CFAES

Fifth National Climate Assessment (NCA5): Midwest Chapter Overview

Midwest Drought Early Warning System (DEWS) Partners Meeting
August 20, 2024 | Indianapolis, Indiana

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https://nca2023.globalchange.gov/chapter/24

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

U.S. Global Change Research Program

- USGCRP began as a Presidential initiative in 1989
- Mandated by Congress in the **Global Change Research Act (GCRA) of 1990** "to assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change"
- Overseen by the Subcommittee on Global Change Research, composed of representatives from each of the USGCRP member agencies

Legislative Origins of the NCA

Global Change Research Act of 1990, Section 106:

Not less frequently than every 4 years [USGCRP] shall prepare and submit to the President and Congress an assessment which:

- **Integrates, evaluates, and interprets** the findings of [USGCRP] and discusses the scientific **uncertainties** associated with such findings
- Analyzes the effects of global change on the **natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity**
- Analyzes **current trends** in global change, both human- induced and natural, and **projects major trends** for the subsequent 25 to 100 years.

It’s an Assessment

- **Evaluation** of a body of scientific or technical knowledge that **synthesizes** studies, data, models, and assumptions, and **applies best professional judgment** to bridge uncertainties.
- **Consensus-based** view of the state of science.
- **Relevant for policy** and decision-making but **do not prescribe** specific policy interventions or advocate for a particular viewpoint.
- **Authoritative, timely, and transparent**.
- Analyzes the effects of global change on the **natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity**
- Analyzes **current trends** in global change, both human- induced and natural, and **projects major trends** for the subsequent 25 to 100 years.

NCA Chapters

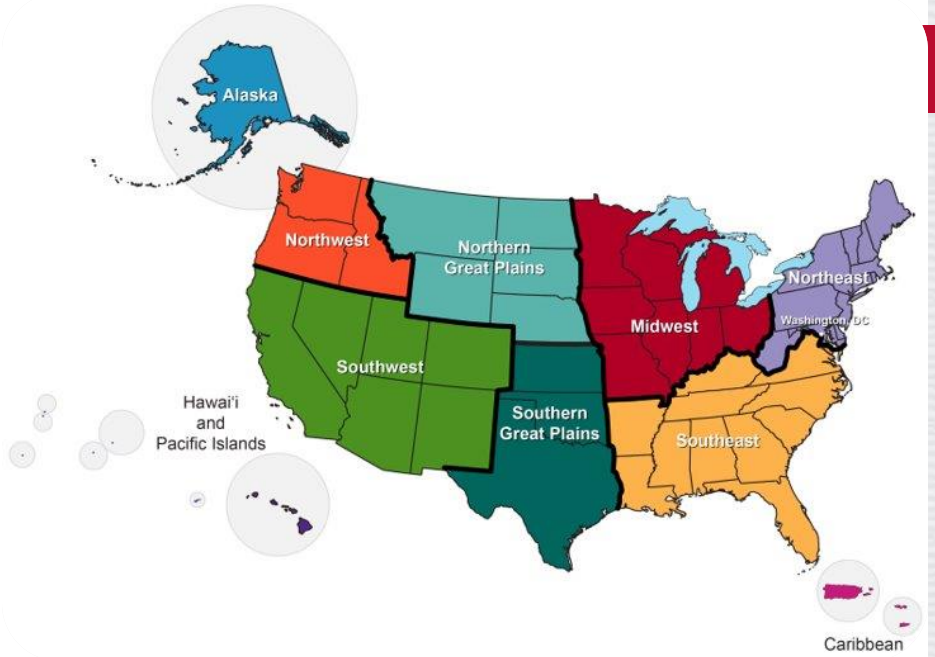
Overview

Physical Science
- Climate Trends
- Earth System Processes

National Topics
- Water
- Energy
- Land Cover and Land Use
- Forests
- Ecosystems and Biodiversity
- Coastal Effects
- Oceans and Marine Resources
- Agriculture
- Built Environment
- Transportation
- Air Quality
- Human Health
- Tribes and Indigenous Peoples
- International
- Complex Systems
- Economics
- Social Systems and Justice

✱ New chapters or features highlighted in blue

Regions
- Northeast
- Southeast
- U.S. Caribbean
- Midwest
- Northern Great Plains
- Southern Great Plains
- Northwest
- Southwest
- Alaska
- Hawai'i and U.S.-Affiliated Pacific Islands



Response
- Adaptation
- Mitigation

Focus on…
- Compound Extreme Events
- Western Wildfires
- COVID-19
- Supply Chains
- Blue Carbon

Appendices
- Process
- IQA
- Data Tools
- Indicators

Timeline

- Feb 2020 - Federal Steering Committee established
- Spring 2021 – Coordinating and Chapter Leads selected
- Fall 2021 – Zero Order Draft and Public Engagement
- Spring/Summer 2022 – 1OD and Agency Review
- Summer/Fall 2022 – 2OD, 3OD, Public and National Academies Review
- Winter/Spring 2023 – 4OD, Agency Review
- Summer 2023 – 5OD, Federal Steering Review
- Fall 2023 – Finalize and Publish

The Midwest Team

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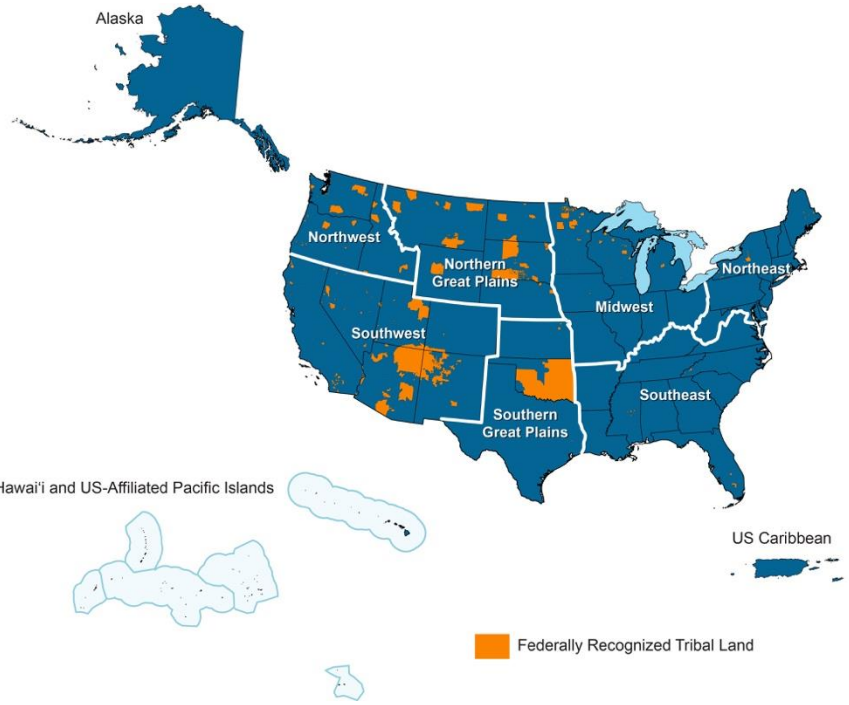
Nikki Way
Snowed/Iced In
(2021, watercolor collage)

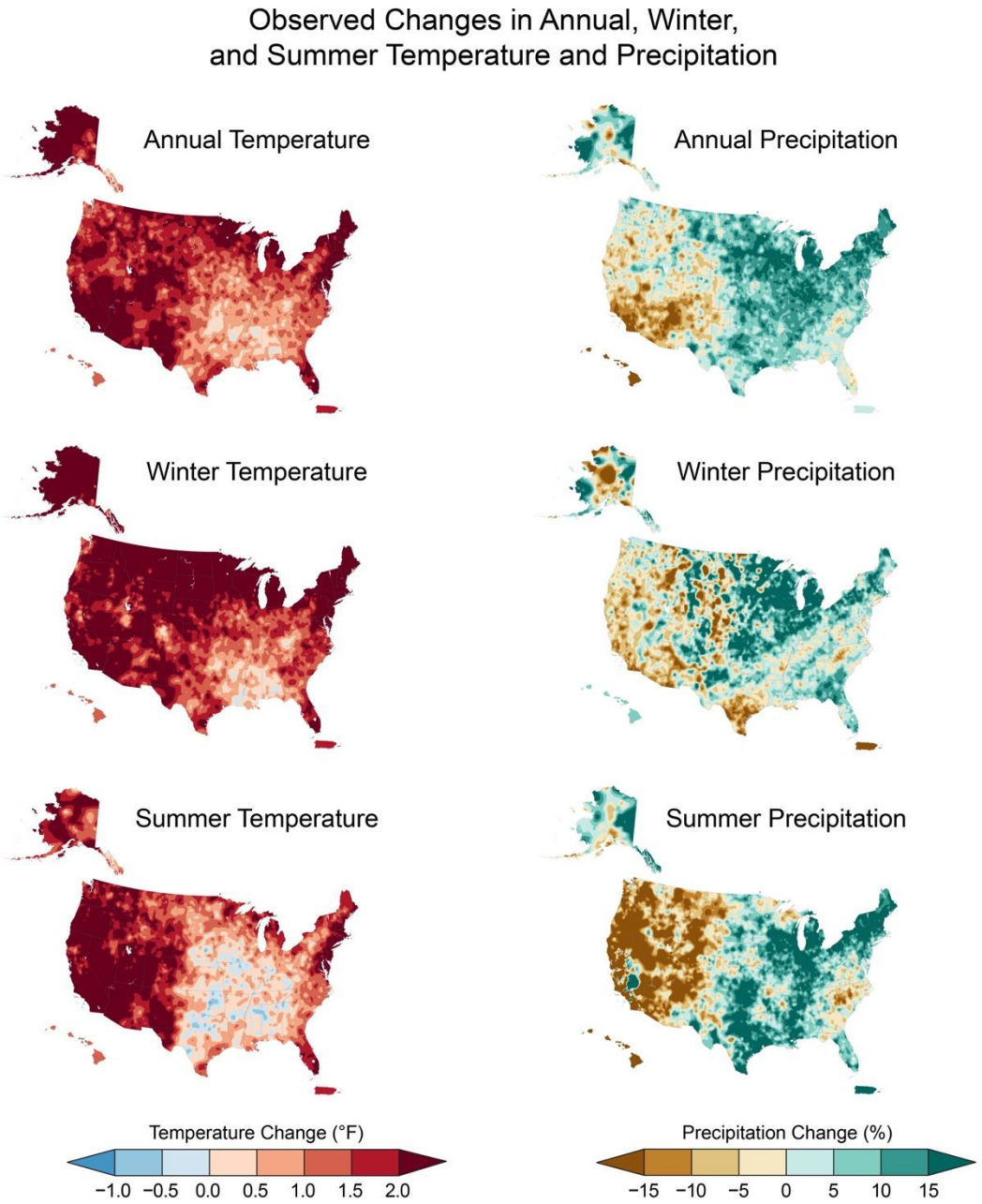
The Midwest Chapter Summary

Chapter Summary: Increasing temperatures and oscillations between extreme droughts and floods threaten agriculture, transform aquatic and terrestrial ecosystems, disrupt important cultural connections, increase risk to individual and community health, exacerbate racial and socioeconomic inequities, and challenge our ability to manage the major waterways that maintain the flow of goods and services throughout the Midwest and the country. Midwesterners are responding in ways that offer hope for the future.



5th National Climate Assessment

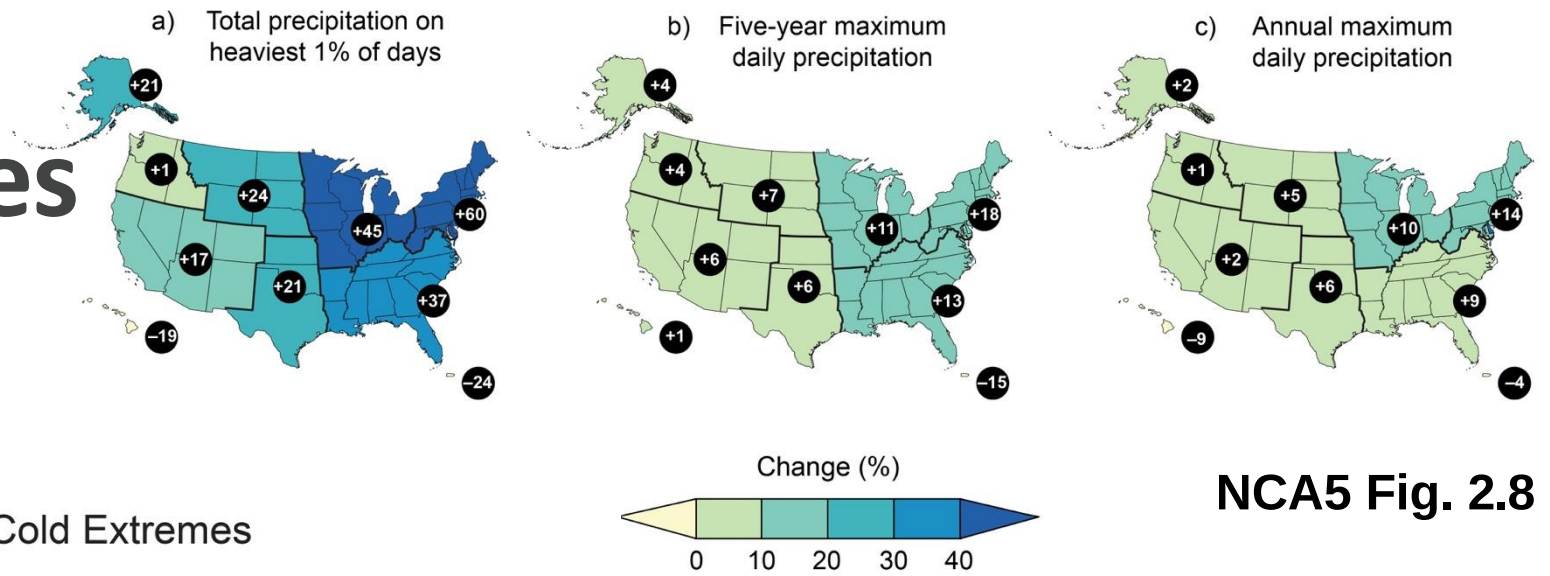
- Annual average temperatures have increased; 0.5°F-2.0°F
- Amplification of warming toward Great Lakes and northern latitudes
- Seasonal differences – strong winter warming
- More recent Summer/Fall "warming hole" (Partridge et al. https://doi.org/10.1002/2017gl076463)



