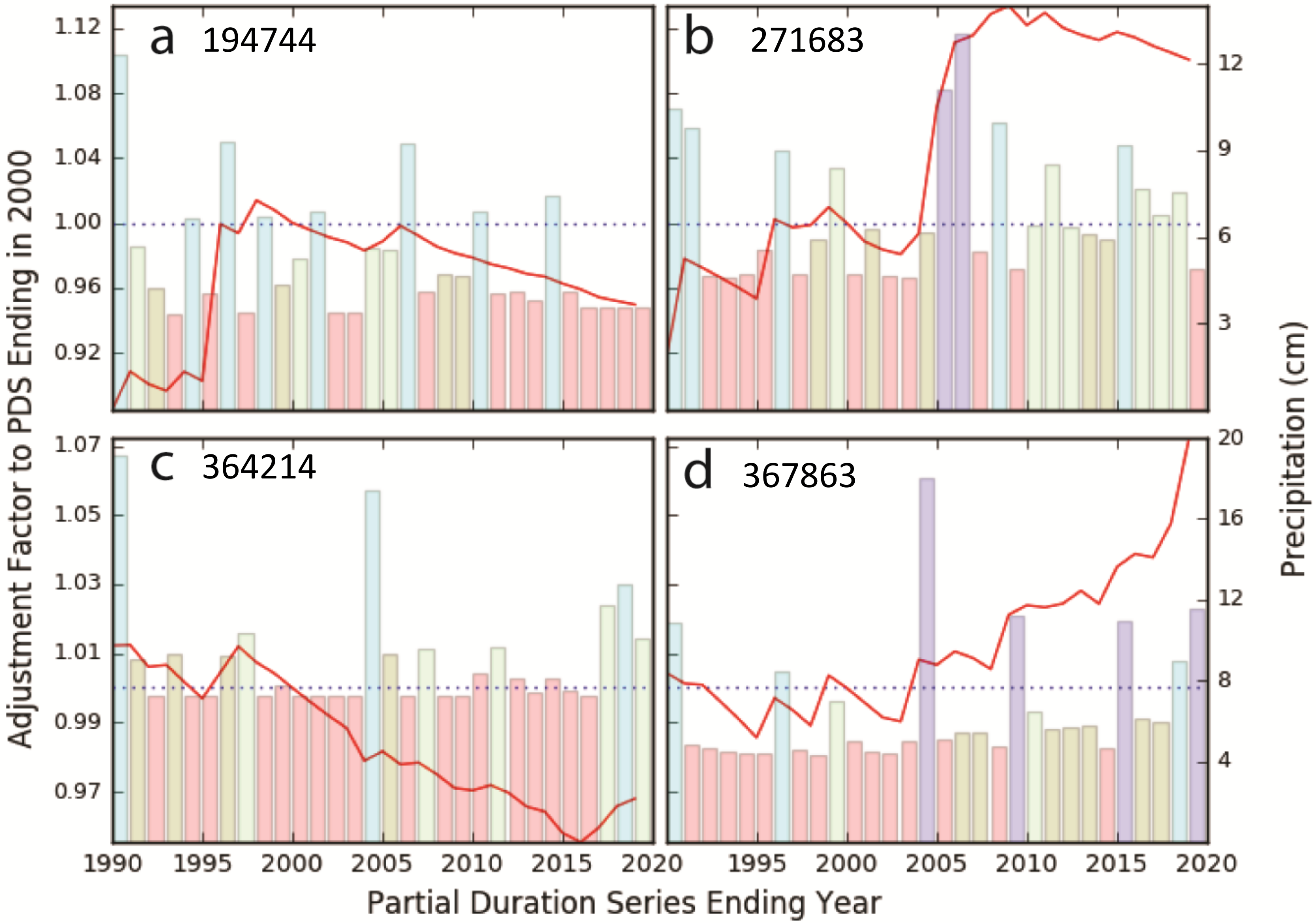



Thank You!
Questions??

Influence of Ending Year



Why the Changes and Differences?



