

# Preparing for Climate Change

November 14, 2024

North Hampton Public Library and Cultural Center

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**Ricardo Nogueira, PhD**

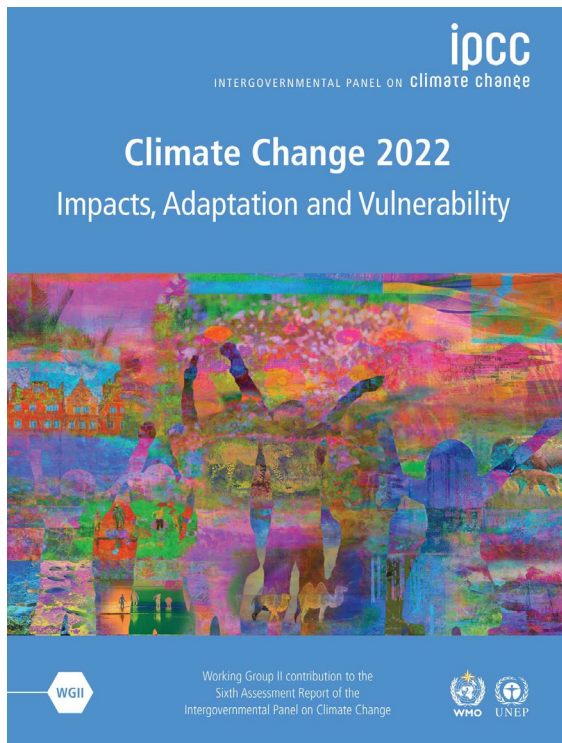
Professor of Meteorology  
Climate Studies Coordinator  
Plymouth State University



## **Gaia Principle:**

**Proposes that living organisms interact with their inorganic surroundings on Earth to form a synergistic and self-regulating complex system that helps to maintain and perpetuate the conditions for life on the planet.**

# One side



The scientific evidence is unequivocal: climate change is a threat to human well-being and the health of the planet.

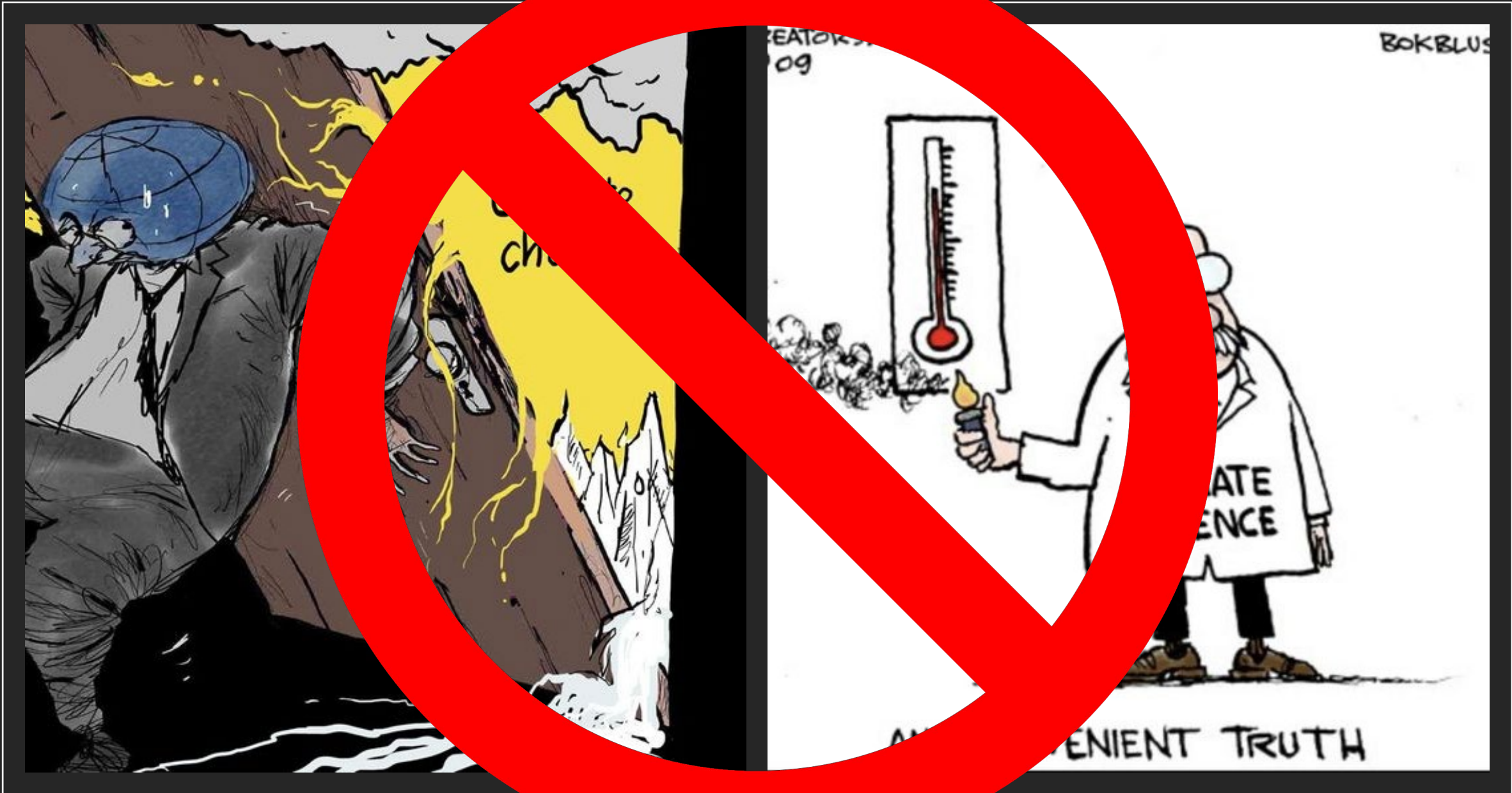
There are increasing gaps between adaptation action and what's needed to preserve life and prevent the worst outcomes.

# The other Side

- ✓ “The scale of climate change is not sufficiently large to take action beyond sensible least-cost measures.”
- ✓ 'Scientists can't even predict the weather next week, so how can they predict the climate years from now?'
- ✓ “Climate has changed naturally in the past and therefore current climate change must be natural”
- ✓ “The economic impact of making substantial cuts in greenhouse gas emissions on the scale suggested by the IPCC and other groups is too large.”







