Missouri Basin: Trends & Needs

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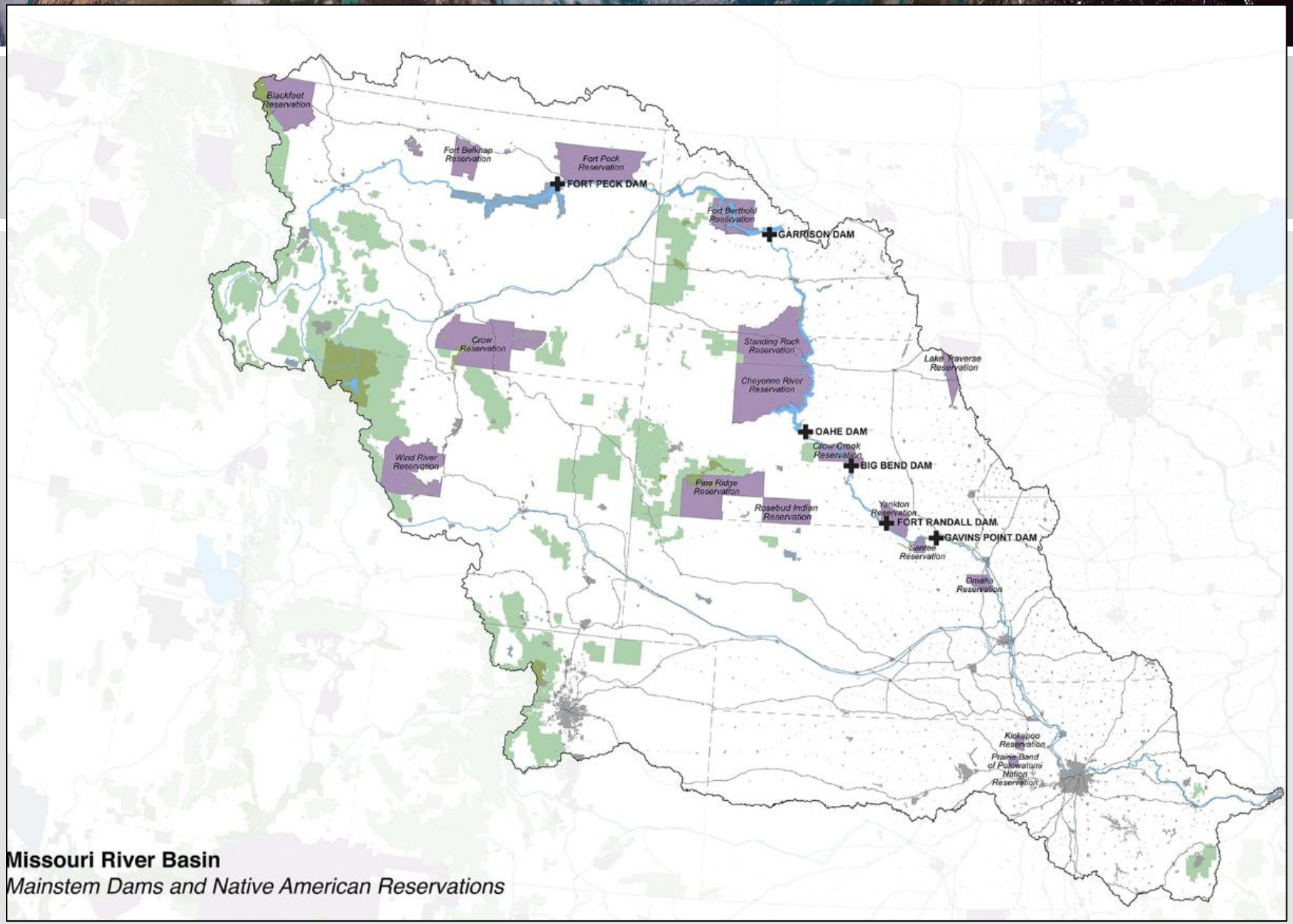
What is the National Centers for Environmental Information