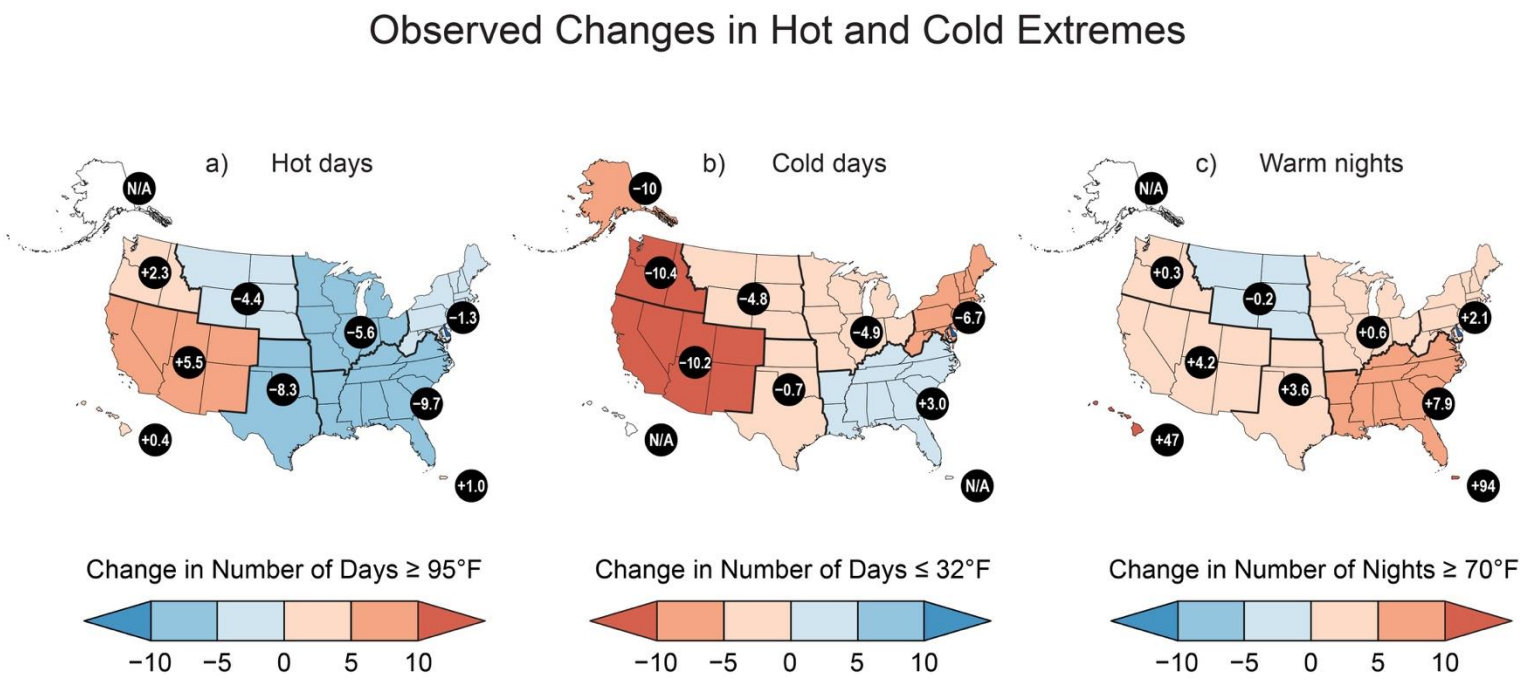
NCA5 Fig. 2.4

5th National Climate Assessment: https://nca2023.globalchange.gov/chapter/2/

Observed Changes in Extremes



NCA5 Fig. 2.8

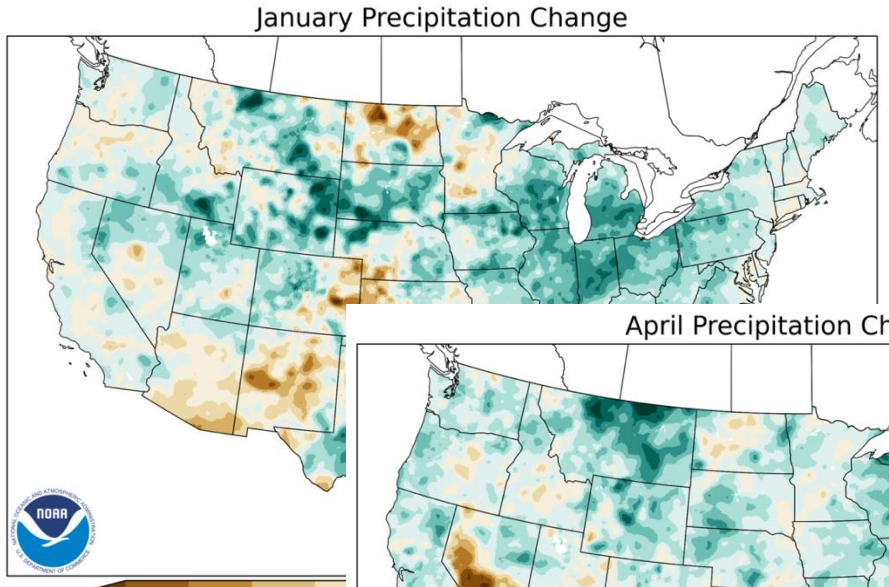


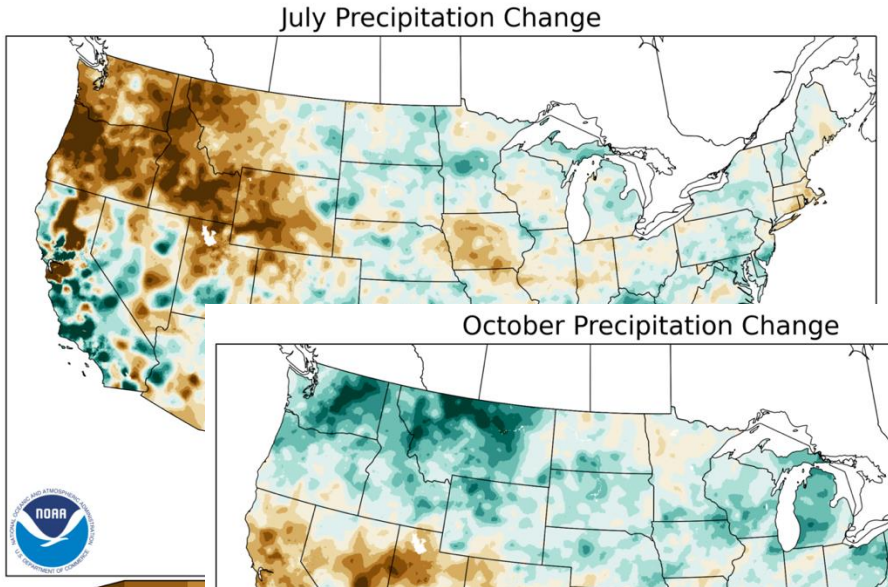
NCA5 Fig. 2.7

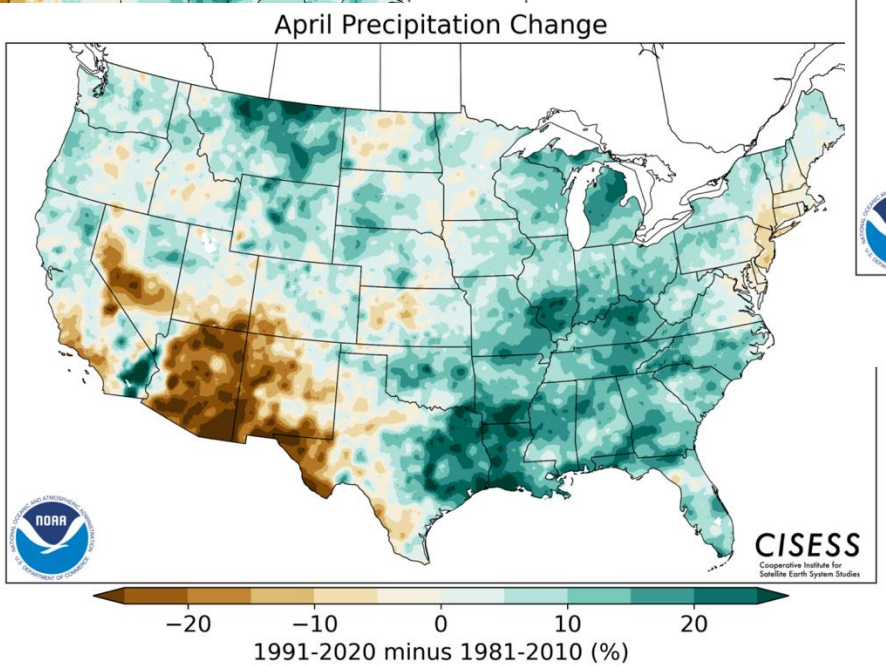
5th National Climate Assessment: https://nca2023.globalchange.gov/chapter/2/

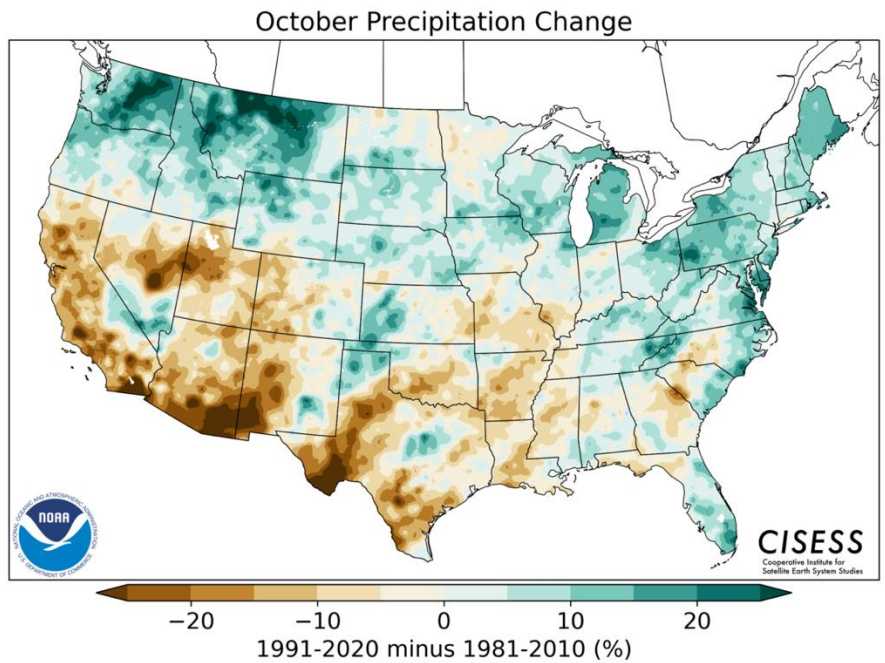
Seasonal Changes

https://www.ncei.noaa.gov/products/us-climate-normals









Increasing Risk of Extreme Rainfall

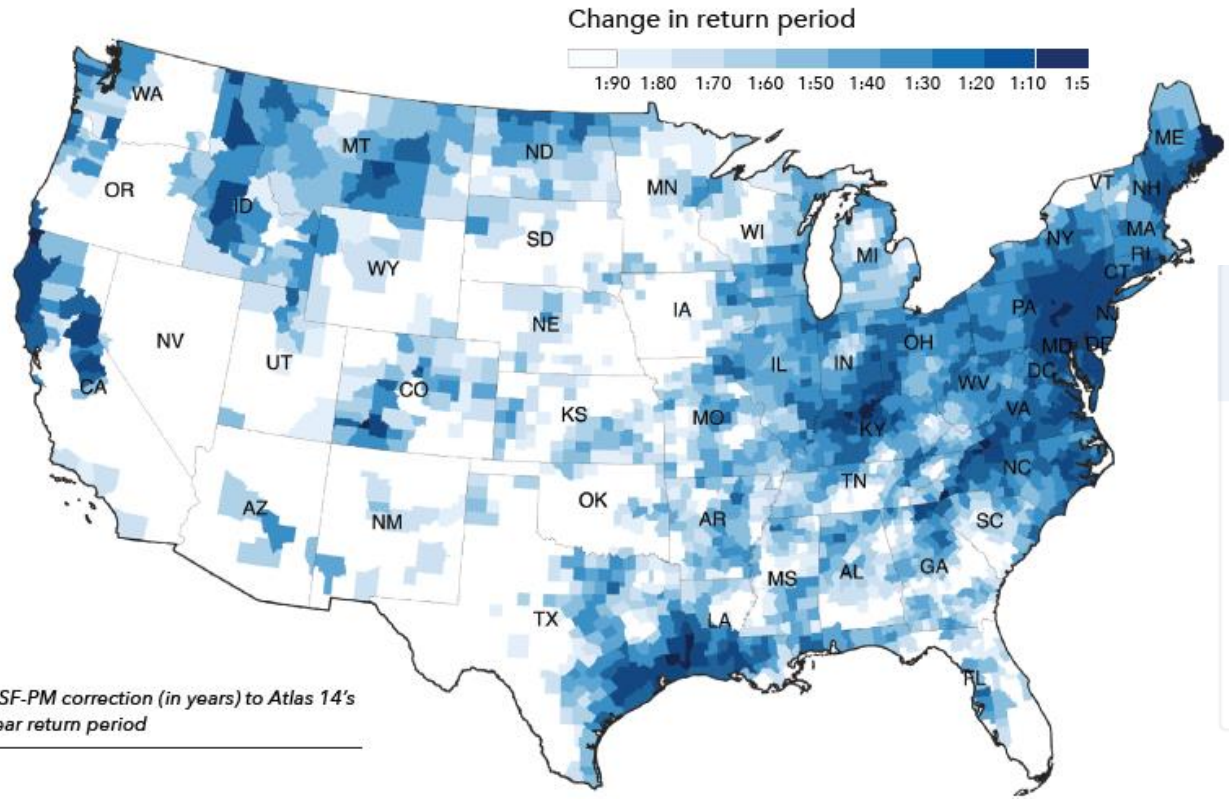


Figure 3: FSF-PM correction (in years) to Atlas 14's 1-in-100 year return period

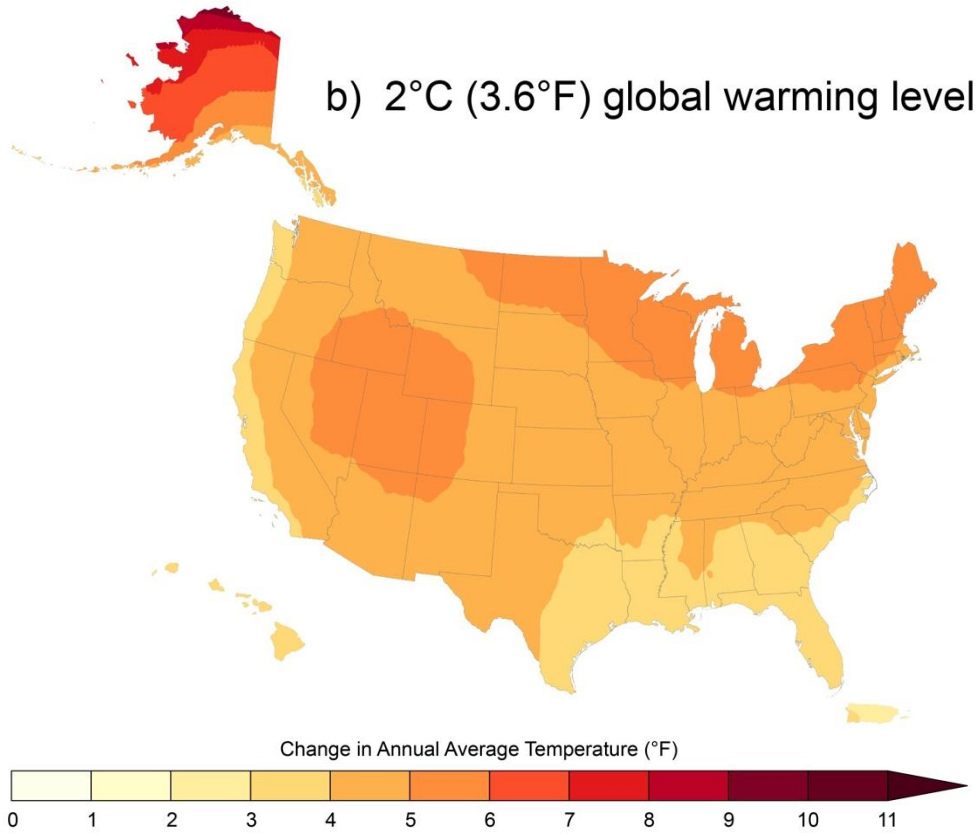
First Street Foundation:
https://firststreet.org/research-lab/published-research/article-highlights-from-the-precipitation-problem/