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U.S. EPA's Creating Resilient Water Utilities

Collaborating with communities to increase their resilience to climate change through greater understanding of climate science data and potential long-term adaptation options

Overview

- CRWU's Mission
- Technical Assistance and Training Workshops
- Tools and Resources – Resilient Strategies Guide and CREAT
- Stories from Recent Partners (focus on adaptation to storm impacts)

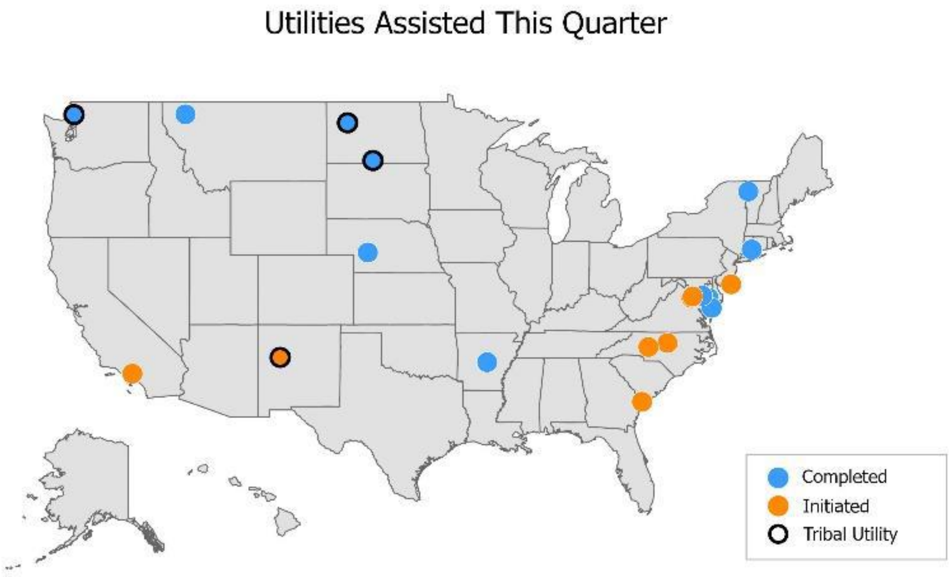
U.S. EPA's Creating Resilient Water Utilities

Davis Water Treatment Plant in Austin, TX

Our Mission:

- Provide water sector utilities with the practical tools, training, and technical assistance needed to increase resilience to climate risks
- Promote a clear understanding of complex climate science and potential long-term adaptation options
- Collaborate with utilities and partners to increase our reach and improve our tools

Adaptation Case Studies Map



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Technical Assistance and Training Workshops

- Climate Change Risk Assessment Technical Assistance:
  - FY23: 50 communities
  - FY24: Call for utilities mid-June (50+ communities – budget dependent)
  - Funding Coordination – Clean Water & Drinking Water State Revolving Funds (States and HQ), WIFIA, FEMA's BRIC Program, USDA's Rural Utility Service, RCAC, Environmental Finance Centers
- Workshops:
  - Virtual and In-Person Tribal Trainings: ITCA, NM, IHS, OK
  - CRWU Training and Engagement Center
- Contacts:
  - Fries.steve@epa.gov
  - Gray.Geneva@epa.gov
- CRWU: www.epa.gov/crwu

Tools and Resources

- Resilient Strategies Guide:
  - Web-based introduction to possible future climate conditions and adaptation options used by the Sector
  - Suited for smaller utilities in the early stages of adapting to climate change

- Climate Resilience Evaluation and Awareness Tool (CREAT):
  - Web-based comprehensive climate change risk assessment tool for all sized water sector utilities
  - Compares the benefits of adapting to climate change with the investment required to implement plans

- Data Services and Maps to Support the Development of Climate Change Scenarios:
  - Storm Surge Inundation and Hurricane Strike Frequency
  - Climate Scenarios Projections
  - Streamflow Projections
  - Snowpack Change for the Western United States
  - Wildfire Conditions and Risk for Water Utilities