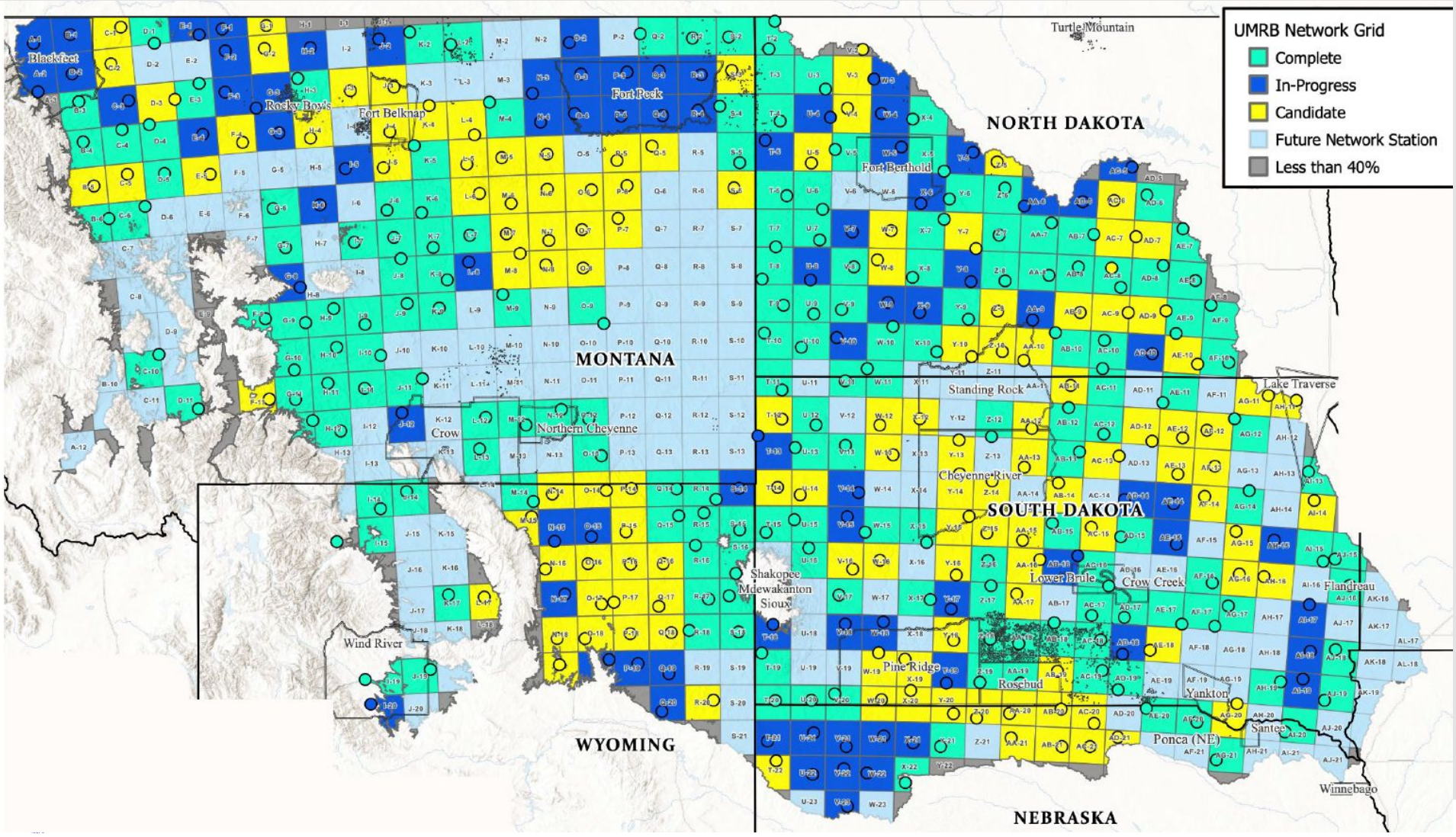
- Responsible for hosting and providing access to one of the most significant archives on Earth, with comprehensive oceanic, atmospheric, and geophysical data
- From the depths of the ocean to the surface of the sun and from million-year-old sediment records to near real-time satellite images
- Nation's leading authority for environmental information



- Kees Lokman, "The Missouri River Basin: Water, Power, Decolonization, and Design," *Scenario Journal 07: Power*, December 2019, https://scenariojournal.com/article/Missouri-River-Basin/.

Upper Missouri Basin Monitoring

540 stations, 1 station/500 sq miles



Lower Brule Nation Station

1. Temperature
2. Humidity
3. Wind
4. Solar radiation
5. Year-round precipitation
6. Snow Depth
7. Soil moisture profile
8. Soil temperature profile
9. Weather camera