# Risk Perception

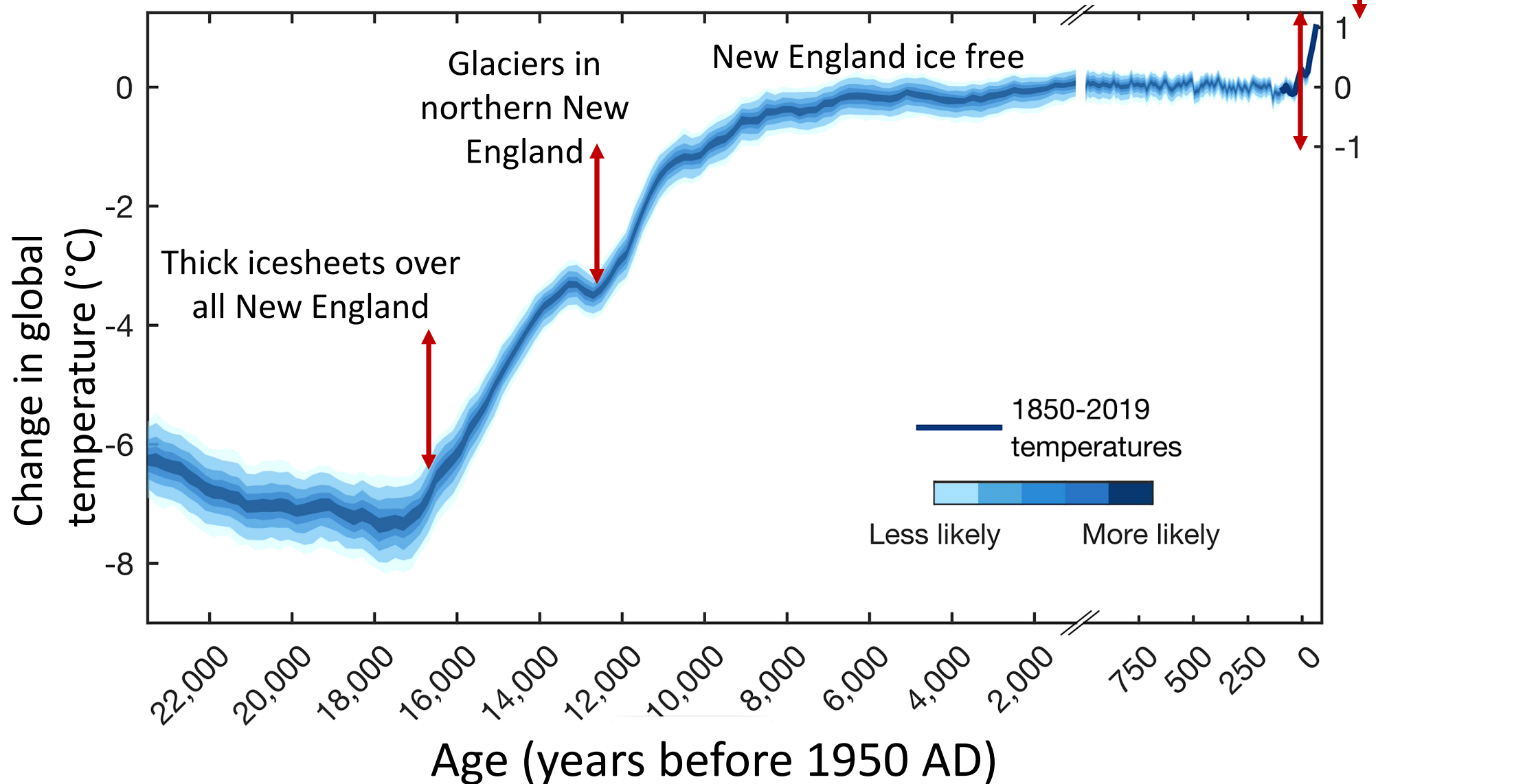


Some aspects of climate change gradually over time.

Climate impacts are often experienced as disastrous weather events - floods, fires, hurricanes – predicted to occur more frequently with increased average temperature.

Disaster risk management is where the “rubber hits the road” in preparing for climate change

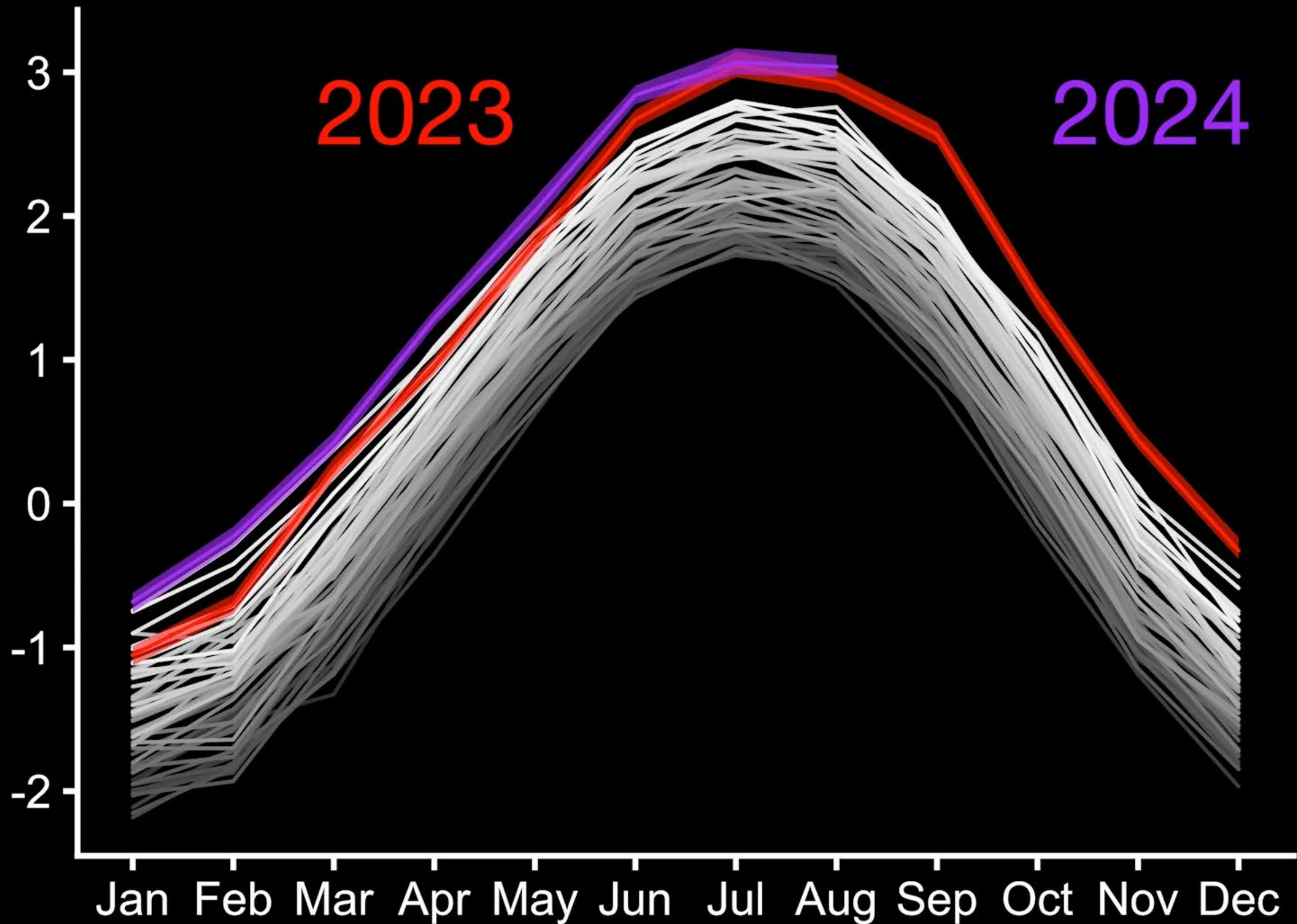
# Current climate trajectory is for an additional 2°C warming by 2080