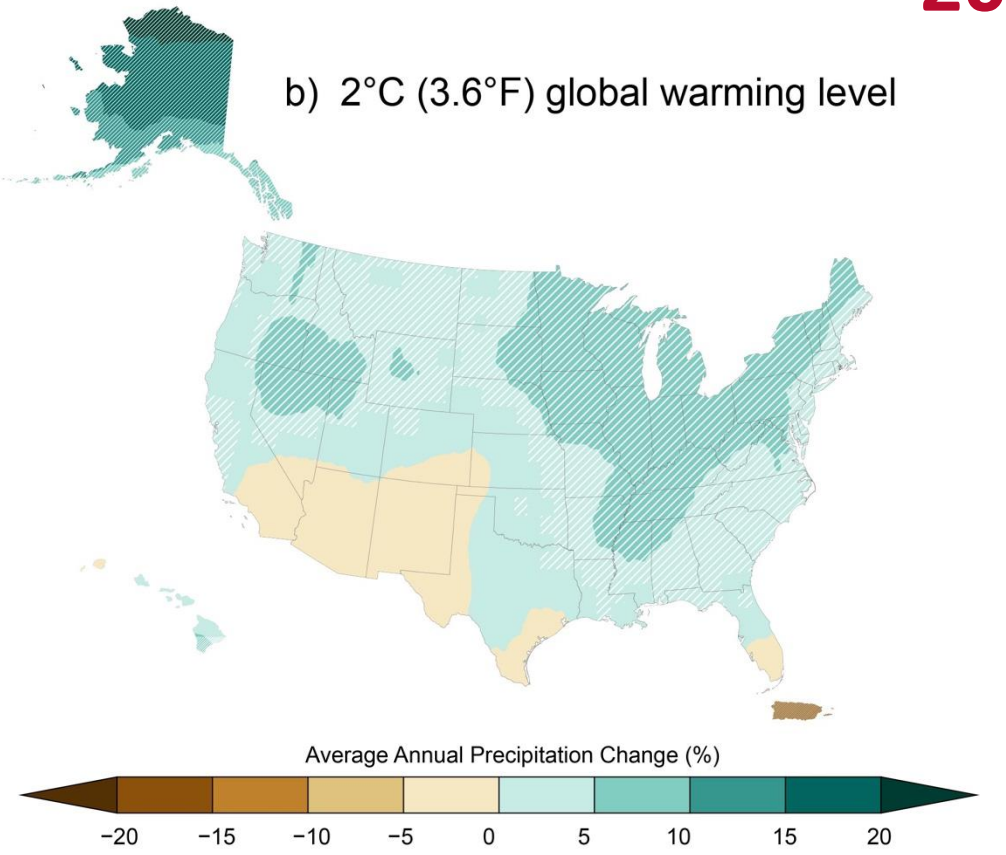
Table 3: Selected highly populated cities impacted by Atlas 14 to FSF-PM corrections

City	Atlas 14	Corrected for today	30 year correction
Baltimore, Maryland	1 in 100	1 in 14 (+614%)	1 in 12 (+733%)
Dallas, Texas	1 in 100	1 in 21 (+376%)	1 in 18 (+456%)
Washington, D.C.	1 in 100	1 in 21 (+376%)	1 in 19 (+426%)
New York City, New York	1 in 100	1 in 23 (+335%)	1 in 19 (+426%)
Philadelphia, Pennsylvania	1 in 100	1 in 29 (+245%)	1 in 20 (+400%)
Chicago, Illinois	1 in 100	1 in 29 (+245%)	1 in 26 (+285%)
Detroit, Michigan	1 in 100	1 in 34 (+194%)	1 in 16 (+525%)
Boston, Massachusetts	1 in 100	1 in 37 (+170%)	1 in 33 (+203%)

Our Future Climate Under Intermediate Scenario

~2053





5th National Climate Assessment: https://nca2023.globalchange.gov/chapter/2/

From NCA5 Figs. 2.9 and 2.10

Rapid Oscillations in Precipitation Regimes

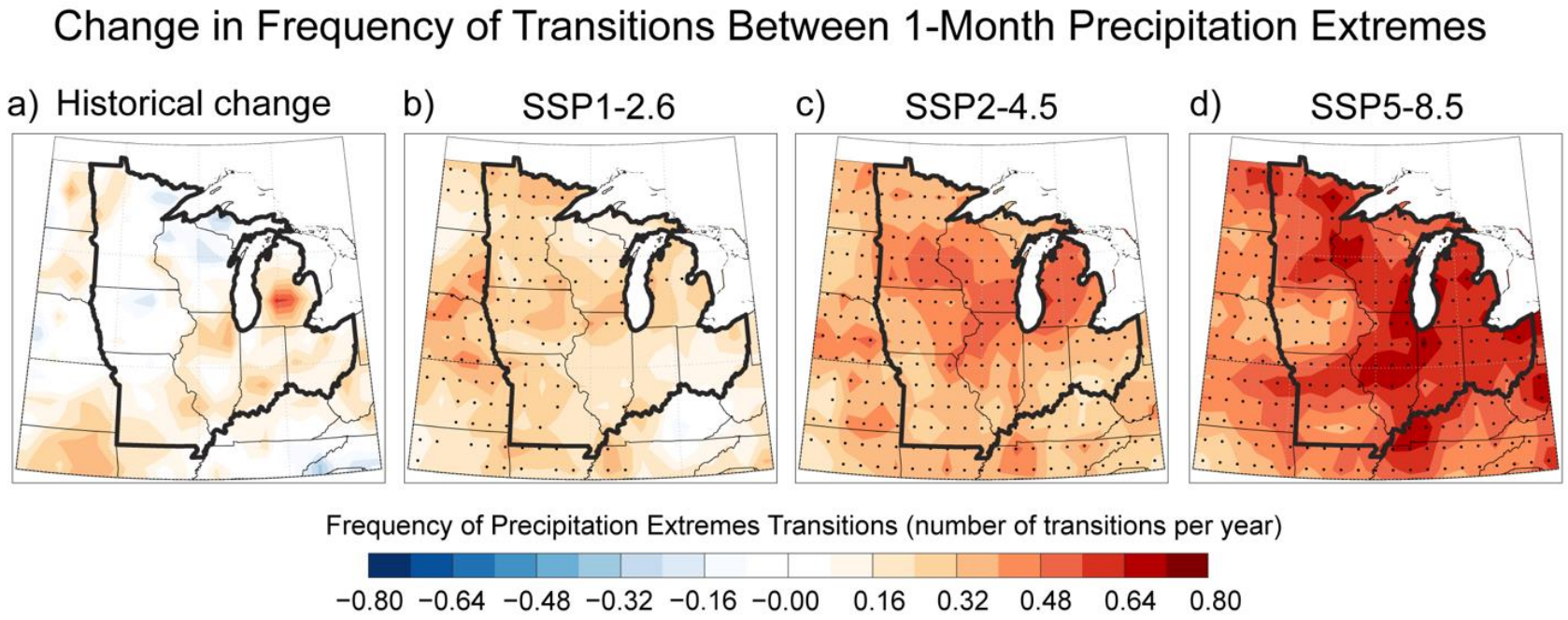


Figure 24.1. The frequency of wet–dry and dry-wet transitions across the Midwest is projected to increase by late century (2071–2100).

Assessing the Risk

Temperature

- Demand for water and energy increases
- Heat-related illnesses increase
- Heatwave burdens on small and local business, gardeners
- Deteriorated air quality – western wildfire smoke induced health issues

Precipitation

- Increased risk of damage to energy & water infrastructure
- Management challenges of rapid oscillations between extreme wet and dry
- Exposure to waterborne pathogens and vector control
- Property damage due to extreme weather events
- Reduced water quality

Key Message 1: Climate-Smart Practices May Offset Complex Climate Interactions in Agriculture

Crop production is projected to change in complex ways (likely, medium confidence) due to increasing extreme precipitation events and transitions between wet and dry conditions (likely, medium confidence), as well as intensification of crop water loss (likely, low confidence). Changes in precipitation extremes, timing of snowmelt, and early-spring rainfall are expected to pose greater challenges for crop and animal agriculture, including increased pest and disease transmission, muddier pastures, and further degradation of water quality (likely, high confidence). Climate-smart agriculture and other adaptation techniques provide a potential path toward environmental and economic sustainability (medium confidence).

Climate Smart

Freeze-Damaged Apple Blossoms

Figure 24.2. Early warmth and flowering followed by freezing temperatures in the spring poses risks to perennial and annual crops.

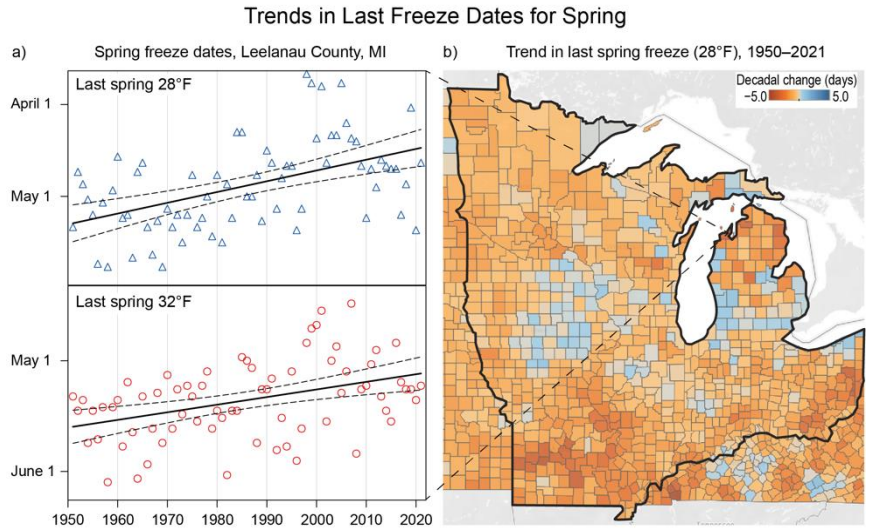
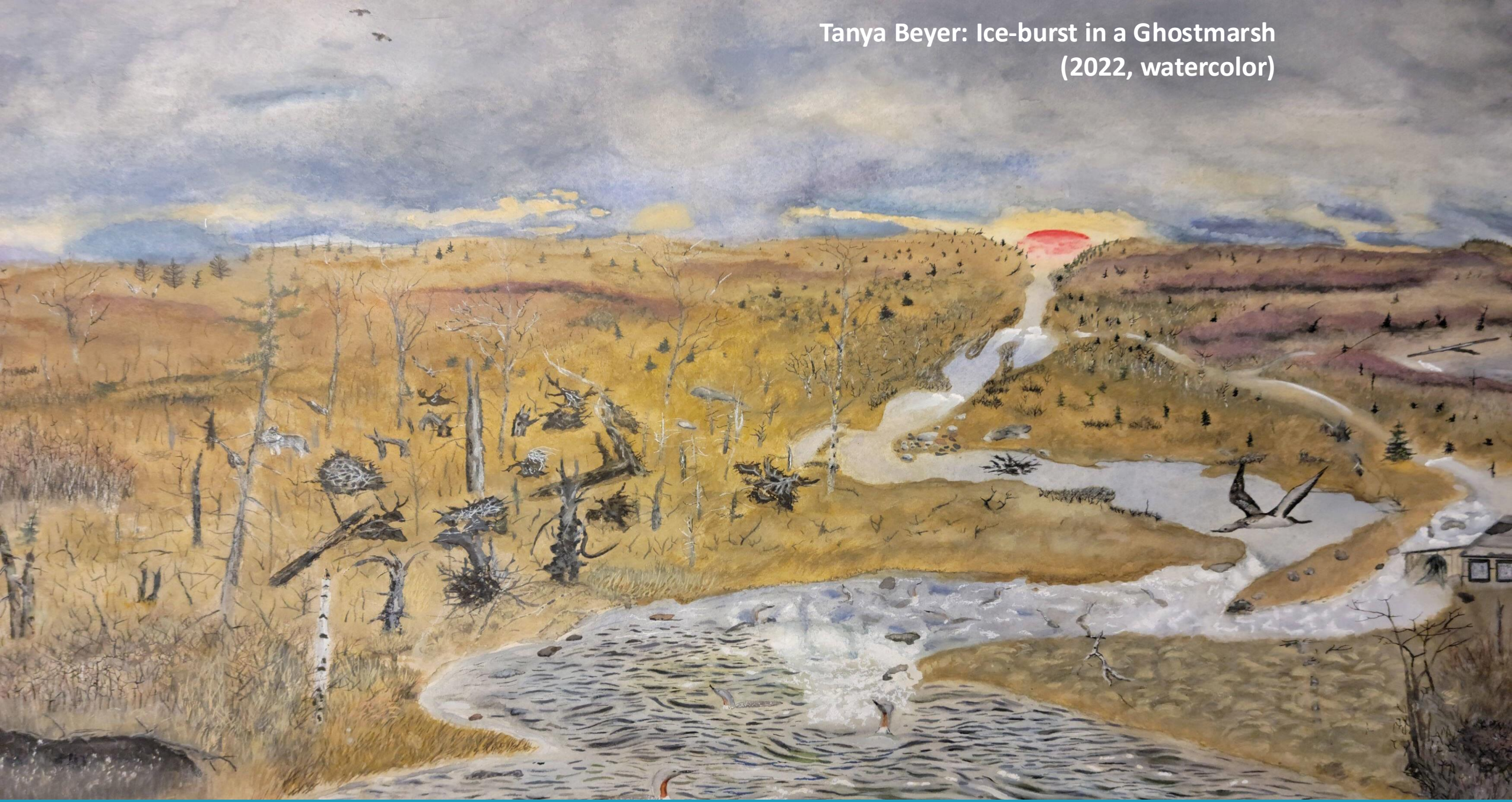


Figure 24.3. Last spring freezes are occurring earlier over most of the Midwest region.