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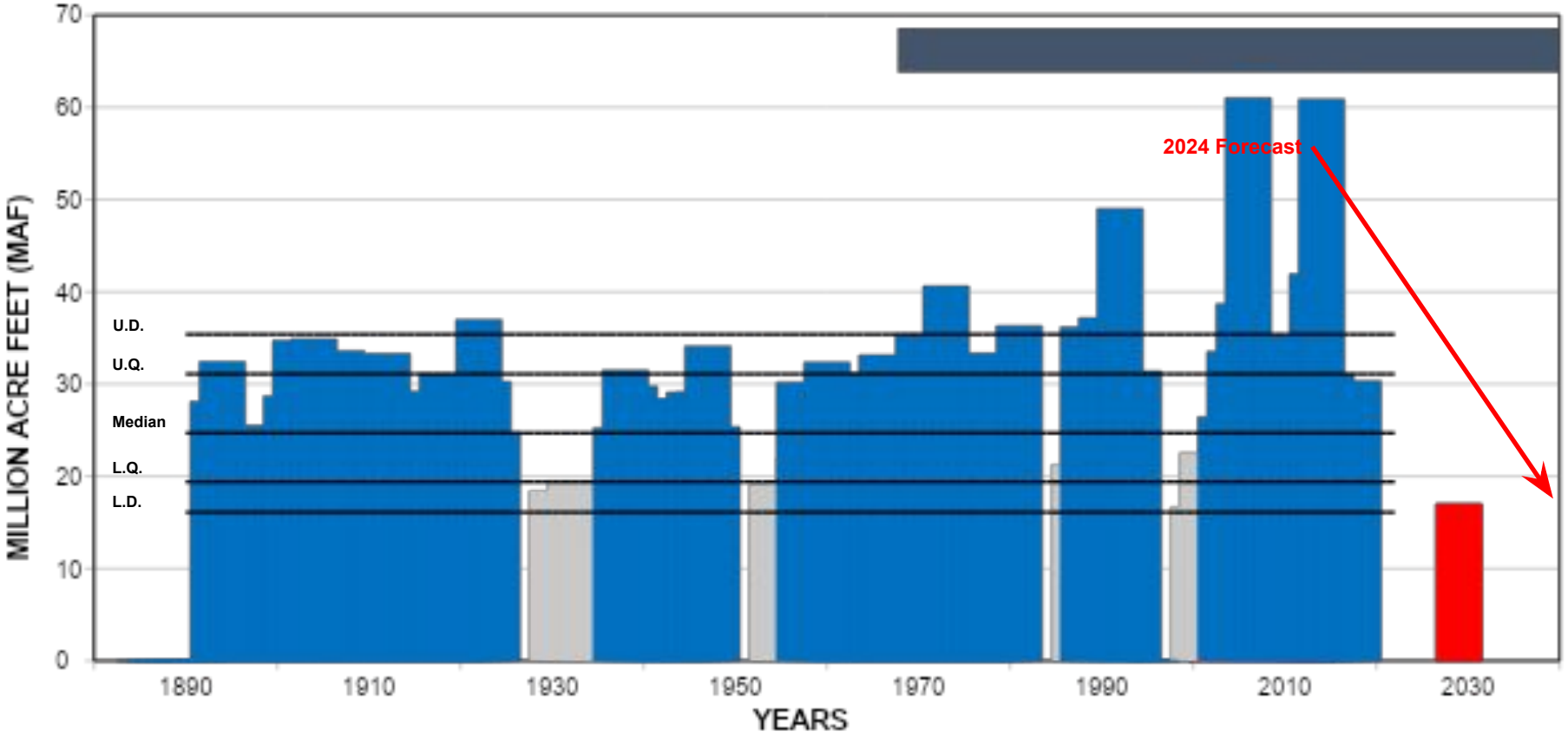
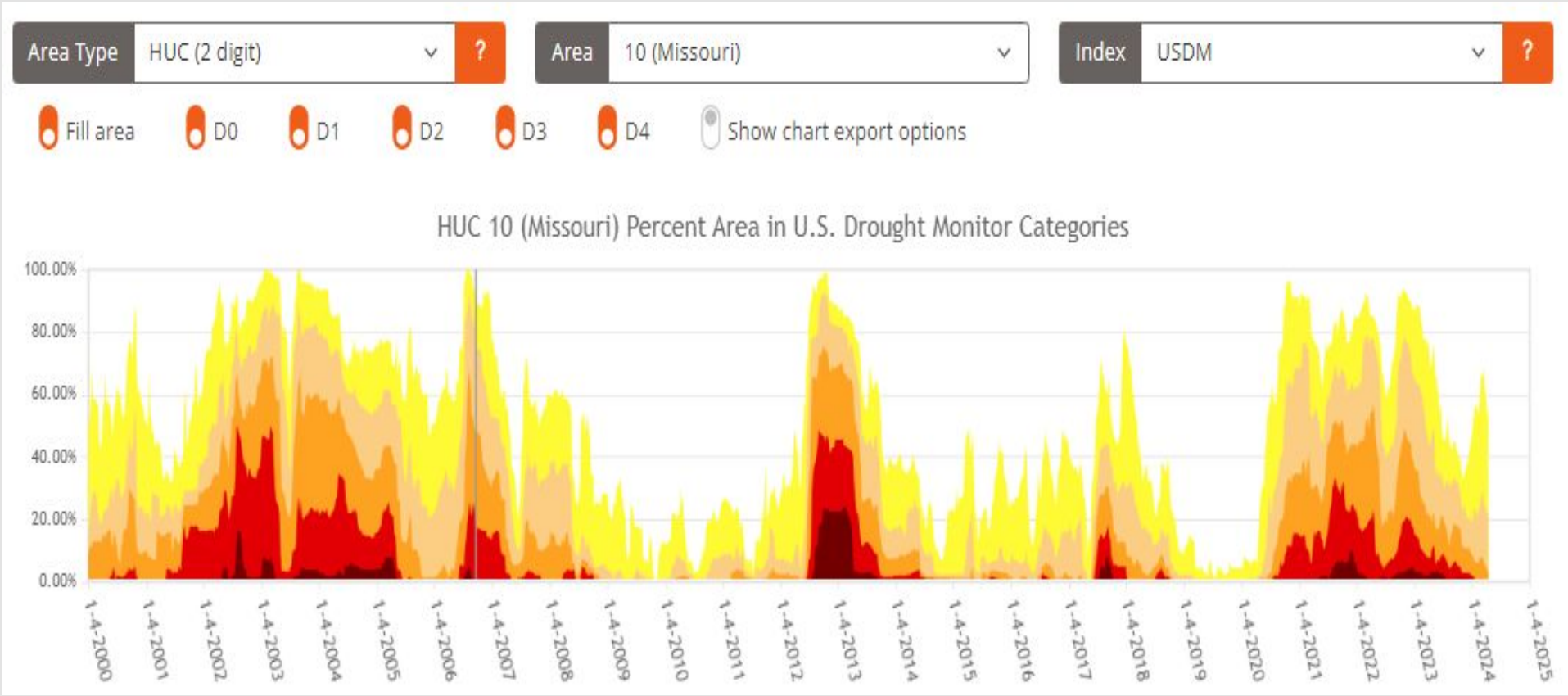
U.S. ARMY