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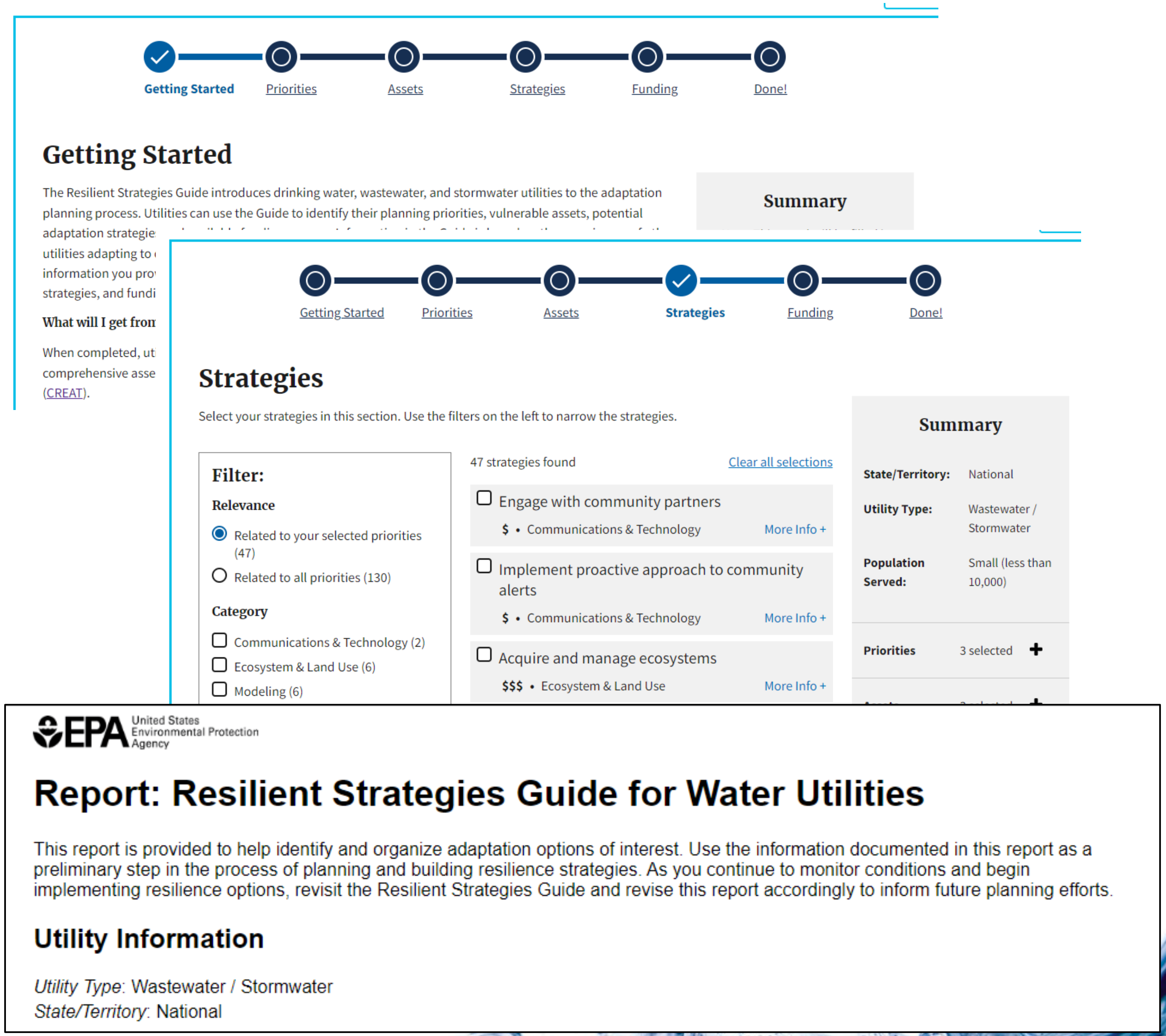
Resilient Strategies Guide