Temperature Anomaly °C





# Risks Specific to Climate Change

## Direct Impacts:

- ✓ Temperature extremes (high & low)
- ✓ High precipitation & floods
- ✓ Low precipitation & droughts
- ✓ Extreme storms (tornados, hurricanes, blizzards)
- ✓ Sea level rise floods
- ✓ Wildfire frequency & range changes

## Indirect Impacts:

- ✓ Agricultural losses
- ✓ Invasive pest & disease migrations
- ✓ Drinking water shortages
- ✓ Ecosystem stresses/deterioration
- ✓ Economic stresses & infrastructure deterioration
- ✓ Tourism, recreation, lifestyle adjustments

# Climate Change Already Affects North America

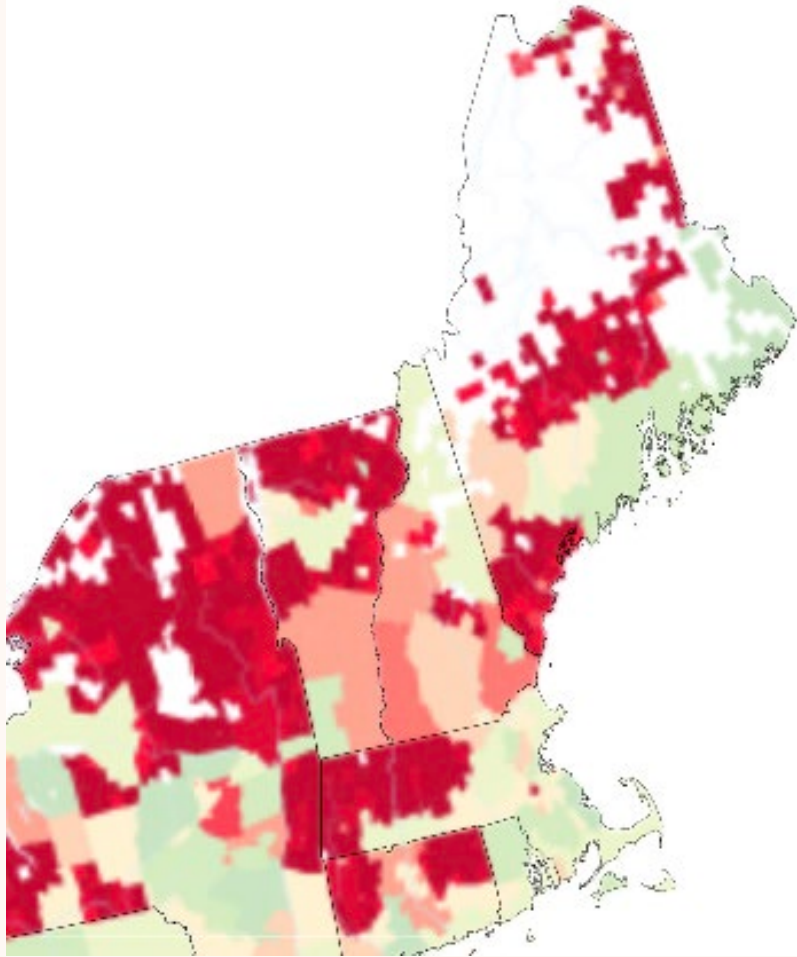
- ✓ Wildfires nearly continuous year-round threat in western states
- ✓ Extreme drought in the west affects crops, drinking supplies, energy production
- ✓ Heat waves coming earlier, lasting longer, more extreme
- ✓ Shortened period of “winter conditions” longer period of “summer conditions”