ANNUAL RUNOFF ABOVE SIOUX CITY, IA
MISSOURI BASIN

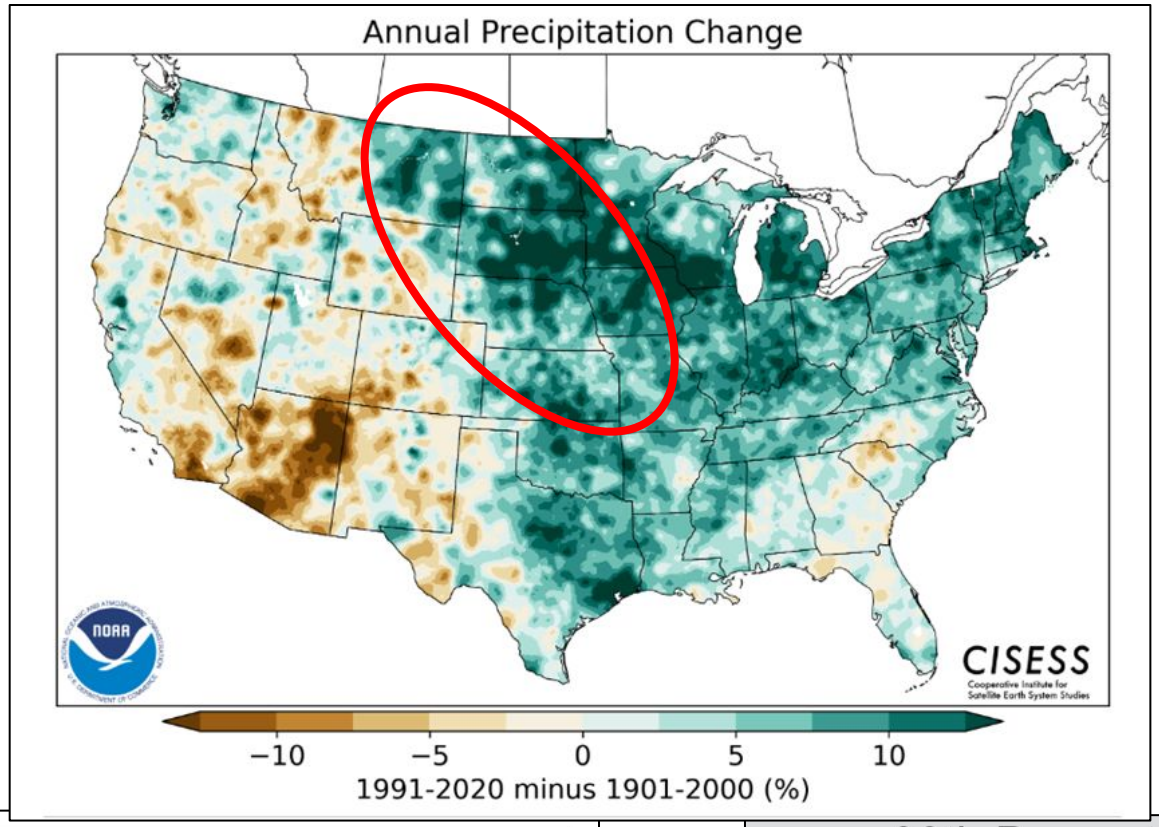


Drought History (2000-Present)



- Missouri Basin
- https://droughtmonitor.unl.edu/CurrentMap.aspx

Recent 30 years (1991-2020) compared to the past (1901-2000)