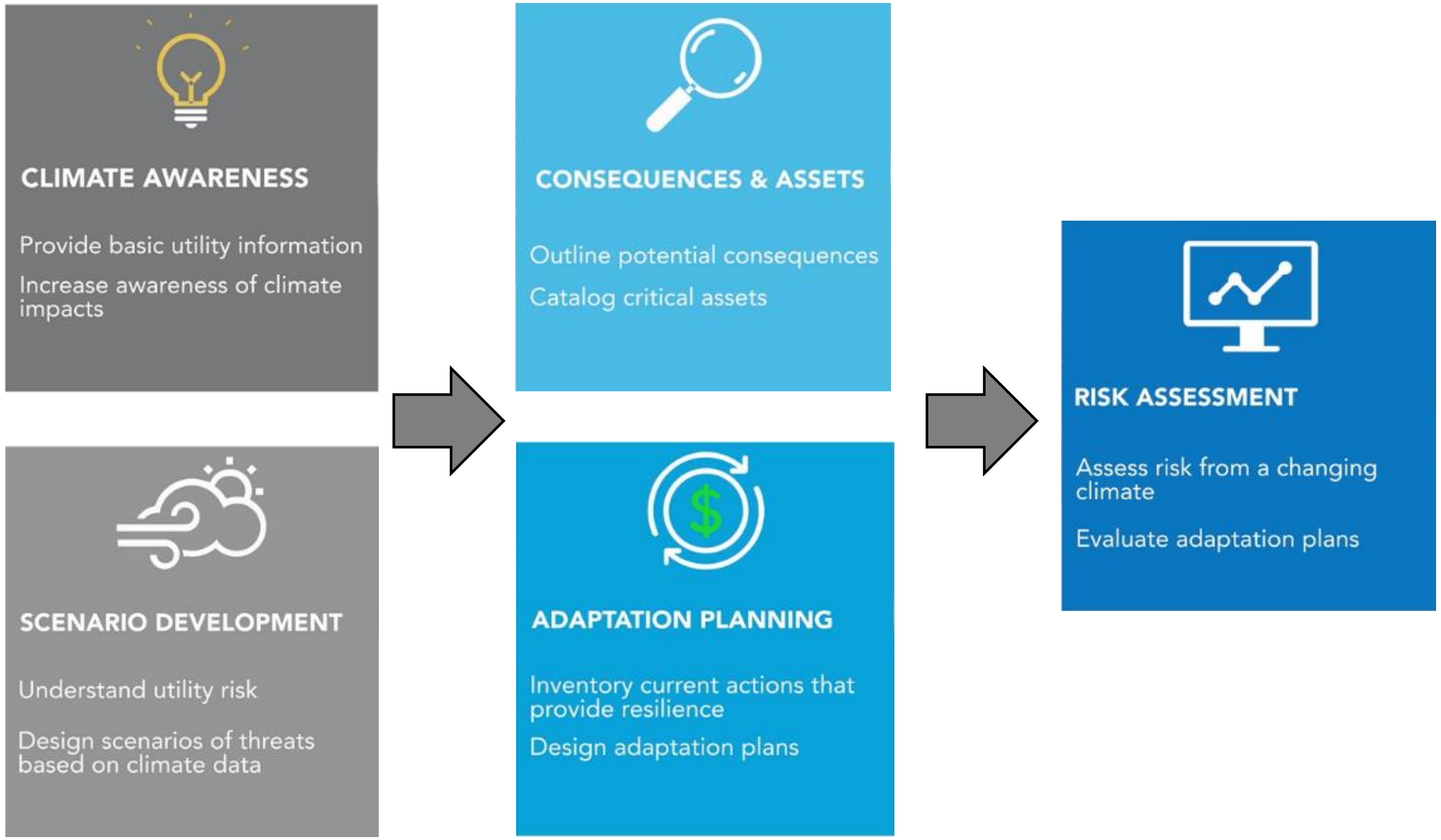
- Introduction to adaptation planning for those with limited knowledge or experience
- Final report documents priorities, vulnerable assets, and relevant strategies to explore during adaptation planning
- Provides financing advice and best practices from other utilities



Climate Resilience Evaluation and Awareness Tool

CREAT 3.0

- **Module-based process** with clearly defined goals and reports
- Presents available climate data at the **regional and local levels**
- Multiple scenarios provided to help **capture uncertainty**
- **Assessment of current resilience** will help inform **adaptation planning**
- Results help utilities compare **risk reduction value** and **implementation costs**