## Greatest Hazard in the Northeast – continues to be floods

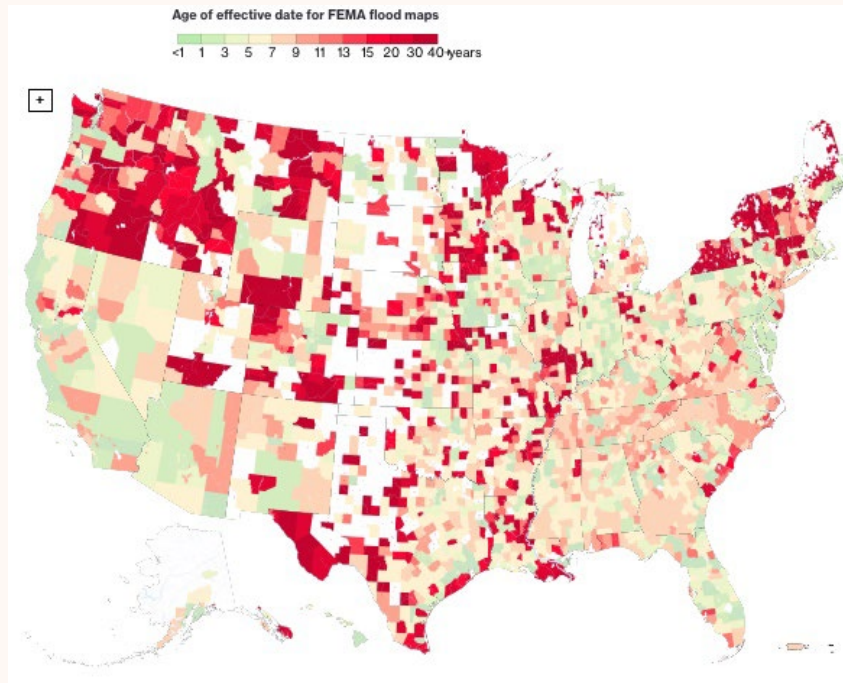
- ✓ Flood threat unusually high Sept-Nov from remnants of tropical storms
- ✓ Increasing flood threat from pop-up storms in summer (extremely heavy downpour lasting 1-2 hours) – small streams flood
- ✓ Increasing likelihood of very heavy rain from passing fronts (2-3 days of heavy rain) – larger river floods



# FEMA Assesses Flood Risk For 22,000 Communities



2017 Homeland Security report finds maps inaccurate for 9200 communities

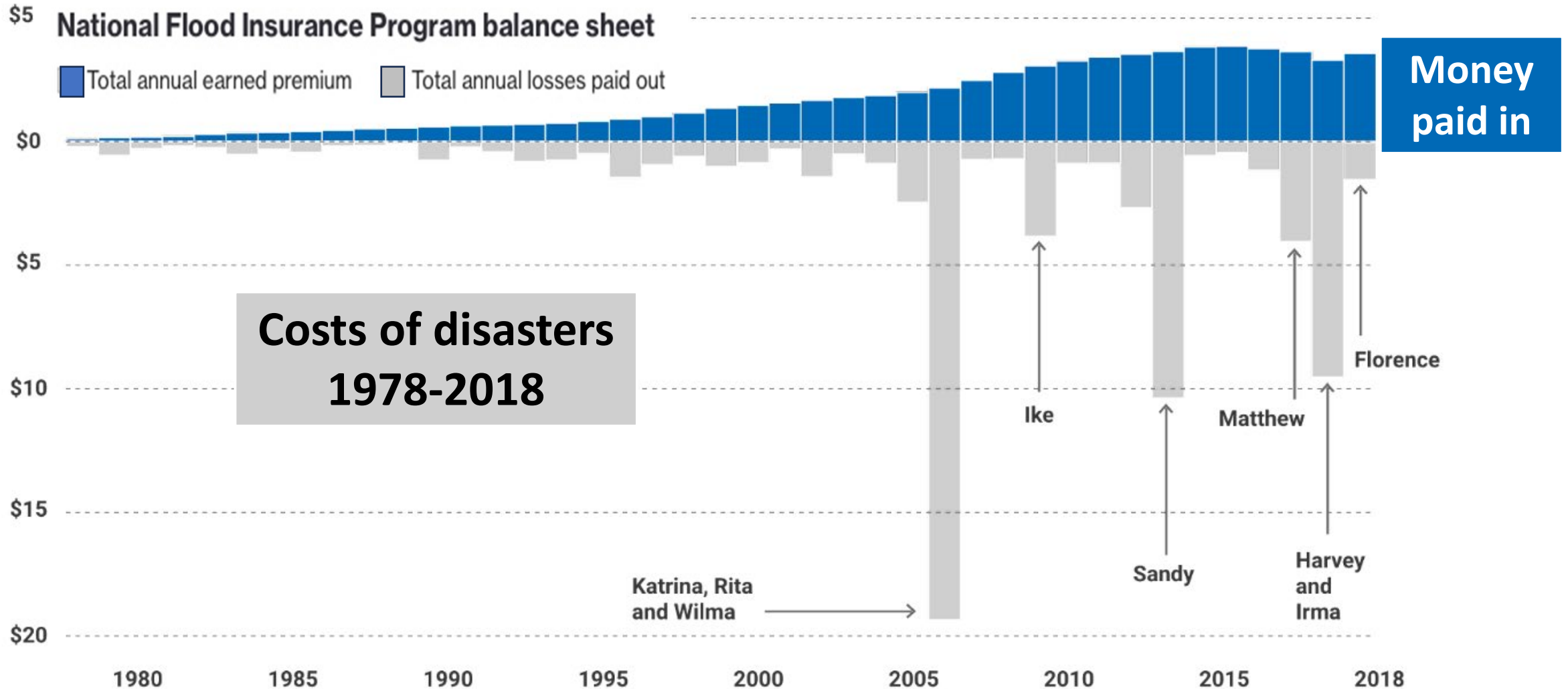


Interval since last assessment too long a time (deep red is 40 years)

[www.bloomberg.com/graphics/2017-fema-faulty-flood-maps/](http://www.bloomberg.com/graphics/2017-fema-faulty-flood-maps/)

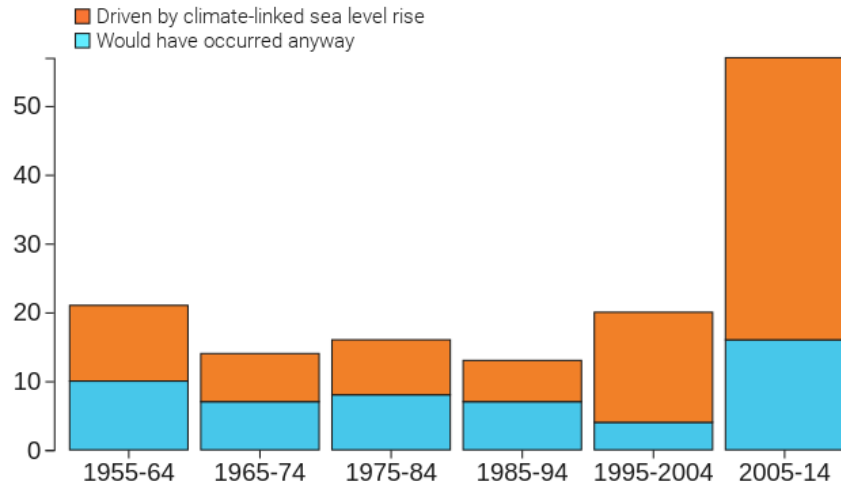


# National costs of recovery high and not averaging-out over time



PORTSMOUTH AREA\*

## Coastal flood days



\*Water level station "Boston" is 51 miles from Portsmouth and is the nearest station analyzed in the Climate Central study behind this figure.