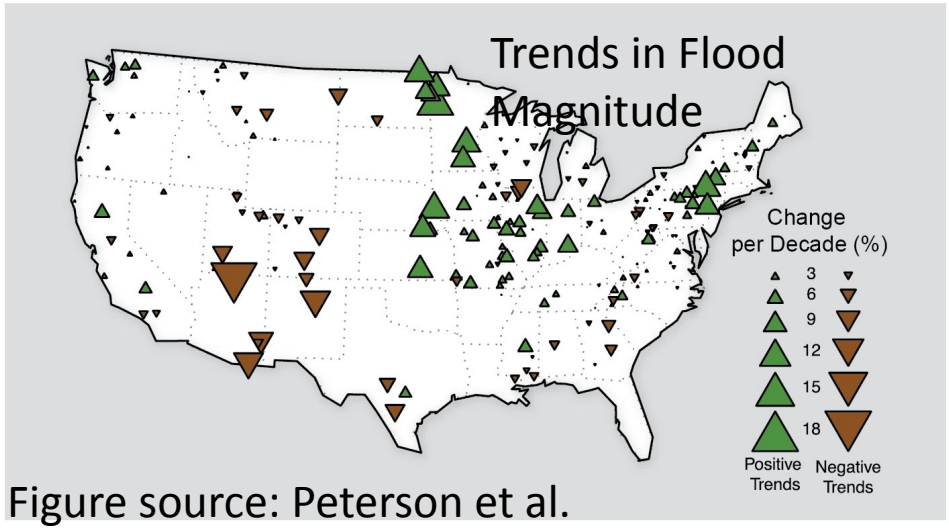
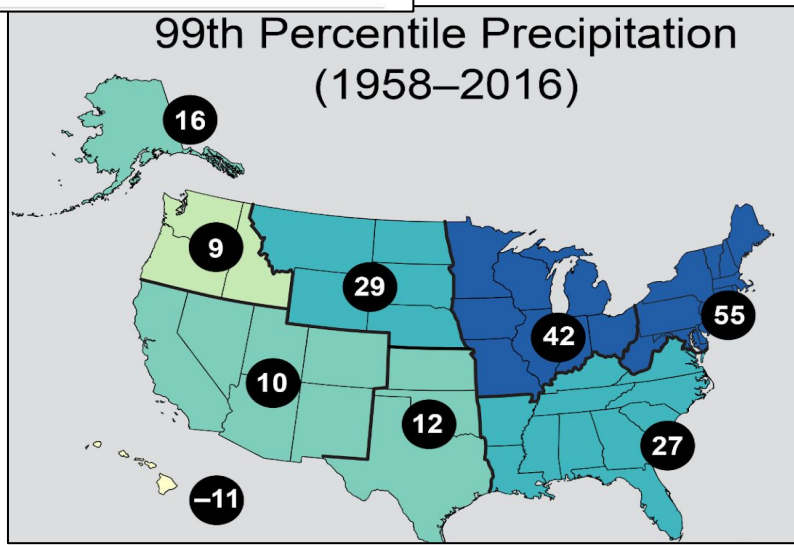


Figure source: Peterson et al.