Figure 24.4. Climate-smart agricultural strategies may have adaptation and mitigation advantages that balance agricultural needs and environmental impacts.



Tanya Beyer: Ice-burst in a Ghostmarsh
(2022, watercolor)

Key Message 2: Adaptation May Ease Disruptions to Ecosystems and Their Services

Ecosystems are already being affected by changes in extreme weather and other climate-related changes, with negative impacts on a wide range of species (likely, high confidence). Increasing incidence of flooding and drought is expected to further alter aquatic ecosystems (likely, medium confidence), while terrestrial ecosystems are being reshaped by rising temperatures and decreasing snow and ice cover (very likely, high confidence). Loss of ecosystem services is undermining human well-being, causing the loss of economic, cultural, and health benefits (medium confidence). In response, communities are adapting their cultural practices and the ways they manage the landscape, preserving and protecting ecosystems and the services they provide (low confidence).

Extreme Rainfall/Ice Cover

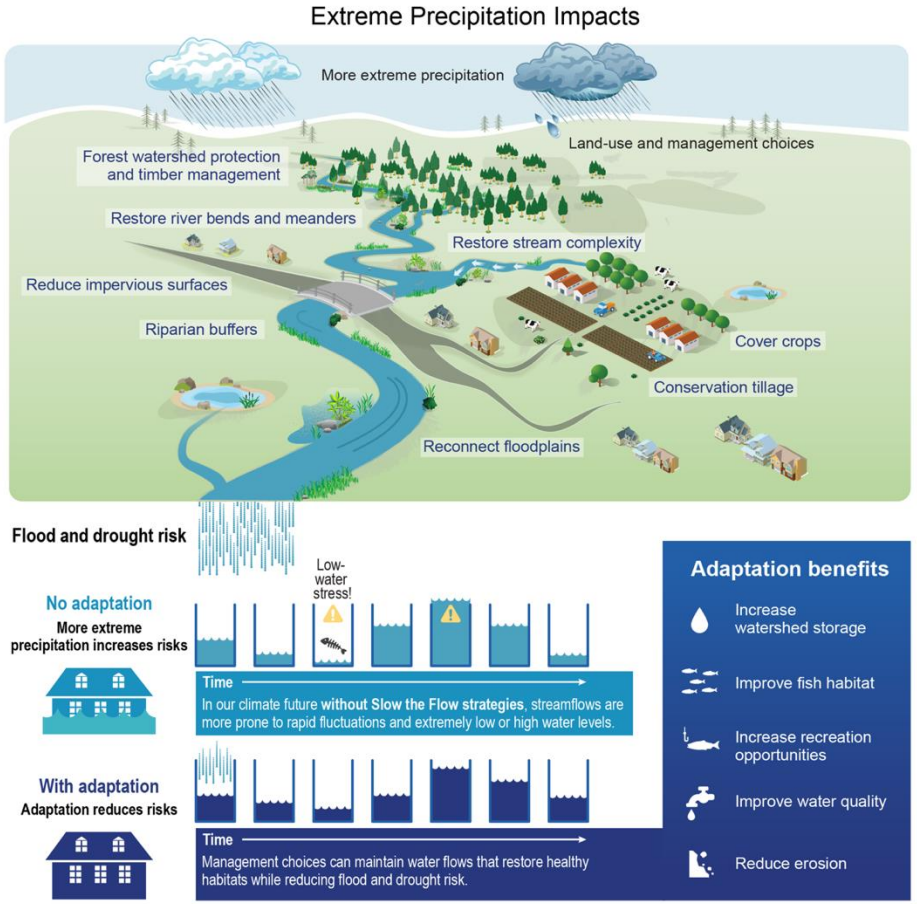


Figure 24.5. Extreme precipitation events have adverse impacts on aquatic and terrestrial ecosystems, human health, infrastructure, and economies. Conservation and management strategies can help moderate these impacts.

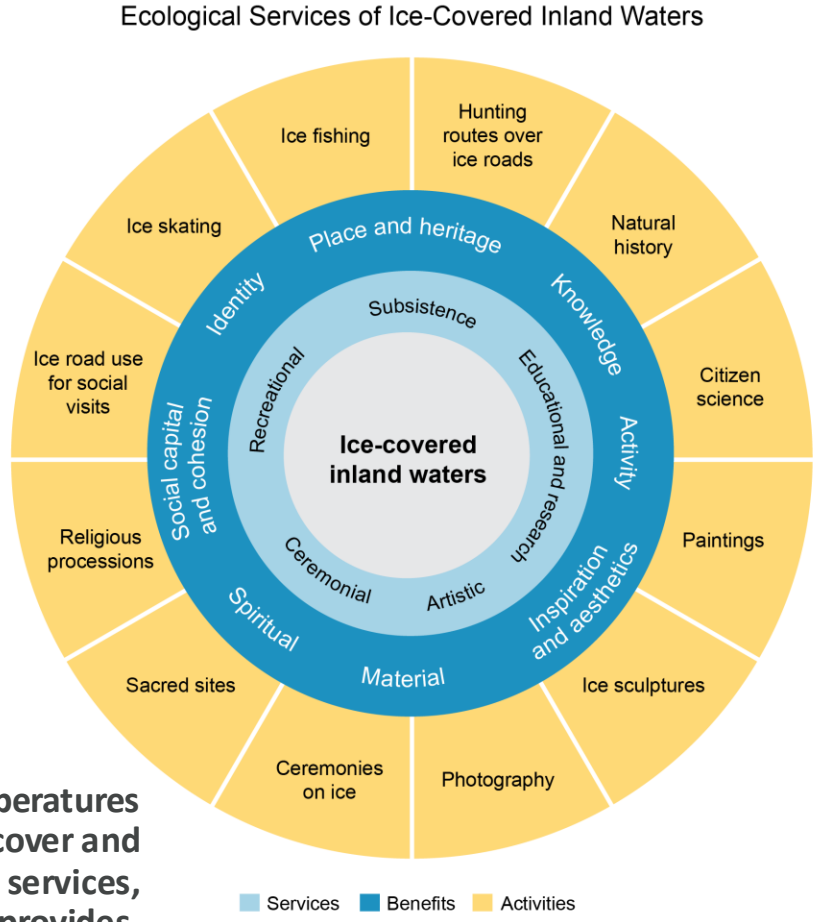


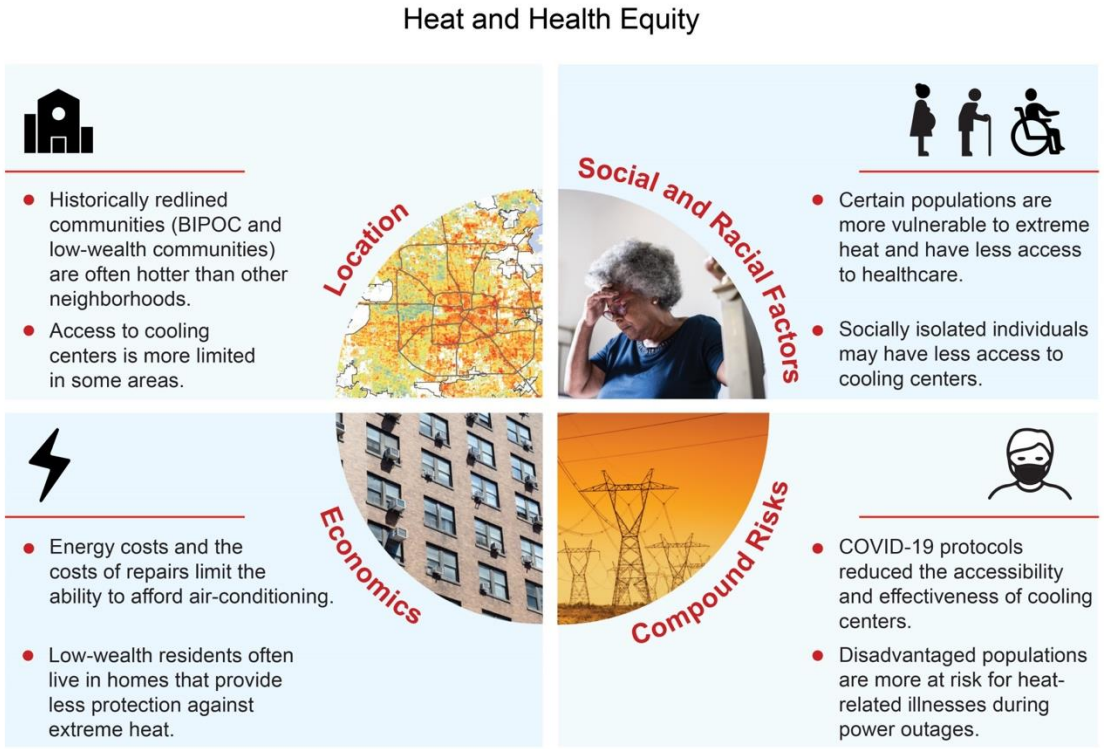
Figure 24.6. Rising winter temperatures are decreasing inland lake ice cover and the associated ecosystem services, benefits, and activities it provides.

Key Message 3: Climate Adaptation and Mitigation Strategies Improve Individual and Community Health

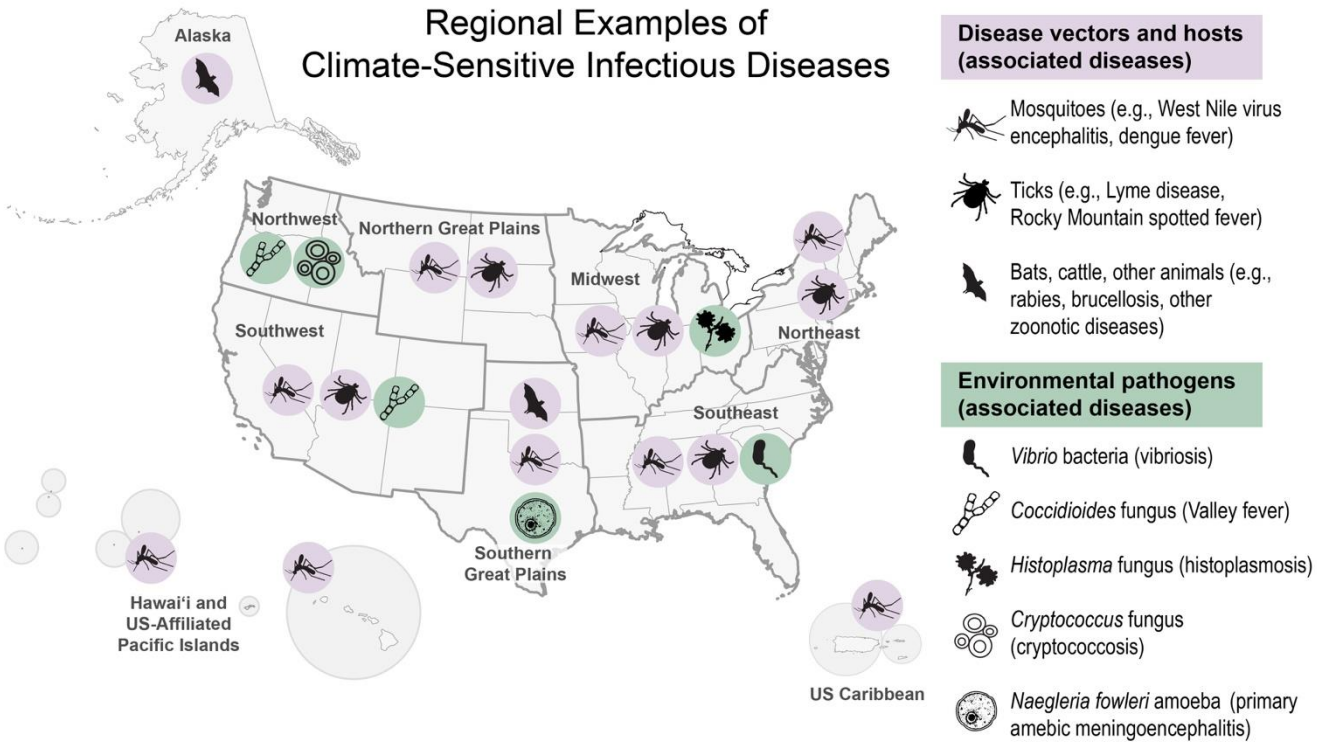
Climate change has wide-ranging effects on lives and livelihoods (very likely, very high confidence), healthcare systems (high confidence), and community cohesion (high confidence). These diverse impacts will require integrated, innovative response from collaborations between public health and other sectors, such as emergency management, agriculture, and urban planning. Because of historical and systemic biases, communities of color are especially vulnerable to these negative impacts (very likely, very high confidence). Mitigation and adaptation strategies, such as expanded use of green infrastructure, heat-health early warning systems, and improved stormwater management systems, when developed in collaboration with affected communities, have the potential to improve individual and community health (high confidence).