**nhpr**  
New Hampshire Public Radio

NHPR 1A  
NEXT UP: 12:00 PM Here and Now  
All Streams

At Grappone Ford

NH News

By Degrees: Covering Climate Change

# NH had more flash flood warnings in July than any full year on record

New Hampshire Public Radio | By Adriana Martinez-Smiley  
Published August 1, 2023 at 4:43 PM EDT

Music Builds CHARACTER.

Instrument Sales & Reliable Repair Services  
Worry-Free Rental Program & Sheet Music

ELLIS MUSIC

Latest Stories

- NH News: Former Portsmouth police officer charged in assault that victim says was racist attack
- NH News: Mistrial declared in domestic violence trial of former NH state senator
- NH News: Feds pick New England's offshore wind area, drawing cheers and questions
- NH News: Manchester NAACP President

# Community Action on Flooding

- ✓ Conduct stream crossing surveys in your town; seek funding to fix undersized or collapsed culverts – this helps move flooding into channels and away from roads and structures
- ✓ Let rainwater soak into the ground wherever possible.
- ✓
- ✓ Replace asphalt with surfaces that allow rainwater to absorb into the ground.
- ✓ Leave dirt roads unpaved.



# Community Action on Flooding...cont.

- ✓ Encourage permeable pavement in parking areas.
- ✓
- ✓ Set limits to impermeable surface areas in developments, subdivisions, malls.
- ✓ Promote zoning ordinances to protect floodplain habitat. Maintain floodplain forests.
- ✓ Support and volunteer for organizations that protect open space (permeable ground!)
- ✓ Plant or maintain vegetation along streams to reduce erosion, slow water flow.

# Water Impacts

- ✓ Heavy exploitation of water supplies, deteriorating freshwater infrastructure, and reduced water quality heighten water security risks.
- ✓ Water scarcity arises in droughts and from diminished snowpack. Summer peak water demand may exceed water supply, leading to economic losses and increased pressures on groundwater as a substitute for surface water supplies.
- ✓ Golf courses, swimming pools, water parks and water features compete for high quality drinking water .... good quality ground water takes years to develop.



**Webster Lake – Oct 2016 cyanobacteria bloom**

- **Climate change drives widespread shifts in lake thermal habitat.** Kraemer et al 37 (2021). Nature Climate Change 11: 521-529.
- **Widespread deoxygenation of temperate lakes.** Jane et al. (2021). Nature 594: 66–70.
- **Blue Waters, Green Bottoms: Benthic Filamentous Algal Blooms Are an Emerging Threat to Clear Lakes Worldwide.** Vadeboncoeur et al. (2021). BioScience, biab049.



NEWS ENVIRONMENT

## Rising groundwater threatens to spread toxic pollution on U.S. coastlines

By 2100, sea level rise could push groundwater into hundreds of Superfund sites

### Contaminant Mobilization:

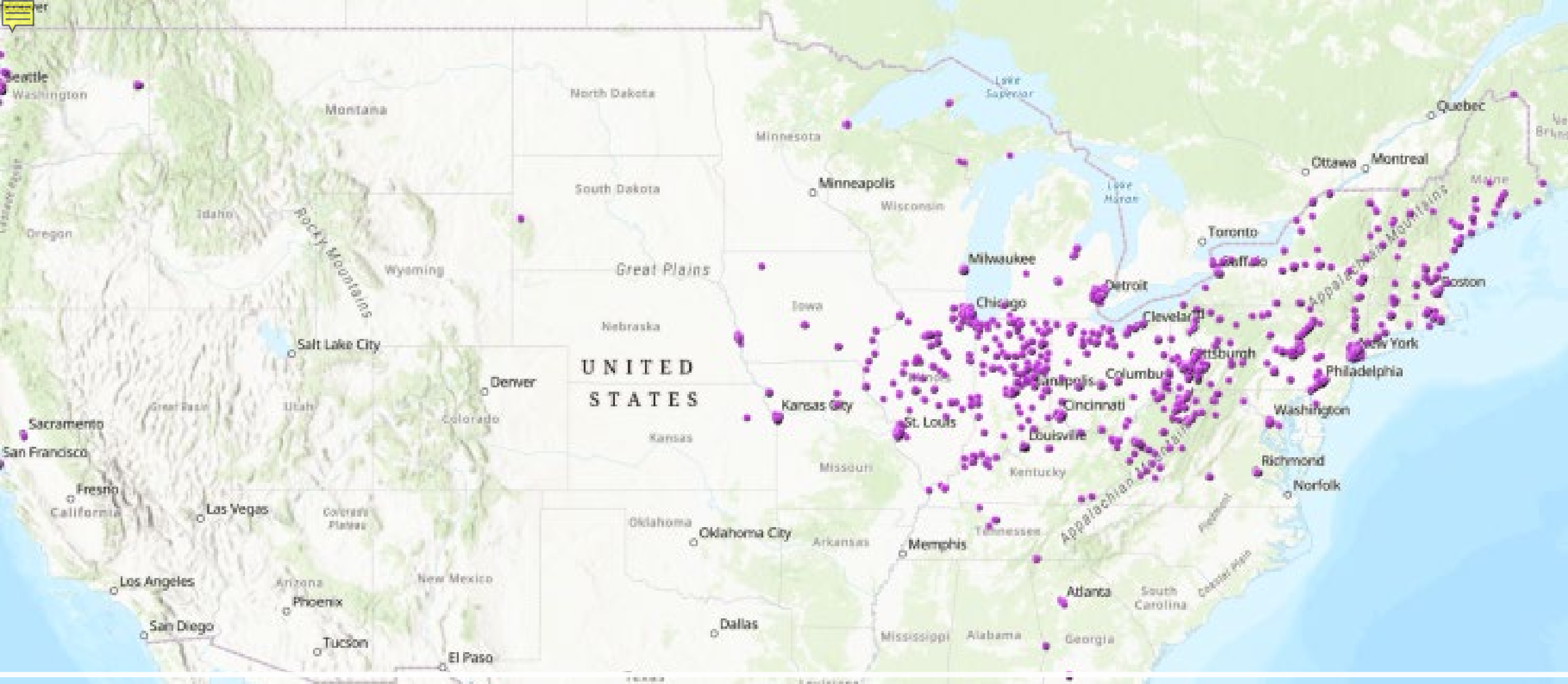
- *As sea levels rise, the accompanying increase in coastal groundwater levels can significantly exacerbate existing contamination at coastal sites by mobilizing pollutants and spreading pollution further.*
- *Damaging underground infrastructure like pipes and building foundations through increased corrosion and potential flooding caused by the rising water table.*



The Halaco Engineering Company site in Oxnard, Calif., is one of hundreds of Superfund sites on U.S. coastlines where rising groundwater could spread pollution to nearby communities.