Recent High Missouri River Basin Runoff Was Unlikely Caused by Climate Change

Conclusions

Historical Context

Runoff increases in 1990-2019 vs. 1960-1989 caused by precipitation increases

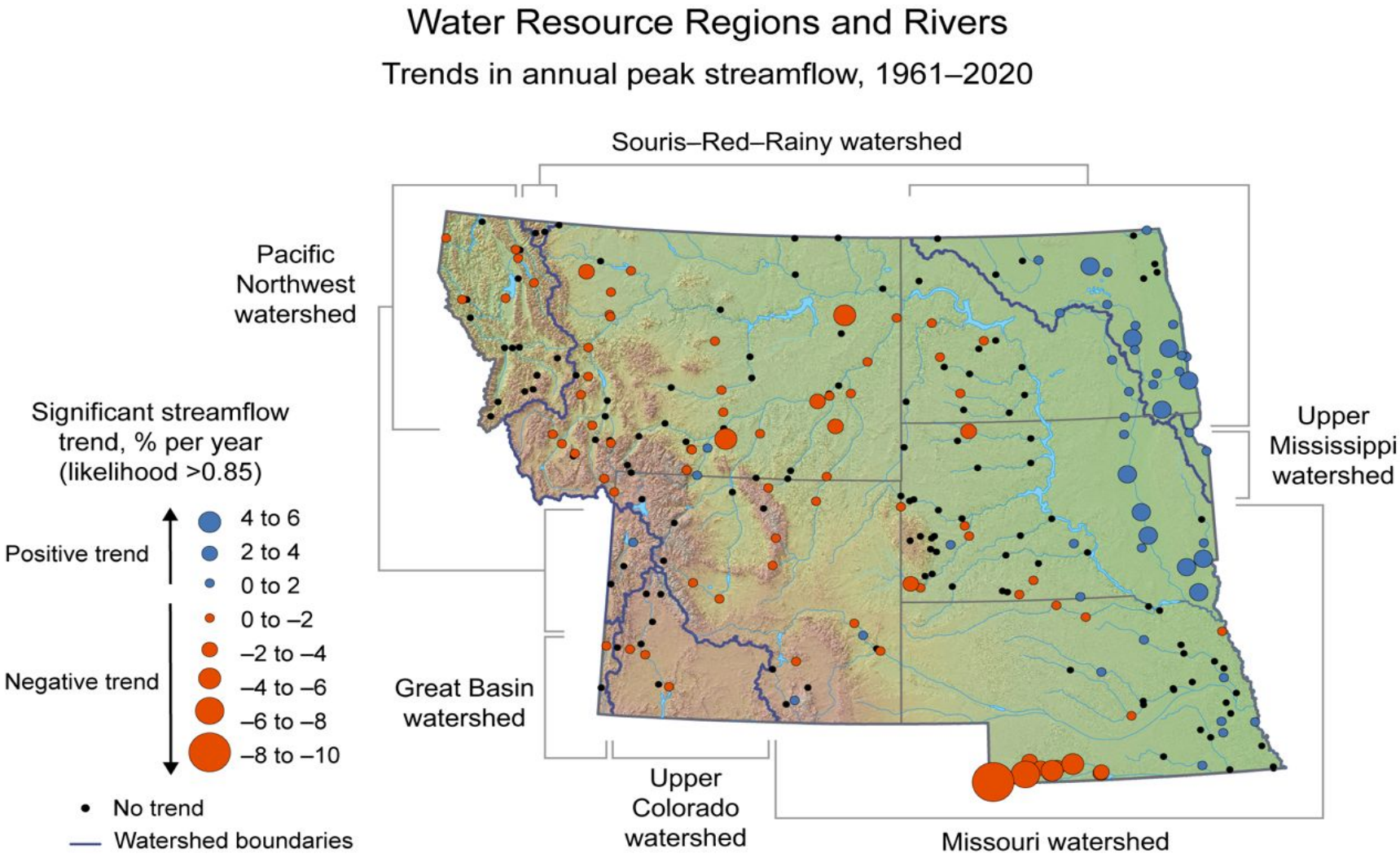
Anthropogenic Effects to Date

Anthropogenic effects have mainly contributed to decreased runoff due to warming

Future Runoff

Runoff will most likely decrease by 2050 as warming increases

Hoell, A., M. Hoerling, X. Quan, and R. Robinson, 2023: Recent High Missouri River Basin Runoff Was Unlikely Caused by Climate Change. *J. Appl. Meteor. Climatol.*, **62**, 657–675



Annual peak streamflow—a proxy for flooding—has been rising in eastern portions of the region and declining in the west.

KEY MESSAGE 1

Climate Change Is Compounding the Impacts of Extreme Events

The Northern Great Plains region is experiencing unprecedented extremes related to changes in climate, including severe droughts (*likely*, *high confidence*), increases in hail frequency and size (*medium confidence*), floods (*very likely*, *high confidence*), and wildfire (*likely*, *high confidence*). Rising temperatures across the region are expected to lead to increased evapotranspiration (*very likely*, *very high confidence*), as well as greater variability in precipitation (*very likely*, *high confidence*).

- **Heavy precipitation events are becoming more frequent and intense across much of the country**
- **Total annual precipitation is projected to be stable across the region but will show increased inter-annual variability**
- **Warming temperatures will lead to increased evapotranspiration**

Wildfire

- Fire potential increases across the region in summer and autumn with fire season becoming longer
- Number of large grassland wildfires increased by 213% in the past 3 decades.
- Increased fire season length by 85 days in western MT and WY forests