Broad Health Concerns

5th National Climate Assessment: https://nca2023.globalchange.gov/chapter/15/

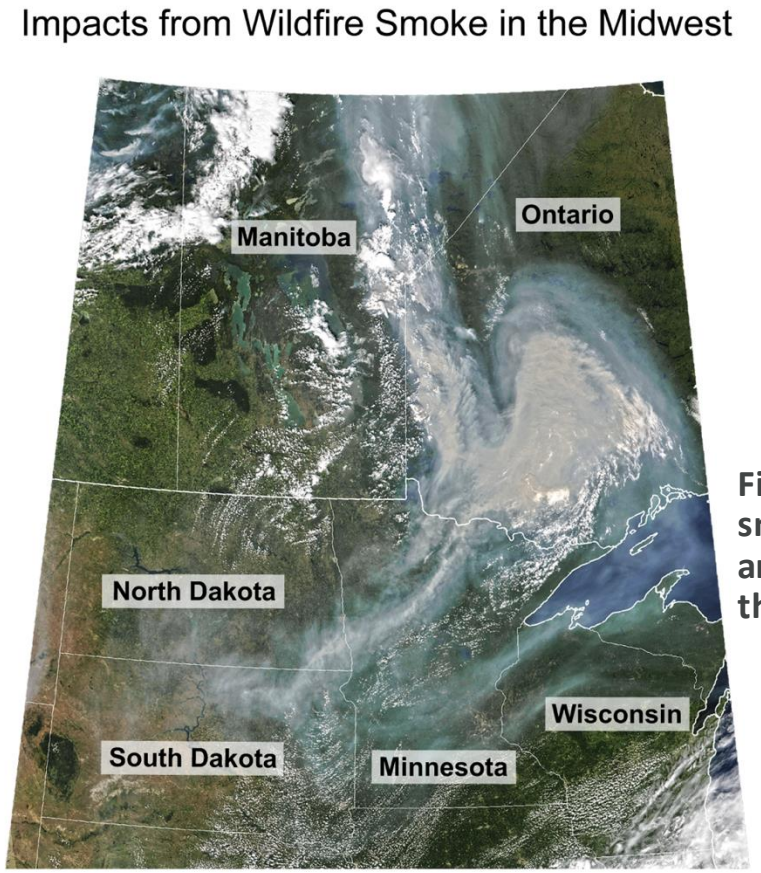


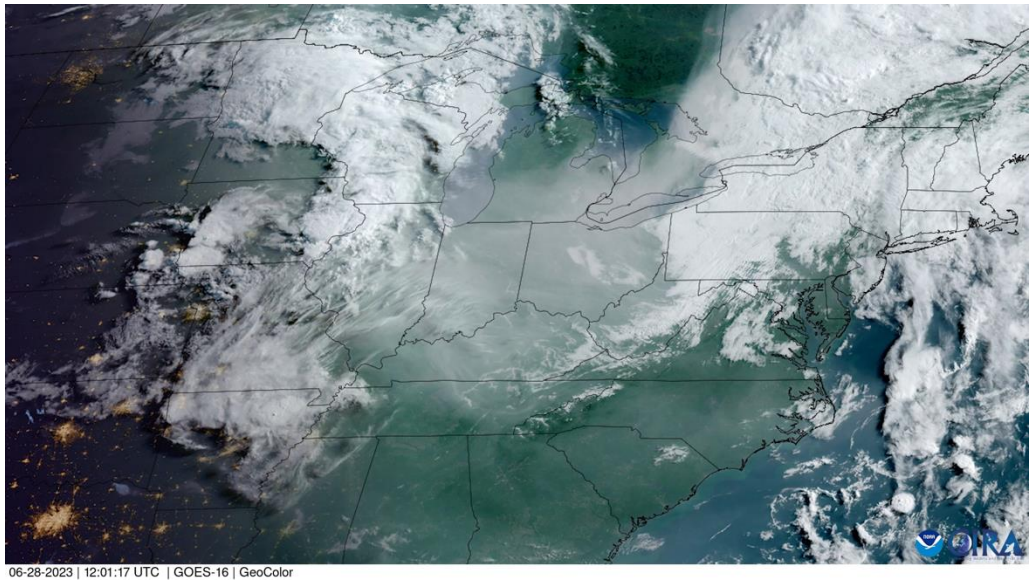
NCA5 Fig. 15.1



NCA5 Fig. 15.2

Wildfire Smoke





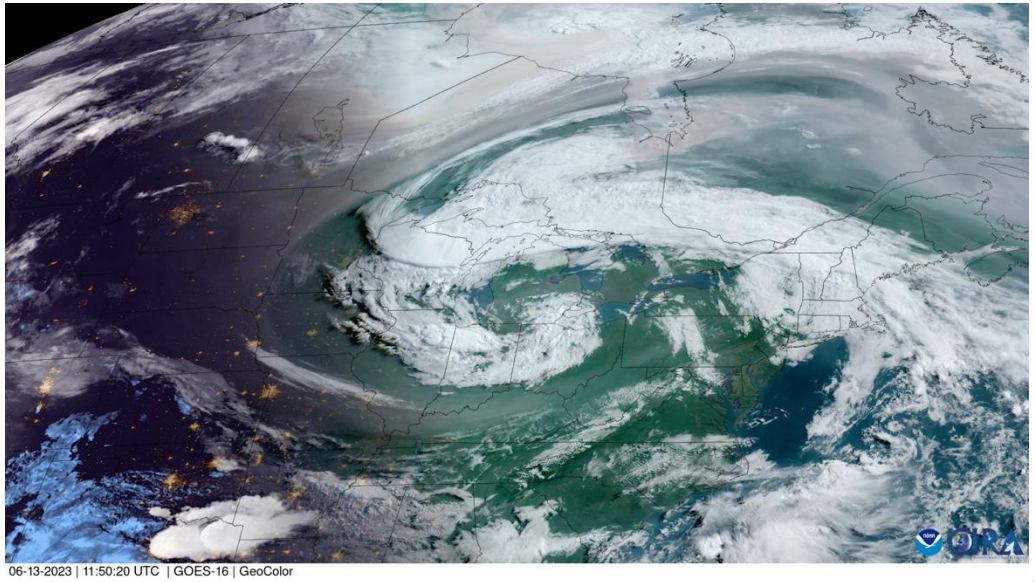


Figure 24.7. Wildfire smoke from both local and distant sources threatens human health.

Lyme Disease

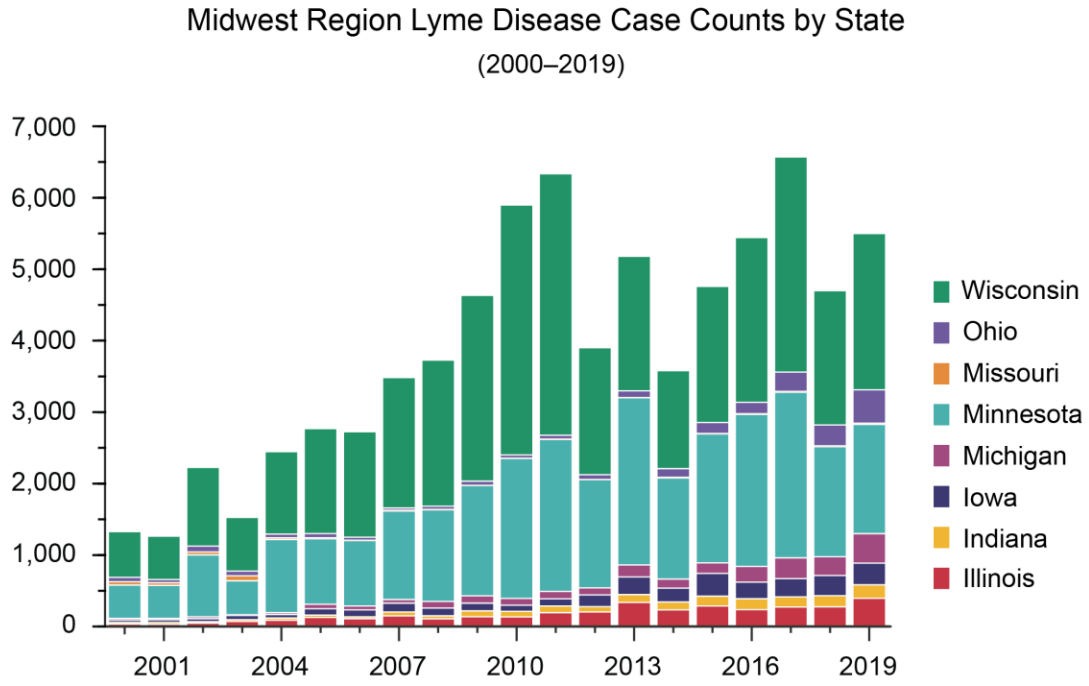


Figure 24.8. Lyme disease incidence has increased across the Midwest.

Climate Resilience for *Healthier* Outcomes

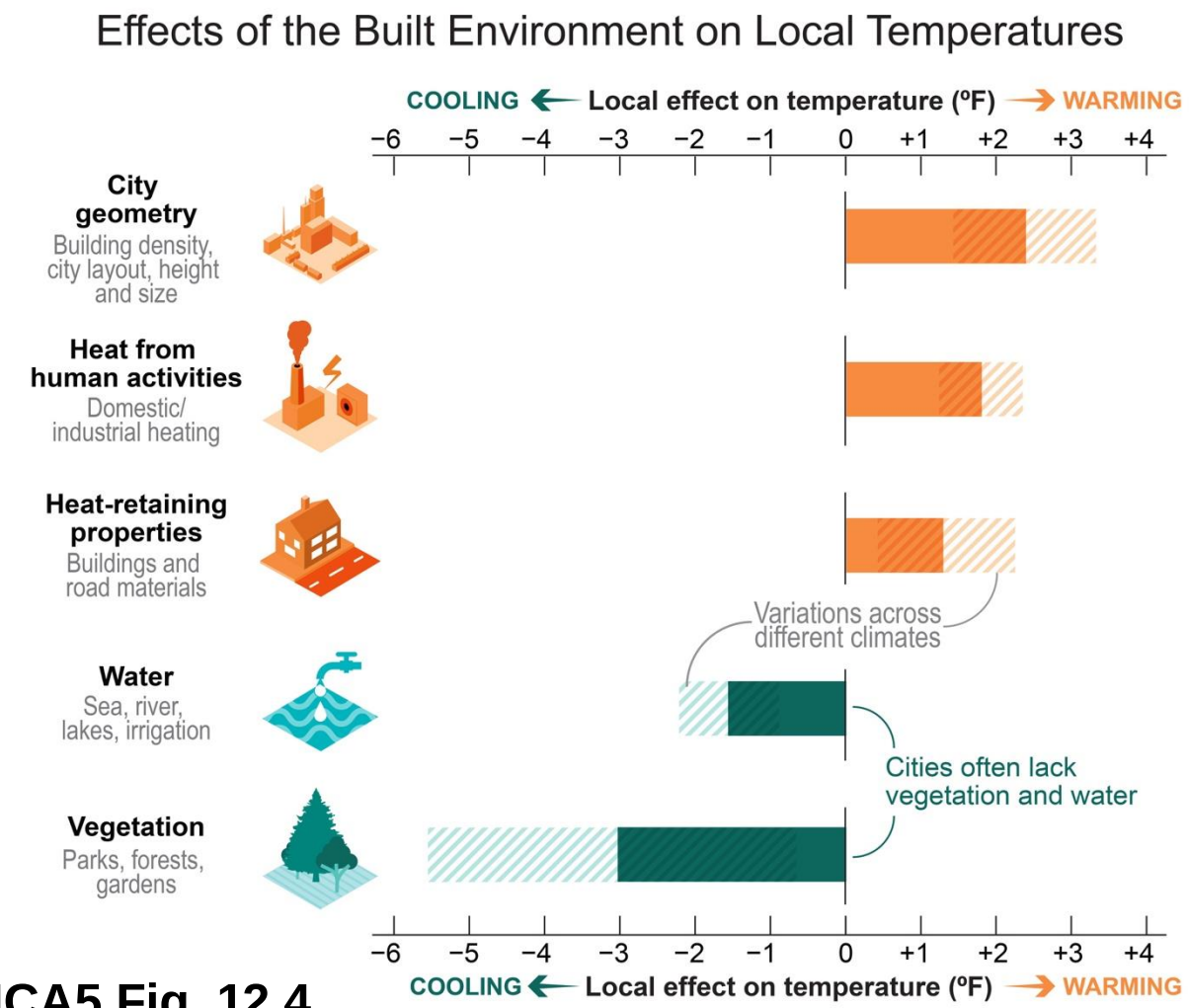
- Health outcomes are linked to key social and environmental determinants of health - disrupt community well-being
- Actions across the Midwest include increasing tree cover, weatherization programs, improved stormwater management, and heat-health early warning systems
- Leadership efforts by the emergency management sector in the Midwest to address climate threats to individual and community health highlight the important role for this sector in adaptation planning.

Key Message 4: Green Infrastructure and Investment Solutions Can Address Costly Climate Change Impacts

Increases in temperatures and extreme precipitation events are already challenging aging infrastructure and are expected to impair surface transportation, water navigation, and the electrical grid (likely, medium confidence). Shifts in the timing and intensity of rainfall are expected to disrupt transportation along major rivers and increase chronic flooding (likely, high confidence). Green infrastructure and public and private investments may mitigate losses, provide relief from heat, and offer other ways to adapt the built environment to a changing climate (medium confidence).

EGLE Water Resources Division

Impacts on Local Conditions



NCA5 Fig. 12.4

5th National Climate Assessment: https://nca2023.globalchange.gov/chapter/12/

Resilient Infrastructure

Innovative Finance and Green Infrastructure

- Federal funding and increase in private investment and environmental impact bonds (EIBs)
- Milwaukee Metropolitan Sewer ; Bee Branch Watershed Flood Mitigation Project in Dubuque, Iowa

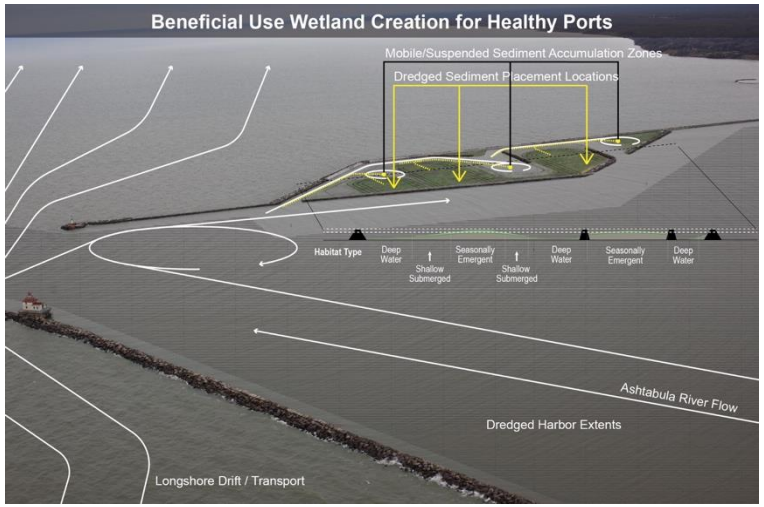


Figure 24.9. Innovative design of coastal infrastructure, such as the Ashtabula Port, allows the built environment to deliver social and environmental services.