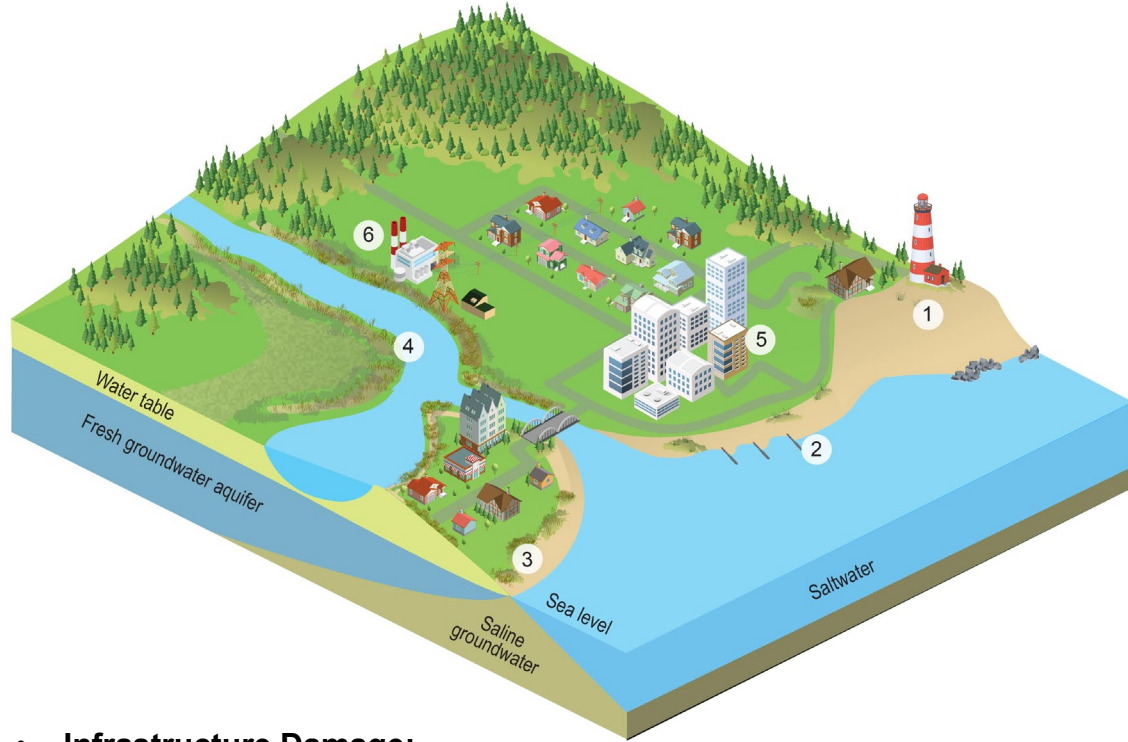
STEVE OSMAN/LOS ANGELES TIMES VIA GETTY IMAGES



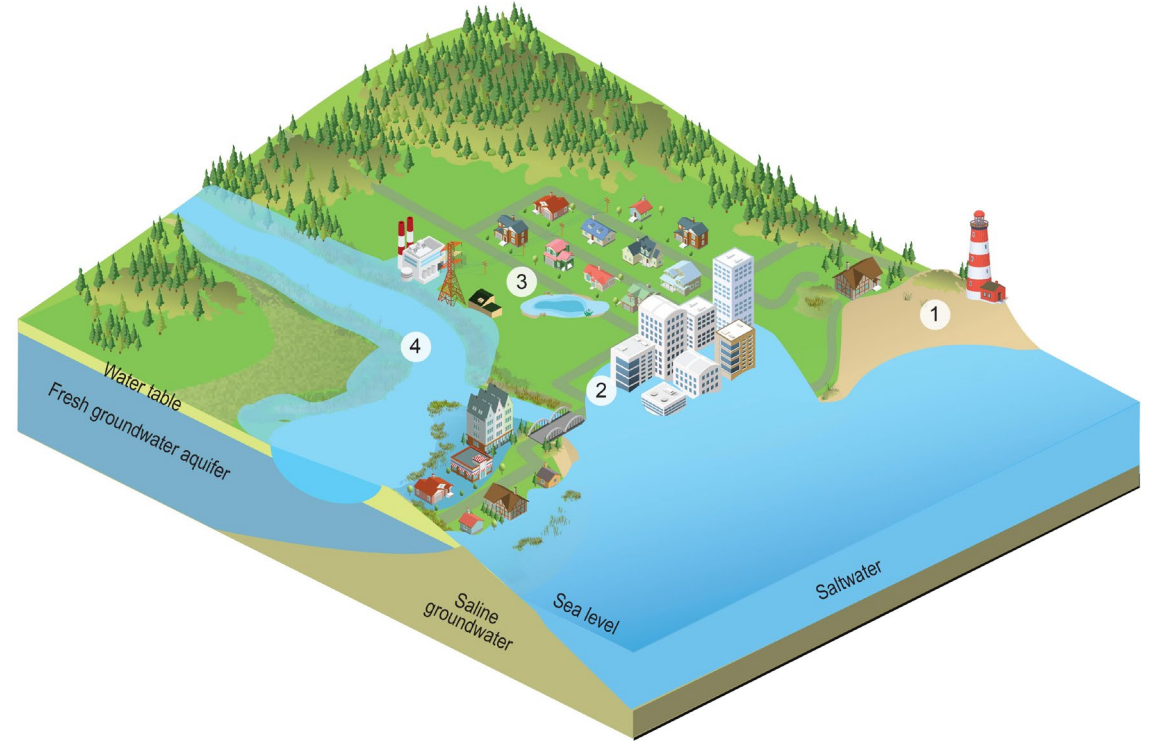


# The link between combined sewers and gastrointestinal illness

Existing Conditions in a Coastal Community



Increasing Hazards in a Coastal Community



- **Infrastructure Damage:**

- The rising groundwater can also corrode and damage underground infrastructure like sewage pipes, drainage systems, and building foundations due to increased salinity and corrosive conditions.