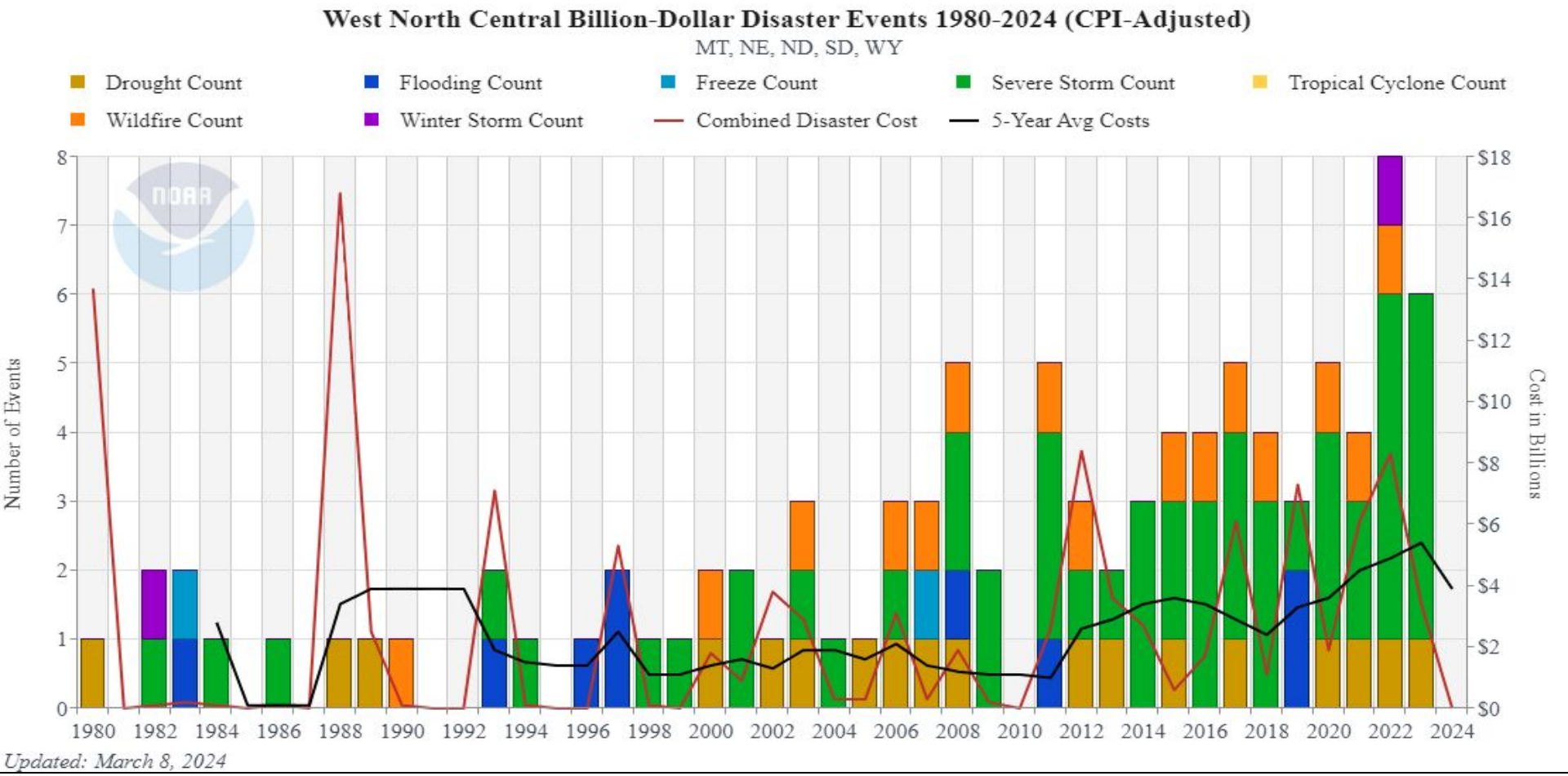
Drought

- Drought is projected to increase.
- Summer drought is more probable than spring drought.
- Flash droughts are a growing concern.

KEY MESSAGE

Extremes – Northern Plains

(Inflation Adjusted)



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

Potential Needs and Gaps

- Better integration of remote sensing and in situ data (i.e. Mesonet)
  - Many farmers rely on station-based data (or what appears to be station-based data. They're always looking for more local data and what conditions are in their little corner of the world. Anything water, soil or vegetation related is useful. Data access is an issue. Farmers also don't access remotely sensed data in general—some do, but most will not seek out NASA sources for example unless it's integrated in some farm data app or website.
- More meaningful product lines expressly focused with ag. producers for decision making

More needs

Rangeland Resources & Systems Research Unit

- Soil moisture at fine spatial/temporal scales (e.g., weekly/daily at 30m)
- Hourly precipitation at finer spatial scale (<= 500 m)
- Snow cover (%) daily at 30 m
- Woody vegetation cover (%) at 30 m
- A better cloud/shadow mask for the Harmonized Landsat Sentinel (HLS) dataset
- Evaporative demand at finer spatial scales (<= 500m)
- A gridded product of daily photosynthetically active radiation (PAR) (<= 1km)

More Needs

- How to leverage connection with the new surface monitoring with NASA resources. Both need to connect.

- NASA needs work with locals from the beginning before, during and after. Basically, more iteration with those served.
  - They create lots of products, but don't seem to work more locally/regionally to how to better use them.

More Needs

- Satellite images of small stock-pond/stock-dam, so we can inventory where they are on the landscape and analyze changes in water levels within and across seasons (to identify water sources for livestock and wildlife that are experiencing longer-term drying).
- Satellite sensors that can detect grass greenup and estimate biomass underneath tree and shrub canopies (so we can improve and expand products like Grass-Cast and the Rangeland Analysis Platform to pastures/allotments with heavier shrub and tree cover).

Thank You – doug.kluck@noaa.gov
Questions-Comments?