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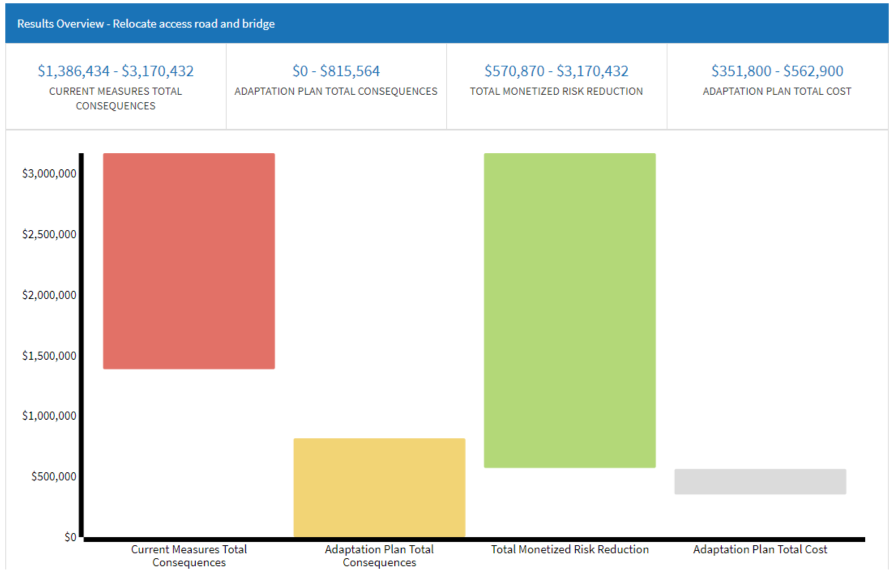
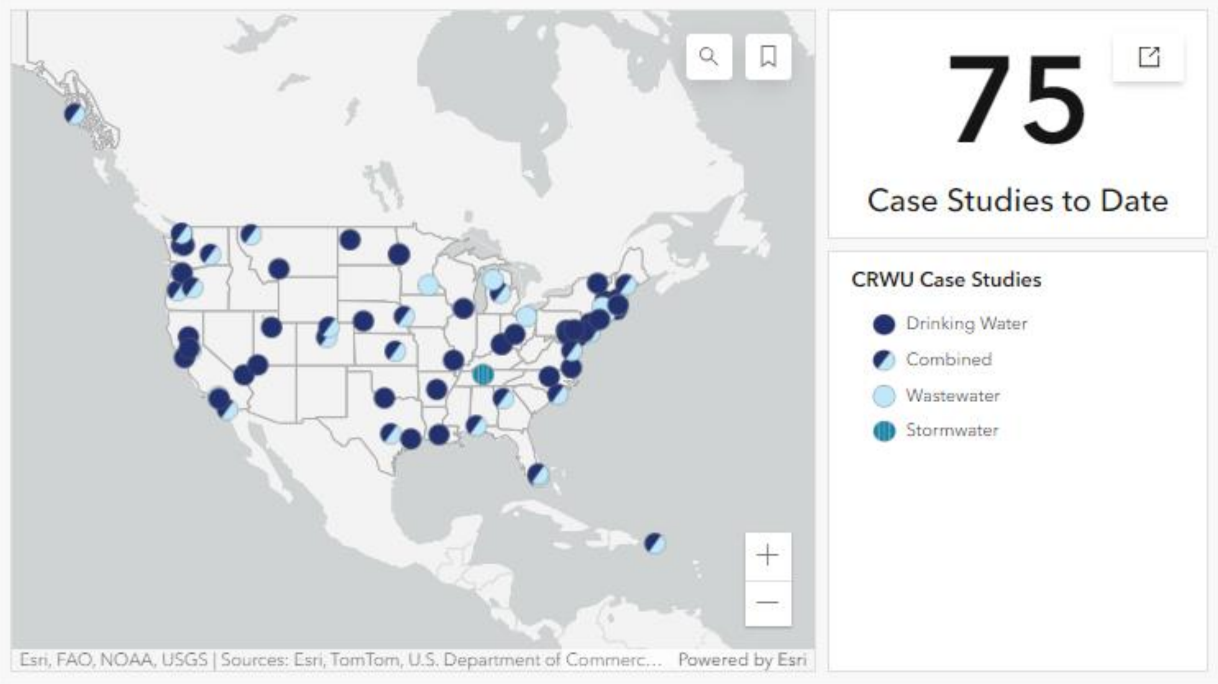
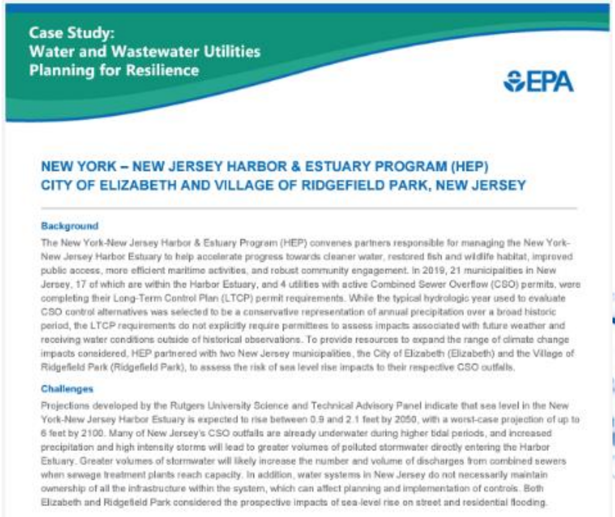
Climate Risk Assessments