- **Hidden Threat:**

- This impact is often considered a "hidden threat" because the damage occurs below ground, making it difficult to detect until significant issues arise.

- **How it works:**

- **Saltwater Intrusion:**

- As sea levels rise, saltwater pushes further inland, mixing with freshwater in the coastal aquifer, increasing its salinity.

- **Groundwater Elevation:**

- This influx of saltwater elevates the overall groundwater level, potentially inundating previously dry areas.

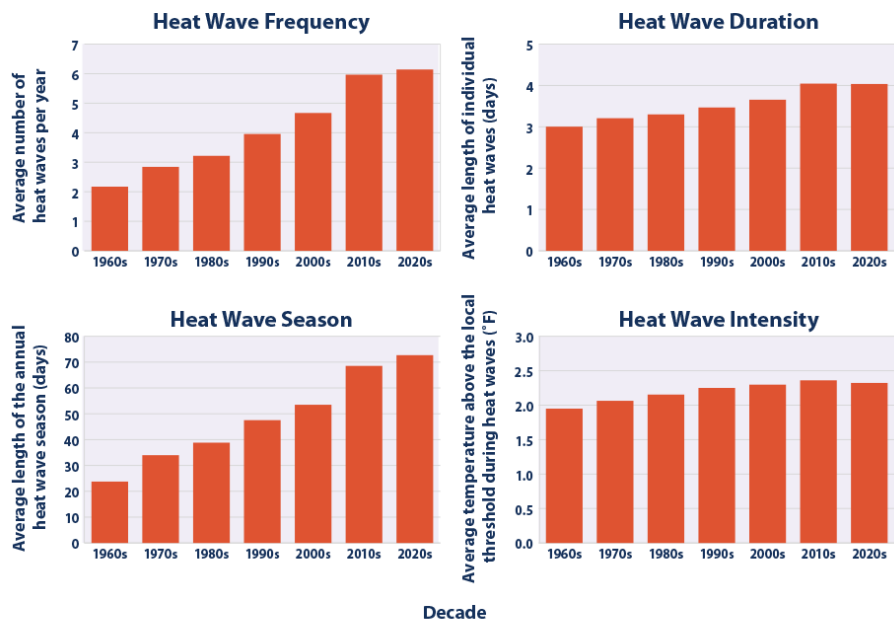
# Mitigation Strategies:

- **Monitoring and Assessment:**
  - Regularly monitoring groundwater levels and salinity to identify potential risks.
- **Site Remediation:**
  - Implementing proactive remediation measures at contaminated sites to reduce contaminant mobility.
- **Infrastructure Adaptation:**
  - Upgrading underground infrastructure to withstand increased corrosion and water levels.
- **Coastal Planning:**
  - Incorporating sea level rise projections into coastal development plans to minimize vulnerabilities.





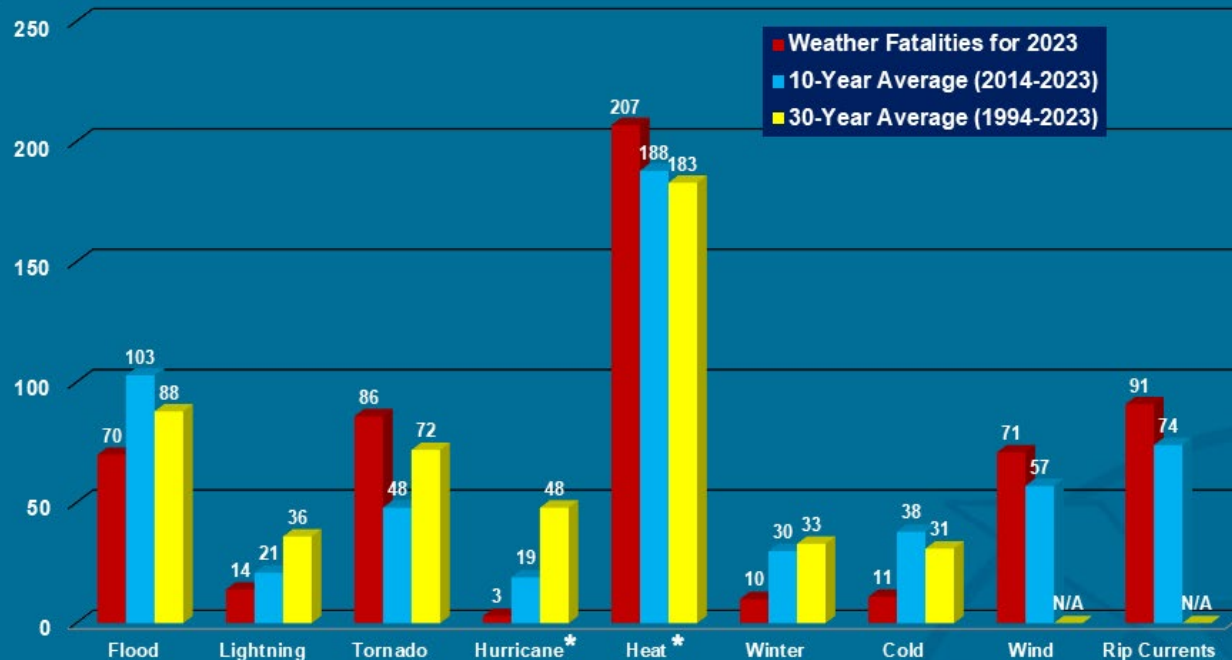
### Heat Wave Characteristics in the United States by Decade, 1961–2021



Data source: NOAA (National Oceanic and Atmospheric Administration), 2022. Heat stress datasets and documentation. Provided to EPA by NOAA in February 2022.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at [www.epa.gov/climate-indicators](http://www.epa.gov/climate-indicators).