Drought Rain Gauge

Figure 1. 2012-2021 Billion-Dollar Weather and Climate Disaster Costs as a Share of Total State Tax Revenues

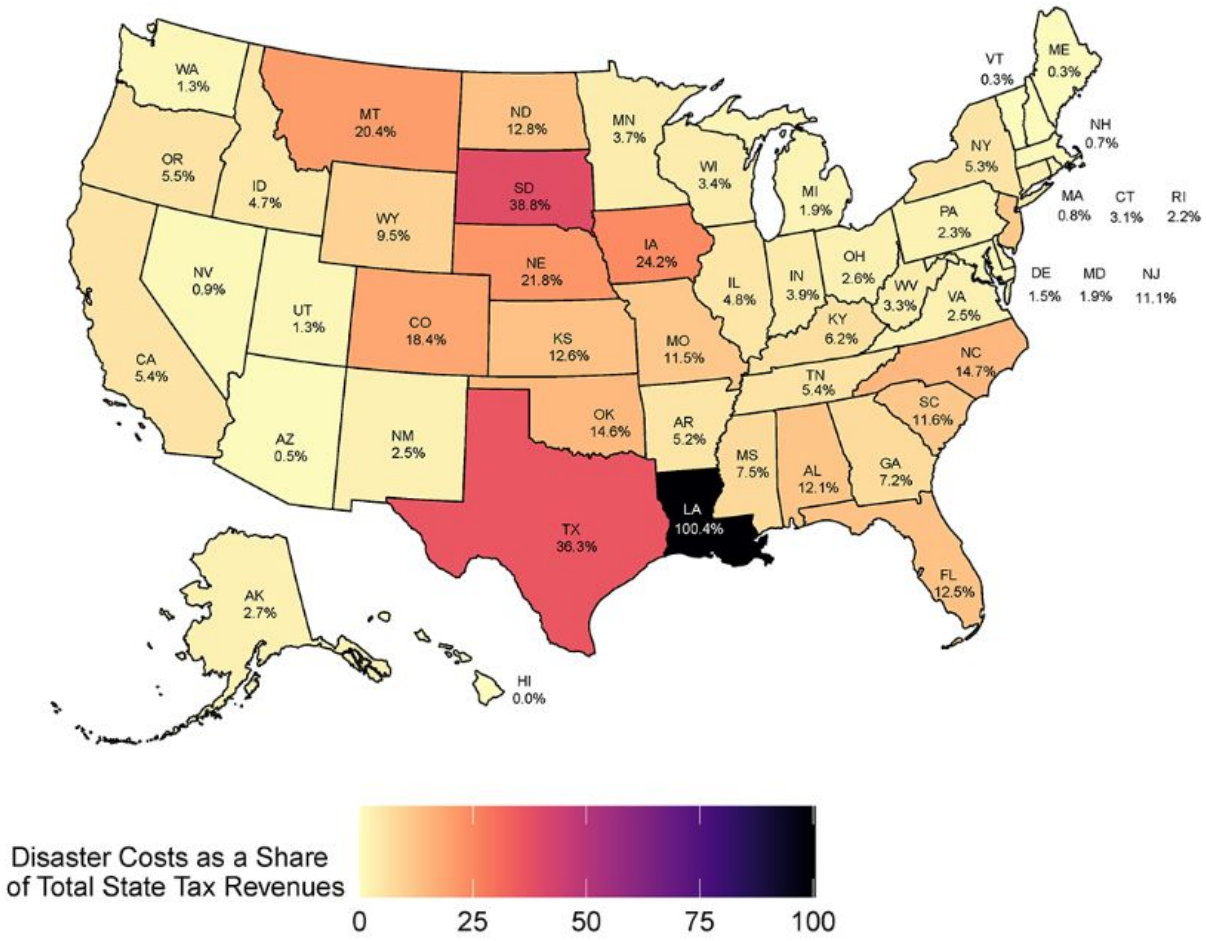


Figure 1 - Costs as a % share of Total State Tax Revenues **-** four factors:

(1) **frequency**, or the number of extreme weather events;

(2) **hazard**, or the intensity of the event;

(3) **exposure**, or the number of firms and households affected by the event; and

(4) **vulnerability**, or the resilience of each firm, household, or local economy to the event.

Each of these factors is changing over time.

Source: **Brunetti, Celso, Benjamin Dennis, Gurubala Kotta, and Adam Smith (2023). "Analyzing State Resilience to Climate Change," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, September, 07, 2023, https://doi.org/10.17016/2380-7172.3342.**

Current and Potential Impacts

Health (smoke, heat, allergies, invasive diseases)

Water (quantity, quality)

Drought/Flood (flash, urban/rural issues, energy production)

Cascading issues (e.g. migration, supply chains)

Infrastructure (transportation, utilities etc..)

Rural (Ag. implications, untimely freezes)

Ecosystems (loss of habitat, restorative ability, balance)

Equity: Vulnerable populations especially vulnerable to small "disasters" or series of events

- **Place based vulnerabilities (flood plain, etc…)**