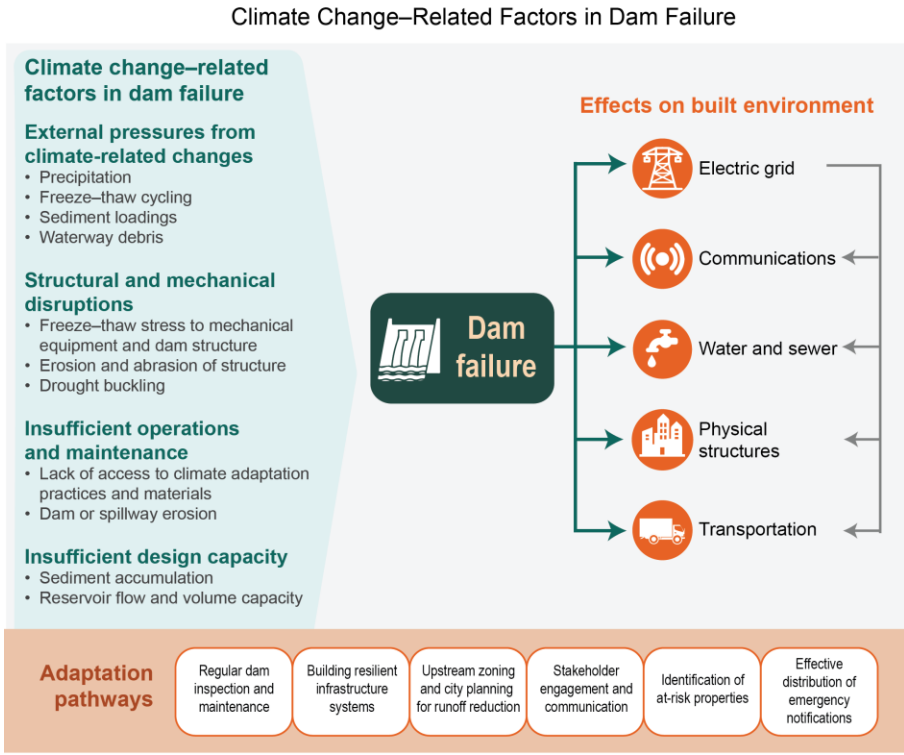
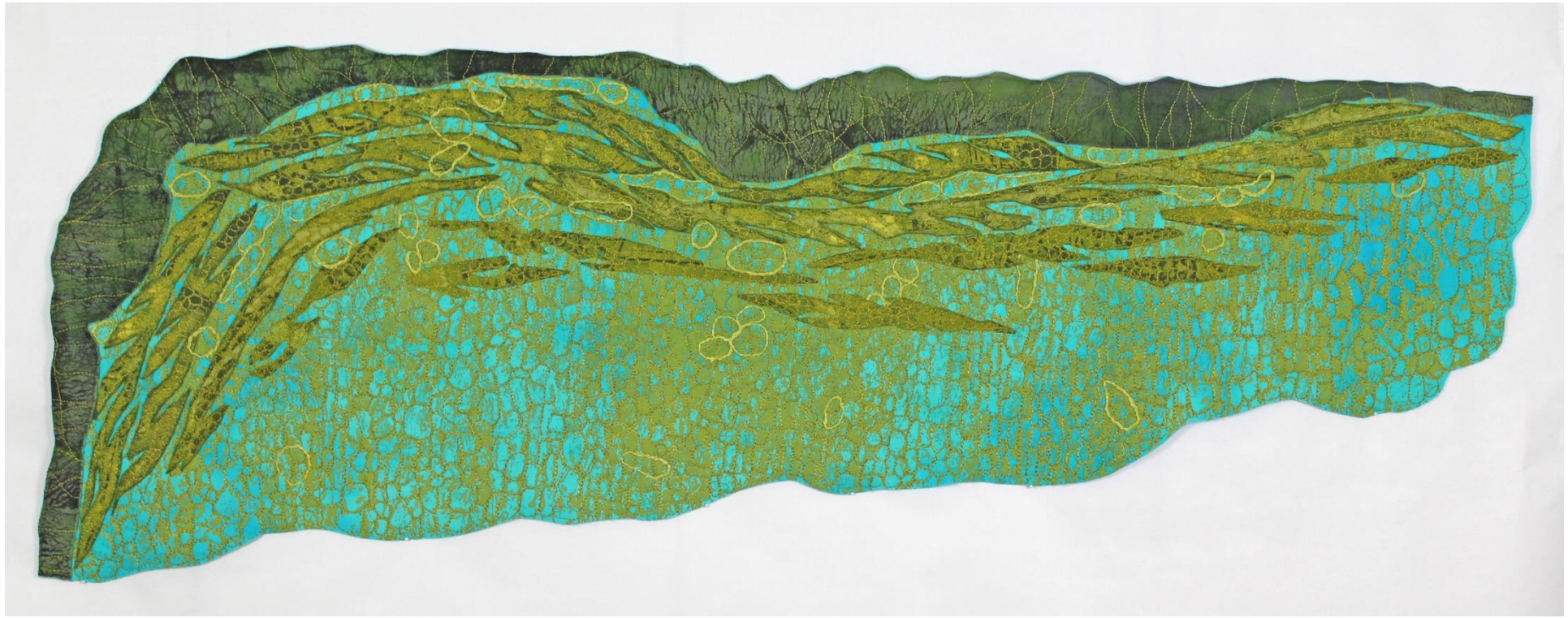
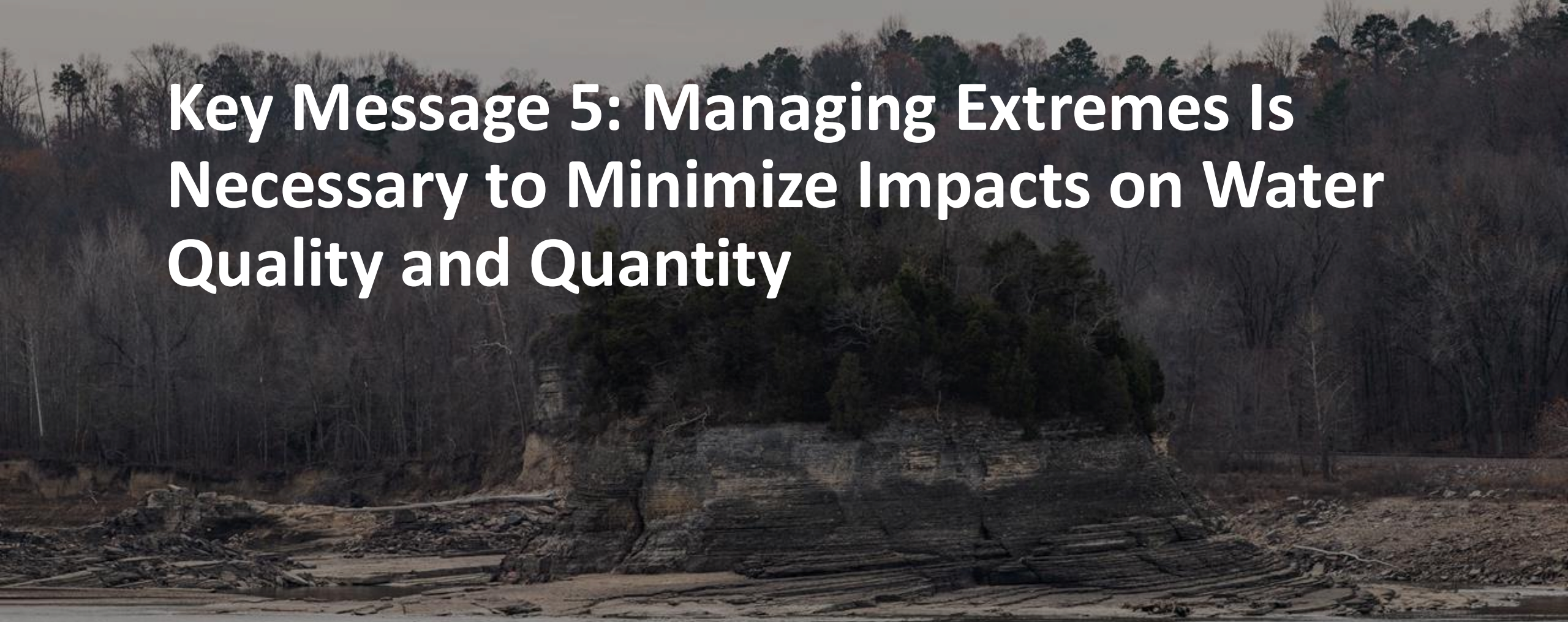


Figure 24.10. Climate change–related factors contribute to dam failure, with cascading impacts on the built environment.

Pat DaRif
Coastal Bloom II
(2020, fiber)

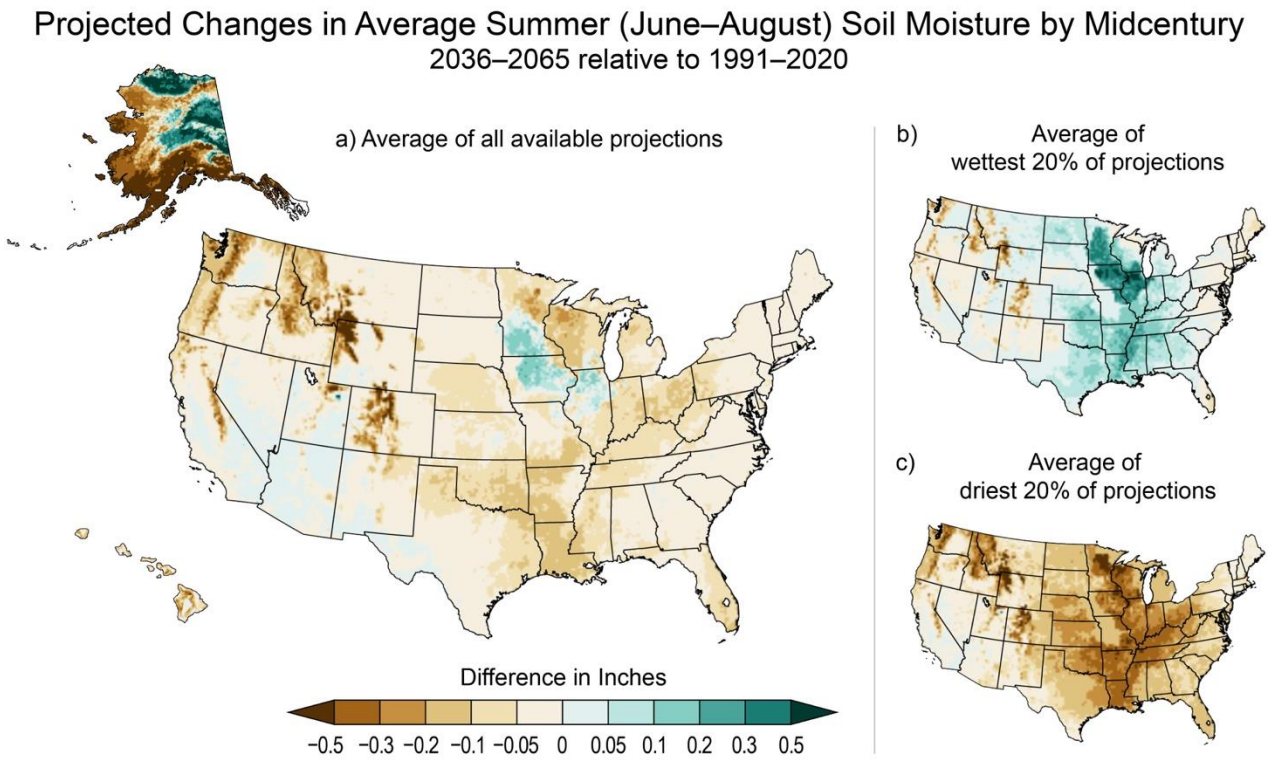




Key Message 5: Managing Extremes Is Necessary to Minimize Impacts on Water Quality and Quantity

Climate-related changes to water quantity and quality are increasing the risks to ecosystem health, adequate food production, surface water and groundwater uses, and recreation (high confidence). Projected increases in droughts, floods, and runoff events across the Mississippi River basin and the Great Lakes will adversely impact ecosystems through increased erosion, harmful algal blooms, and expansion of invasive species (likely, high confidence). Federal and state agencies and nongovernmental organizations are cooperating on adaptation efforts related to streamflow, water quality, and other water issues (high confidence).

Key Message 5



NCA5 Fig. 4.6: Projected Changes in Average Summer (June–August) Soil Moisture by Midcentury

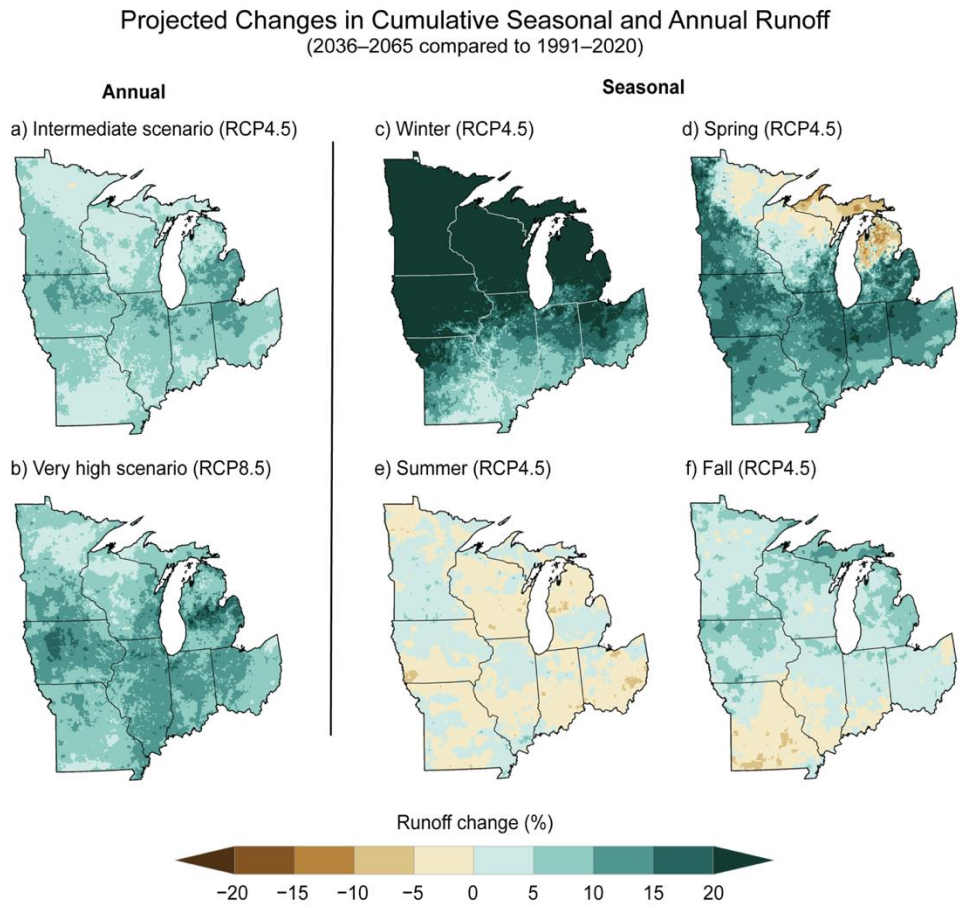


Figure 24.11. Projected changes in cumulative local runoff will lead to increased flooding susceptibility in winter and spring with, increased flash drought potential in summer.