- Results from technical assistance provide assessment results that
  - Characterize current levels of risk and
  - Potential for reduction through adaptation



- Results can help evaluate current performance and planning decisions





Case Study:
Water and Wastewater Utilities
Planning for Resilience

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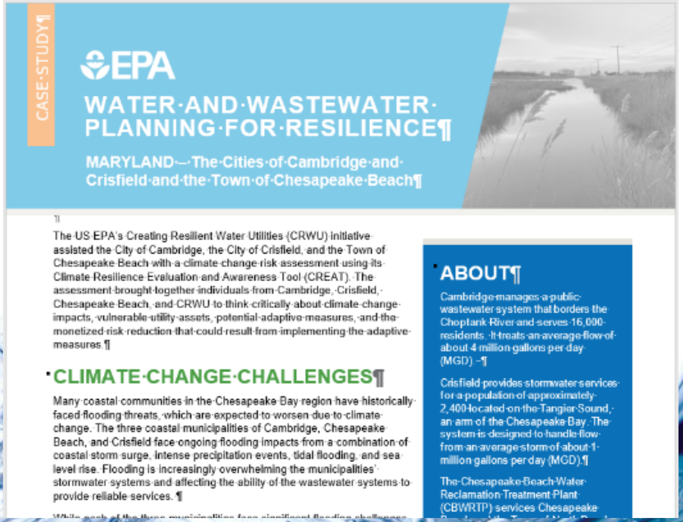
NEW YORK – NEW JERSEY HARBOR & ESTUARY PROGRAM (HEP)
CITY OF ELIZABETH AND VILLAGE OF RIDGEFIELD PARK, NEW JERSEY

Background

The New York-New Jersey Harbor & Estuary Program (HEP) convenes partners responsible for managing the New York-New Jersey Harbor Estuary to help accelerate progress towards cleaner water, restored fish and wildlife habitat, improved public access, more efficient maritime activities, and robust community engagement. In 2019, 21 municipalities in New Jersey, 17 of which are within the Harbor Estuary, and 4 utilities with active Combined Sewer Overflow (CSO) permits, were completing their Long-Term Control Plan (LTCP) permit requirements. While the typical hydrologic year used to evaluate CSO control alternatives was selected to be a conservative representation of annual precipitation over a broad historic period, the LTCP requirements do not explicitly require permittees to assess impacts associated with future weather and receiving water conditions outside of historical observations. To provide resources to expand the range of climate change impacts considered, HEP partnered with two New Jersey municipalities, the City of Elizabeth (Elizabeth) and the Village of Ridgefield Park (Ridgefield Park), to assess the risk of sea level rise impacts to their respective CSO outfalls.

Challenges

Projections developed by the Rutgers University Science and Technical Advisory Panel indicate that sea level in the New York-New Jersey Harbor Estuary is expected to rise between 0.9 and 2.1 feet by 2050, with a worst-case projection of up to 6 feet by 2100. Many of New Jersey's CSO outfalls are already underwater during higher tidal periods, and increased precipitation and high intensity storms will lead to greater volumes of polluted stormwater directly entering the Harbor Estuary. Greater volumes of stormwater will likely increase the number and volume of discharges from combined sewers when sewage treatment plants reach capacity. In addition, water systems in New Jersey do not necessarily maintain ownership of all the infrastructure within the system, which can affect planning and implementation of controls. Both Elizabeth and Ridgefield Park considered the prospective impacts of sea-level rise on street and residential flooding.