Ground Water Considerations

- Variable projections of groundwater recharge – external water added to saturation zone- increased in failures of private wells as water tables fall
- Dependent on the primary source of water use and drinking water – droughts will have different impacts
- Aquifers are more resilient to the rapid transitions but impacted by longer term drought conditions – projected warmer temperatures and more variable summer runoff suggests an increase in drought
- Good stormwater runoff – urban and rural water managers implementing BMPs in ways that make sense locally

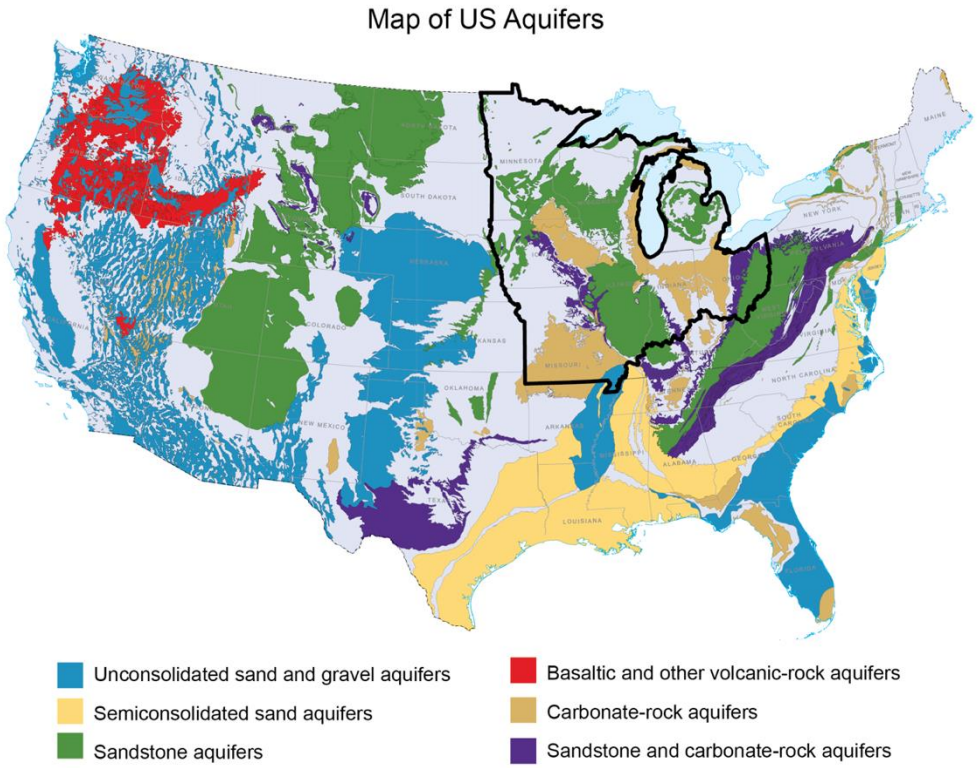
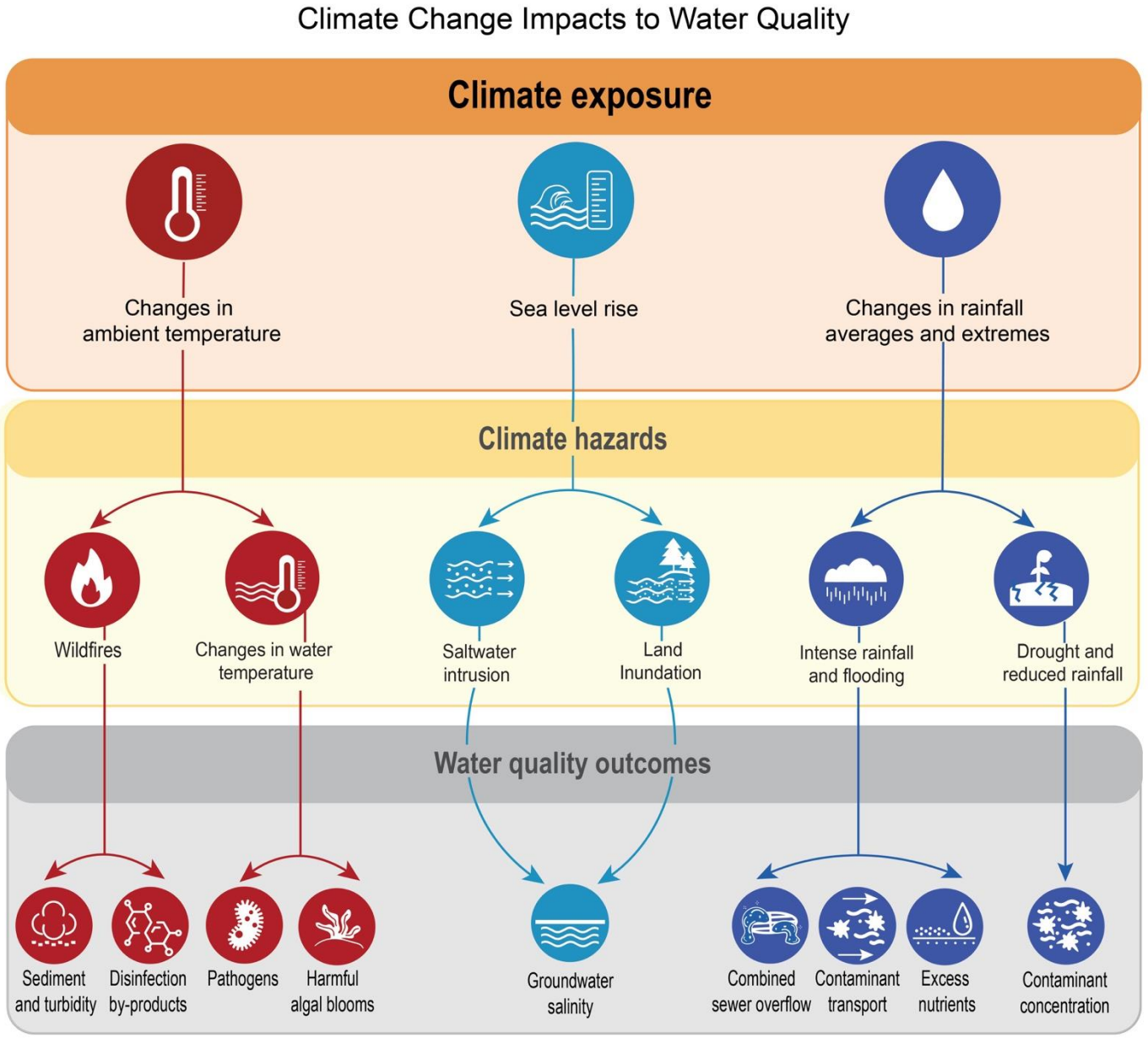


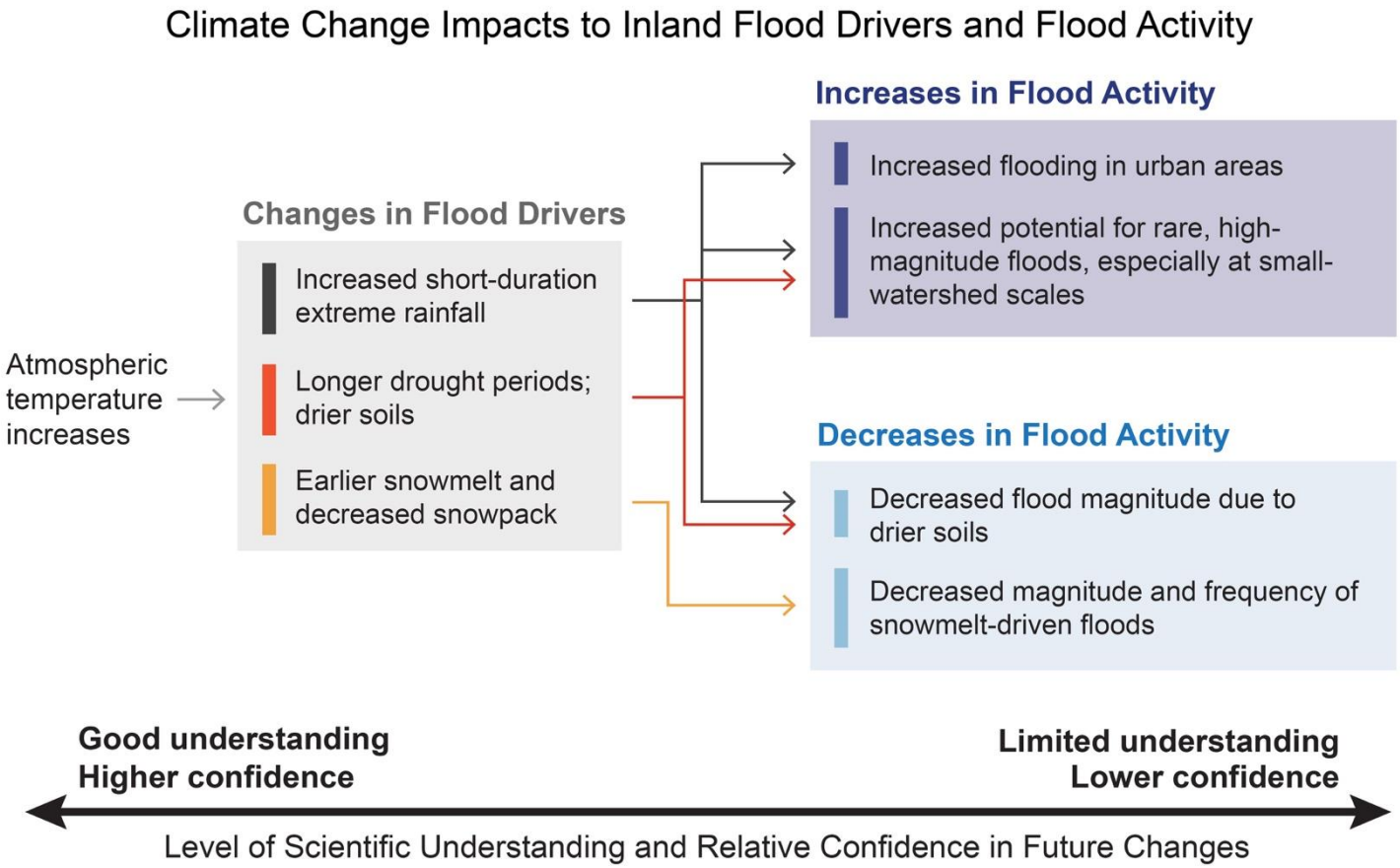
Figure 24.12. Vulnerability to disruptions in water quality and quantity varies by location, depending on the primary source of water for drinking and other uses.

Climate Change Impacts to Water Quality

https://nca2023.globalchange.gov/chapter/4/



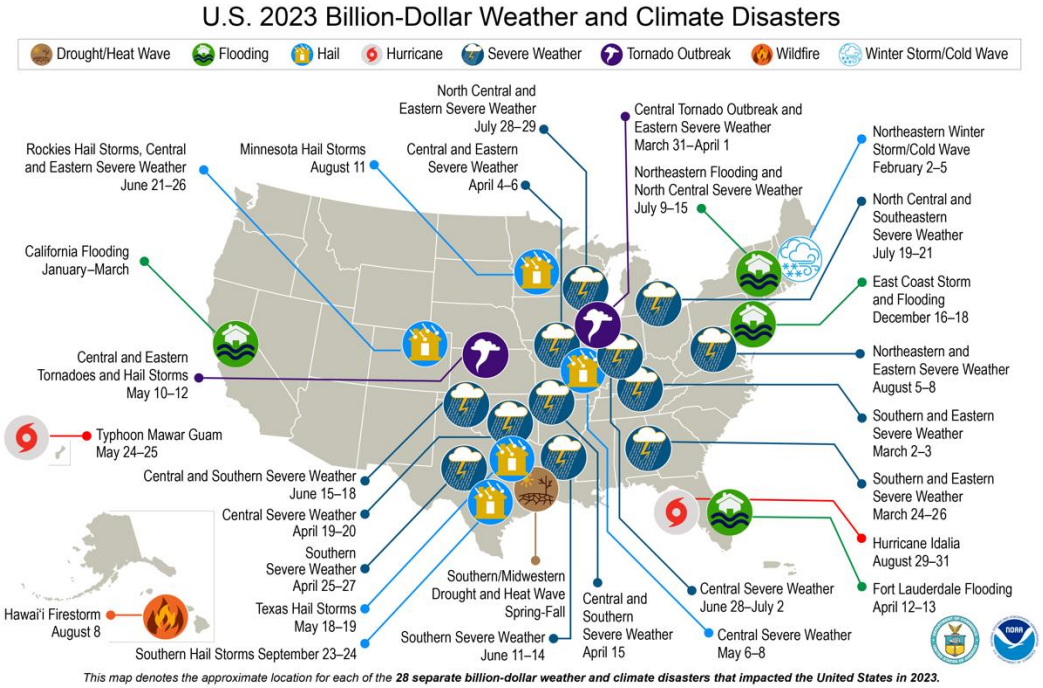
Inland Flood Drivers and Activity



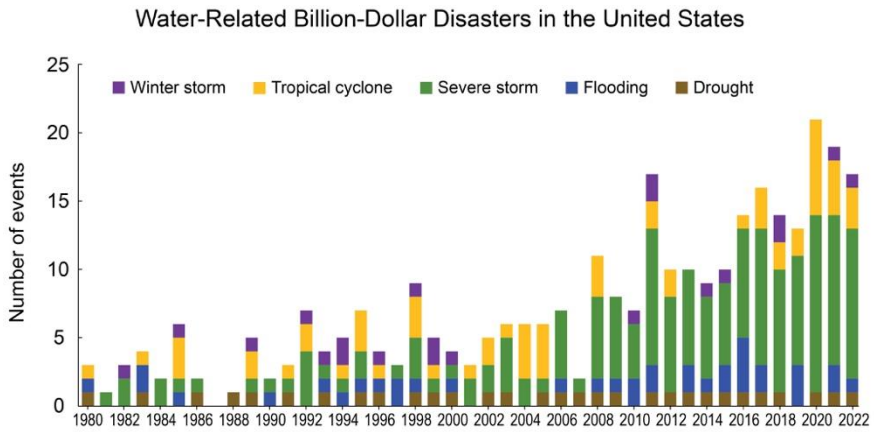
- Human Migration
- Supply Chain Disruptions
- Disproportionate burden on low-wealth communities and groups historically excluded from decision-making

https://nca2023.globalchange.gov/chapter/4/

Billion Dollar Disasters Floods



NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023). https://www.ncei.noaa.gov/access/billions/