CASE STUDY

EPA

WATER AND WASTEWATER PLANNING FOR RESILIENCE

MARYLAND — The Cities of Cambridge and Crisfield and the Town of Chesapeake Beach

The US EPA's Creating Resilient Water Utilities (CRWU) initiative assisted the City of Cambridge, the City of Crisfield, and the Town of Chesapeake Beach with a climate change risk assessment using its Climate Resilience Evaluation and Awareness Tool (CREAT). The assessment brought together individuals from Cambridge, Crisfield, Chesapeake Beach, and CRWU to think critically about climate change impacts, vulnerable utility assets, potential adaptive measures, and the monetized risk reduction that could result from implementing the adaptive measures.

CLIMATE CHANGE CHALLENGES

Many coastal communities in the Chesapeake Bay region have historically faced flooding threats, which are expected to worsen due to climate change. The three coastal municipalities of Cambridge, Chesapeake Beach, and Crisfield face ongoing flooding impacts from a combination of coastal storm surge, intense precipitation events, tidal flooding, and sea level rise. Flooding is increasingly overwhelming the municipalities' stormwater systems and affecting the ability of the wastewater systems to provide reliable services.

ABOUT

Cambridge manages a public wastewater system that borders the Choptank River and serves 16,000 residents. It treats an average flow of about 4 million gallons per day (MGD).

Crisfield provides stormwater services for a population of approximately 2,400 located on the Tangier Sound, an arm of the Chesapeake Bay. The system is designed to handle flow from an average storm of about 1 million gallons per day (MGD).

The Chesapeake Beach Water Reclamation Treatment Plant (CBWRTP) services Chesapeake

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South Monmouth Regional Sewerage Authority (NJ)

- The South Monmouth Regional Sewerage Authority (SMRSA) is located in Monmouth County, New Jersey, and serves over 50,000 people in eight coastal communities,
- A long history of coastal flooding and storm surge motivated their assessment and recent improvements (portable pumping stations)
- Technical assistance guided their use of CREAT, helping to evaluate the performance of several projects they are considering:
    - Relocate the pump station to higher elevation
    - Install flood doors
    - Build a sea wall around pump stations
- The Authority partnered with EPA to host training event for other coastal systems to share experiences and promote climate change considerations when preparing for the next storm

Montague and South Hadley (MA)

- Montague Water Pollution Control Facility and South Hadley Water Pollution Control Division serve 2,000 and 17,000 residents, respectively
- Focus of their assessment was on impacts of changing storms and challenges to collection and treatment
- Technical assistance guided their use of CREAT, helping to evaluate the performance of several current practices (storage, pumping, upgrades/elevation) and potential improvements:
  - Natural Flow Improvements
  - Pump Replacements
  - Inflow and Infiltration Assessment / Pipe Lining
- Participants included Massachusetts Department of Environmental Protection and the Pioneer Valley Planning Commission, fostering the consideration of climate change and potential adaptation into their relationships with State and watershed organizations

City of Crisfield (MD)

- Crisfield provides stormwater services for 2,400 people living on MD's Eastern Shore using a ditch and sewer system designed for 1 million gallons per day (MGD)
- Focus of their assessment was on flooding driven by combination of coastal storm surge, intense precipitation events, tidal flooding, and sea level rise
- Technical assistance guided their use of CREAT, helping to evaluate the performance of two options for a portion of their current system:
  - Ditch Maintenance
  - Convert to Closed System
- Participants are working concurrently with NOAA, FEMA and the Nature Conservancy on projects aimed to build resilience in Crisfield

Traverse City (MI)

- Traverse City provides wastewater services to about 50,000 customers across five townships
- Their assessment focused on flooding along the shoreline of Lake Michigan caused by heavy precipitation events
- Technical assistance guided their use of CREAT, helping to evaluate the performance of two options to mitigate overflows in a portion of their service area:
  - Increased Wet Well Storage Capacity
  - Relocate and Upsize Riverfront Main
- Results of this assessment helped inform changes to SRF-funded project that accommodates higher flow events under some future climate scenarios (project now under construction)