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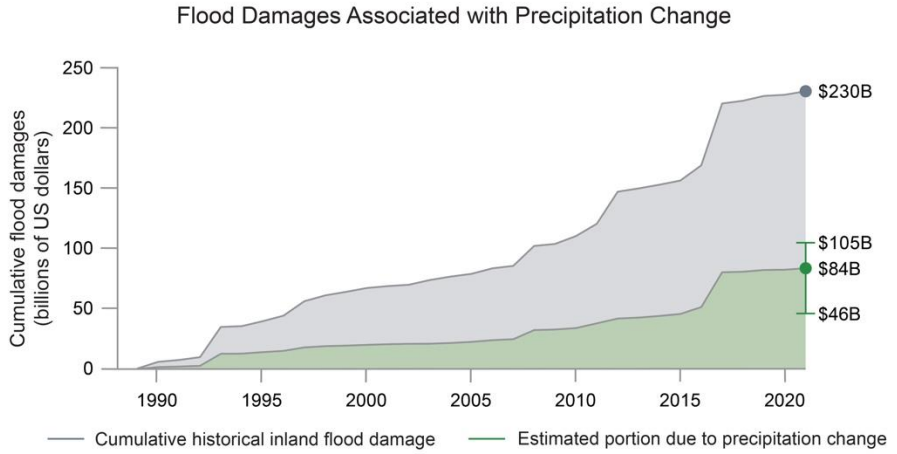
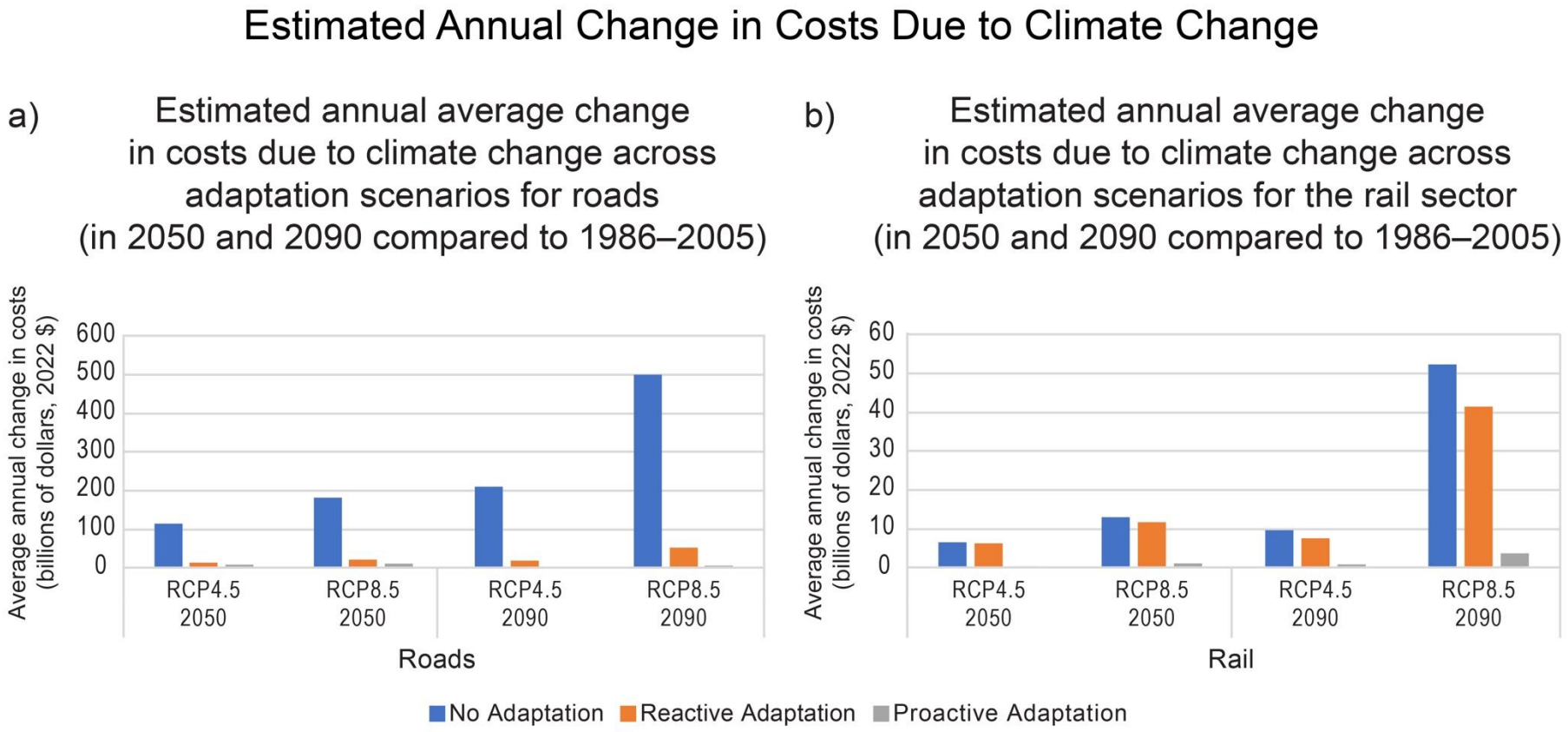


"Climate change–driven changes in precipitation amount and duration, snowpack/snowmelt, and soil moisture have combined with land-cover change and increasing property values to increase overall economic damages from floods."

Road and Rail Adaptation



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State of the Great Lakes

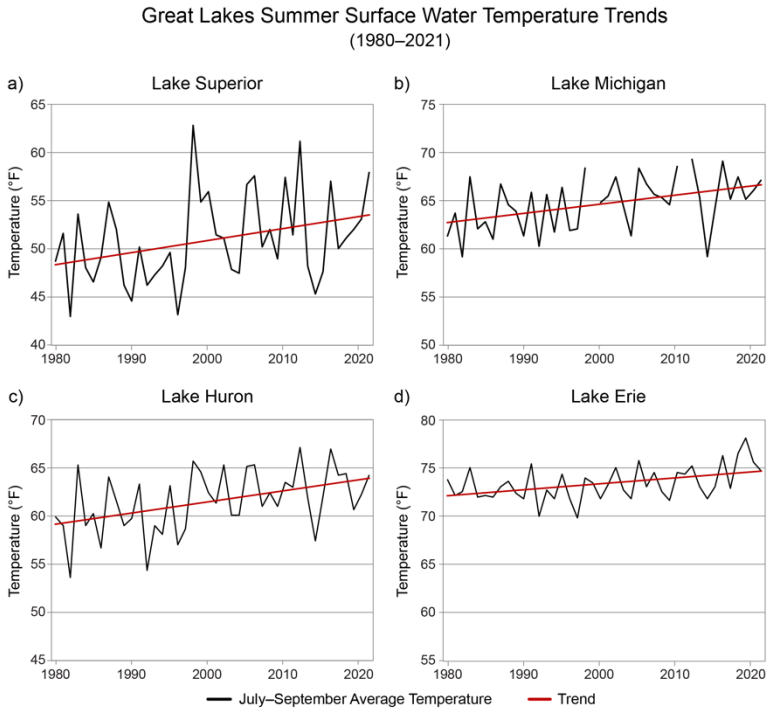


Figure 24.13. Summer surface water temperatures have been increasing for Lakes Superior, Michigan, Huron, and Erie since the late 1970s.

Table 24.1. State of the Great Lakes 2022 Assessment

CAPTION: The EPA and Environment and Climate Change Canada work jointly to meet the mission of the Great Lakes Water Quality Agreement. As part of this effort, the State of the Great Lakes Report is released every three years. The following table details the state of the Great Lakes using 10 Indicators. The assessments are basin-wide and typically vary between lakes. The metrics listed are synthesized to determine the status and trends of each indicator. The definitions for "poor," "fair," and "good" are quantitative, vary between indicators, and are documented in the report (ECCC and EPA, 2022).[282] Status assessments are not provided for the climate trends indicators. Adapted from ECCC and EPA 2022.[282]

Great Lakes Indicator	Metric	Status	Trend
Drinking Water	US/Canadian drinking water standards (microbial, radiological, chemical)	Good	Unchanging
Beaches	*E. coli* assays	Good	Unchanging–improving
Fish Consumption	Polychlorinated biphenyls [PCBs] and mercury in fish flesh	Fair	Improving
Toxic Chemicals	Concentrations of compounds (PCBs, mercury, polybrominated diphenyl ethers, and others) in sediment, water, whole fish, and herring gull eggs	Fair	Unchanging–improving
Habitat and Species	Overall health and habitat conditions and availability of invertebrates, fish, amphibians, birds, plants, connectivity	Fair	Unchanging
Nutrients and Algae	Nutrient concentration, harmful algal blooms, *Cladophora*	Fair	Unchanging
Invasive Species	Rate of introduction	Good	Unchanging
Invasive Species	Aquatic invasive species impacts	Poor	Deteriorating–unchanging
Groundwater	Chloride/nitrate concentrations	Good	Undetermined
Watershed Impacts	Forest and land cover, hardened shorelines, tributary water quality, human population	Fair	Unchanging
Climate Trends	Lake levels	N/A	Unchanging–increasing
Climate Trends	Surface water temperature	N/A	Increasing
Climate Trends	Ice cover	N/A	Decreasing

Assessing the Risk

Temperature

- Demand for water and energy increases
- Heat-related illnesses increase
- Heatwave burdens on small and local business, gardeners
- Deteriorated air quality – western wildfire smoke induced health issues

Precipitation

- Increased risk of damage to energy & water infrastructure
- Management challenges of rapid oscillations between extreme wet and dry
- Exposure to waterborne pathogens and vector control
- Property damage due to extreme weather events
- Reduced water quality

Adapting to Changing Water Cycle

- What strategies slow the progress of water to streams?
- What strategies improve the quality of the soil, thereby improving plant health and water storage capacity?
  - Reduced evaporation of water
  - Combatting higher humidity and/or extreme weather

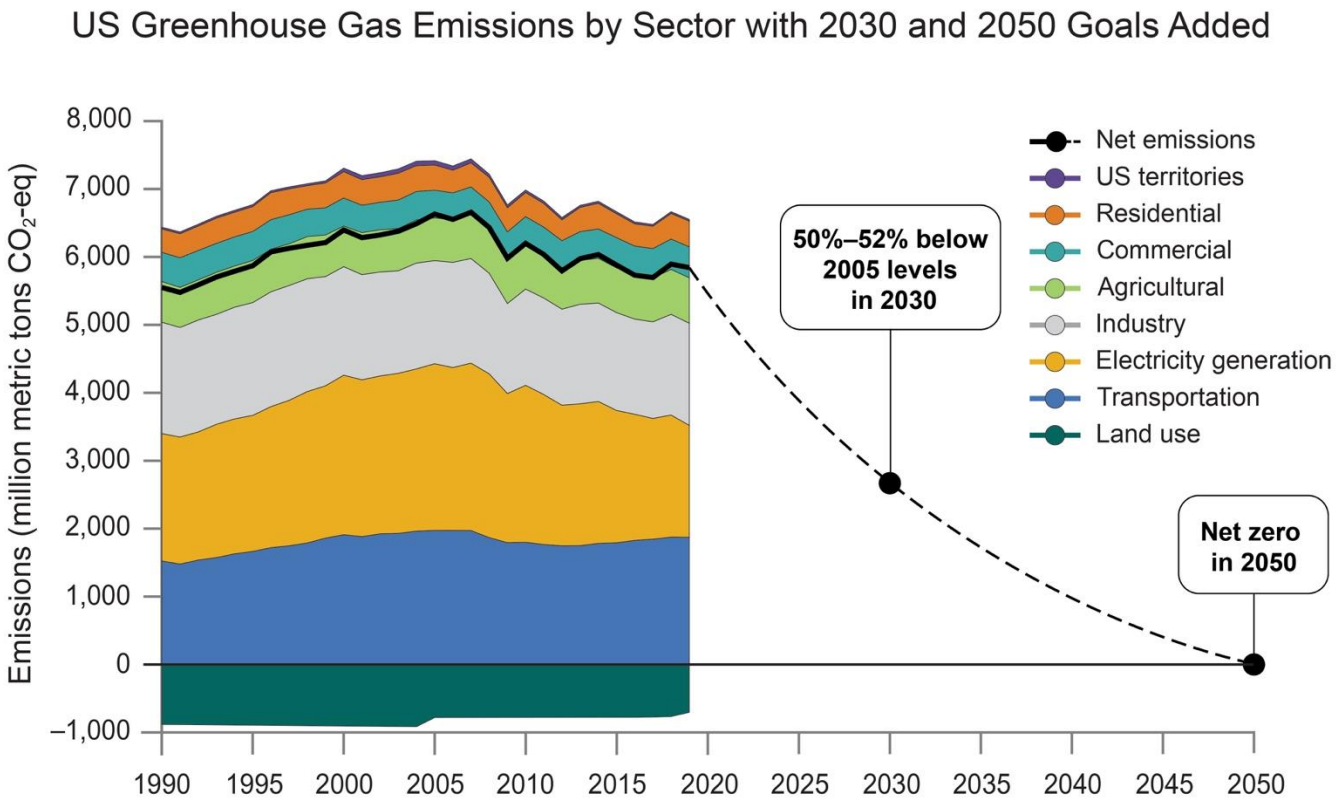
Urban Adaptation and Mitigation

- Green roofs for stormwater runoff retention
- Investments in design, construction, and long-term maintenance
- Done in just and equitable ways

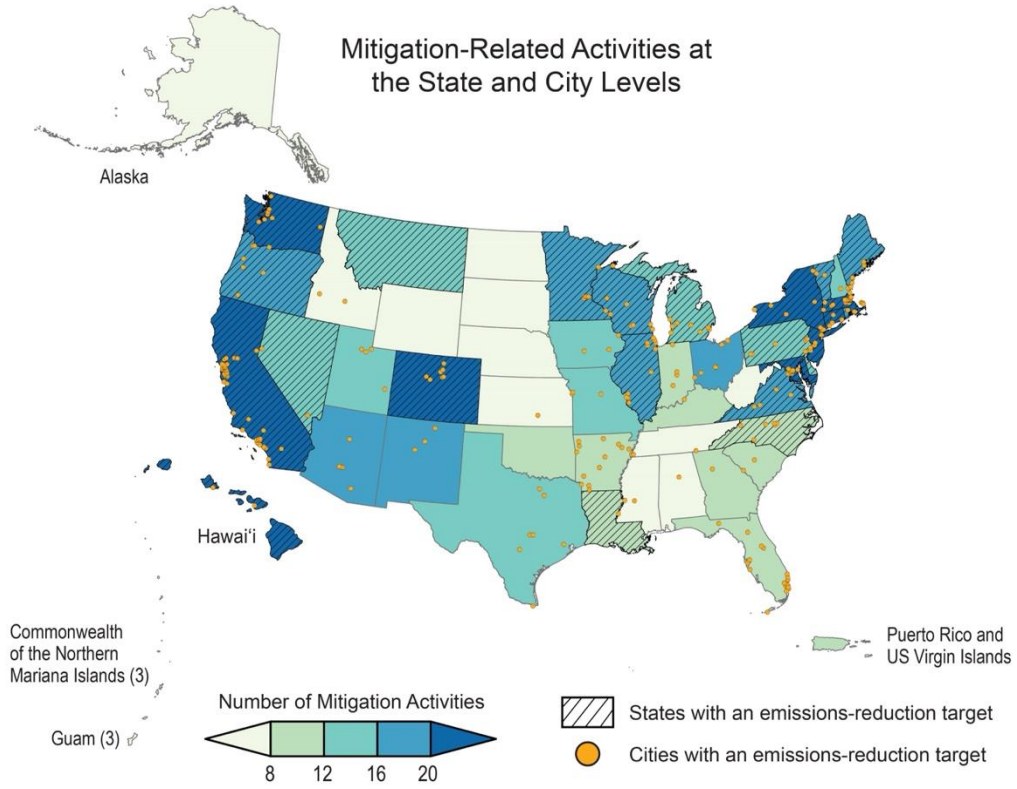
https://nca2023.globalchange.gov/chapter/12/

Emission Reduction Targets

5th National Climate Assessment: https://nca2023.globalchange.gov/chapter/32/



NCA5 Fig. 32.1



NCA5 Fig. 32.20

NCA Midwest Future Considerations

- Climate-smart practices - widespread implementation and interaction of various practices is poorly understood.
- Significant uncertainty concerning how widely human communities are adapting their cultural practices to climate change across the full spectrum of Midwestern communities.
- Gap in research characterizing how climate-related health impacts differ based on local population-specific characteristics and shared realities, particularly across the urban–rural gradient and multiple Tribal Nations and as a result of increasing immigration.
- Tracking smaller-scale events and the related economic impact could enable more effective and equitable distribution of resources before and following extreme storms.
- Better physical representation of the Great Lakes would enhance confidence in how increases in the water temperatures of the lakes (both surface and deep lake) could impact the ecosystem.

Thank You!

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