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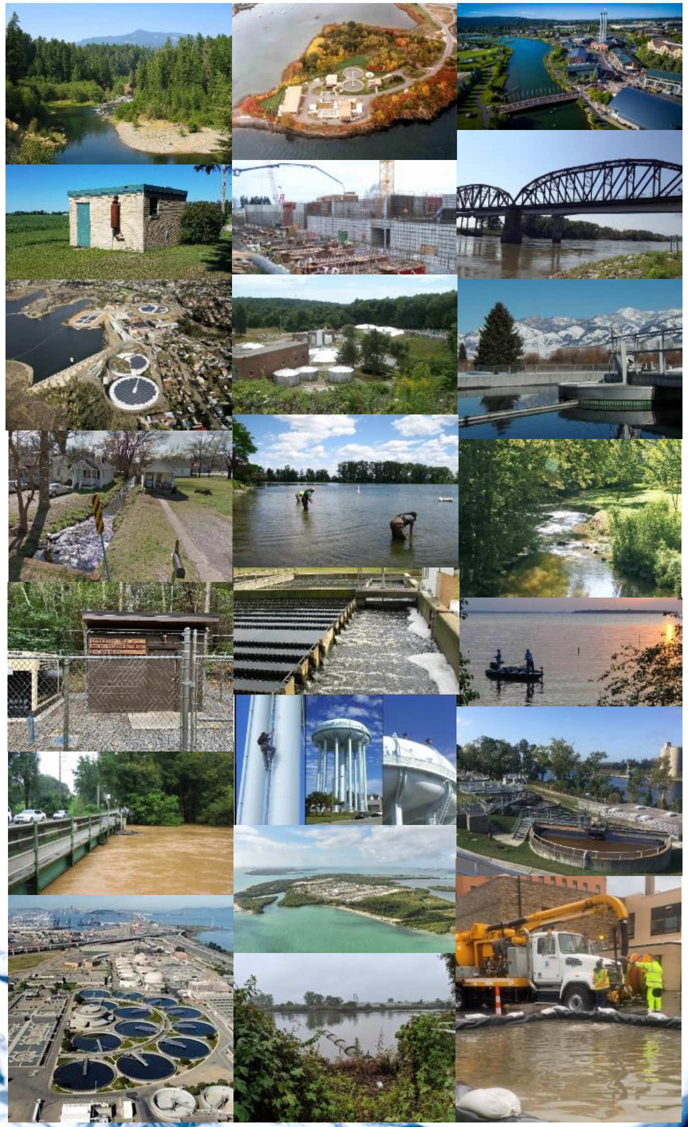
Clackamas County (OR)

- Water Environment Services (WES) provides wastewater collection and treatment services to approximately 190,000 people
- Focus of their assessment was on flooding of pump station in the channel migration zone (CMZ) along the Sandy River and potential to add to their current practices in response to flooding events (backup power, temporary barriers)
- Technical assistance guided their use of CREAT, helping to evaluate the performance of several projects they are considering to mitigate flood damage to vulnerable facilities:
  - Replace with submersible facility of relocate outside CMZ
  - Bypass through higher elevation pumps and new treatment plant

CRWU's Continuing Impact

- Building resilient drinking water, wastewater and stormwater utilities
- Providing access to climate information and risk assessment framework
- Supporting climate adaptation as part of EPA's larger technical assistance efforts
- Connecting systems to partners and funding opportunities



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RESOURCES

- **Data**
- **Tools**
- **Webinars**
- **Funding**
- **Technical Assistance**

A few of interest:

- Showcasing Leading Practices in Climate Adaptation: Experiences from the Water Sector to Empower Other Sectors and Communities (webinar series – NOAA, EPA, WUCA, WRF)
- Scaling and Application of Climate Projections to Stormwater and Wastewater Resilience Planning (WUCA)
- Tools for Utility Risk and Resilience Planning: A Guided Inventory (New England Environmental Finance Center, University of Southern Maine)

QUESTIONS?

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(301) 405-5036

University of Maryland 1856 ENVIRONMENTAL FINANCE CENTER