## Weather Fatalities 2023



\*Due to an inherent delay in the reporting of official heat fatalities in some jurisdictions, this number will likely rise in subsequent updates.

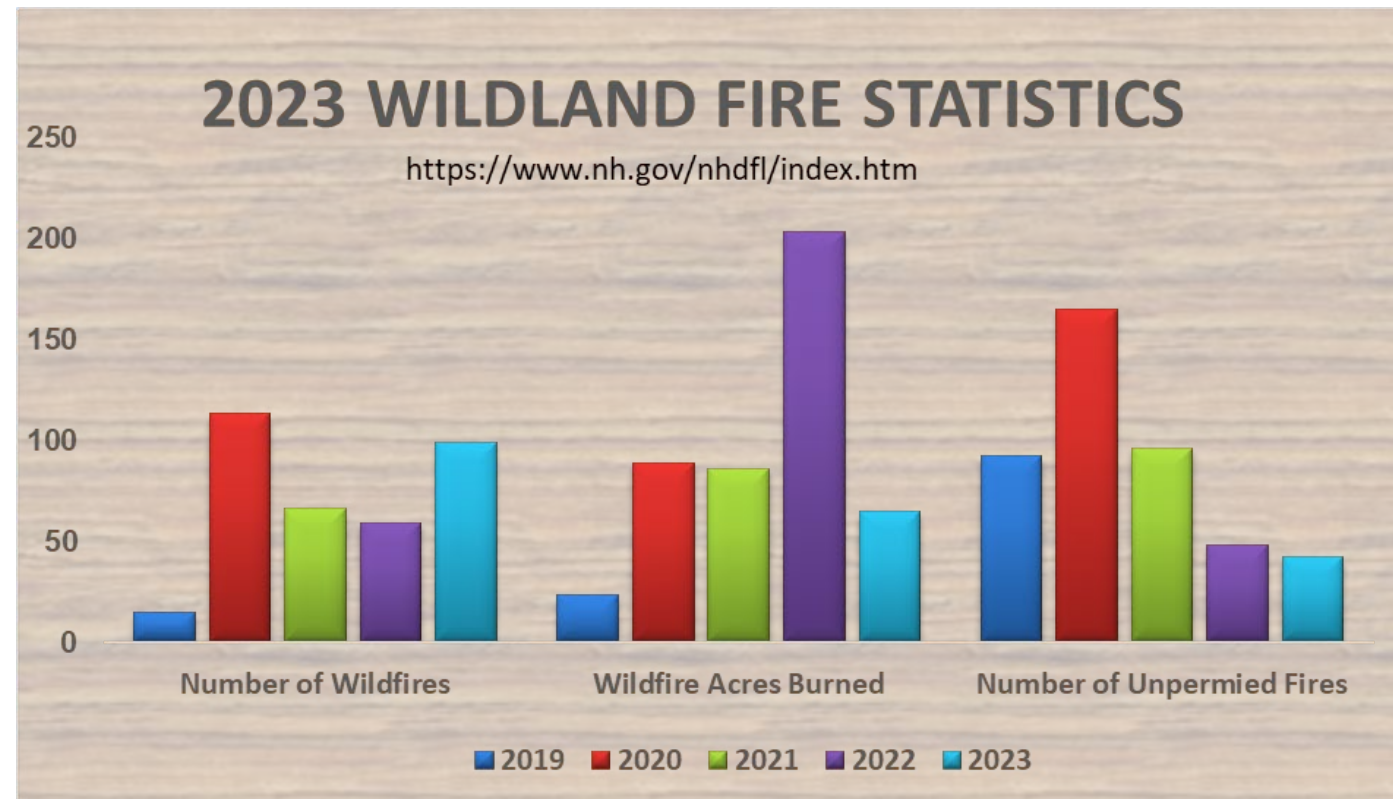
\*The fatalities, injuries, and damage estimates found under Hurricane/Tropical Cyclone events are attributed only to the wind.

# Emerging Hazard in the Northeast – Drought and Wildfire

- ✓ Summer and winter drought causing stress to forests.
- ✓ Insect pests leaving increasingly larger numbers of trees dead or dying.

**West** – zoning laws prohibit certain roof types, strongly recommend creating a treeless buffer around homes, *encourage no vegetation within 3 feet of house.*

**Northeast** - no public education/outreach about reducing risk of wildfires to residential areas, only guidance is on burn permits and (often) campfire bans.



# Ecosystem Risks

- ✓ Increased temperature of air, water, ocean, and ground affect ecosystems.
- ✓ Abnormal conditions cause stress and mortality in plants and animals and make them vulnerable to diseases.
- ✓ Escalating climate change can outpace the ability for wildlife to adapt or migrate.
- ✓ Iconic species and habitats may diminish or disappear – moose, sugar maples, birch.





# Economic Activity

Extreme events and climate hazards adversely affect economic activities across North America. Under current economic and consumption trends, climate change impacts are projected to cause large market and non-market damages across North America.

Winter recreation and tourism (\$ billions) in New Hampshire - especially vulnerable as length of snow cover period becomes shorter.

By 2100, 85% loss in ski areas. The Northeast is receiving *more winter precipitation as rain rather than snow*. Expect a decrease in the overall frequency of Northeast snowstorms this century

(Zarzycki, 2018). *Geophysical Research Letters*, 45, 12,067–12,075.



# Economic activity

- ✓ Warmer July temperatures reduce sugar content of sap the following spring.
- ✓ By the end of the century, the tapping season will be 2-3 weeks earlier (Feb).
- ✓ The optimal region for maple sap production will move northward and most areas will have less production, especially within the U.S.

Morelli & Stinson (2018). Final Report for Climate Effects on the Culture and Ecology of Sugar Maple. <https://www.sciencebase.gov/catalog/item/5bb25f79e4b08583a5d5999d>

**Changing the timing of leaf peeping season** - peak foliage now occurs a full week later than in 1950 (about 1 day per decade). Peak season is now about the second weekend of October. The delay is partly linked to warmer nighttime temperatures.

Source:

<http://www.stephaniespera.com/anpfallfoliage.html>

# Ecosystem Risks

## Food

Climate-induced redistribution and declines in North American food production are a risk to food and nutritional security. Climate change will continue to shift North American agricultural and fishery suitability ranges and intensify production losses of key crops, livestock, fisheries, and aquaculture products.

**Adaptation** – Build strong incentives for locally grown food, short supply chains, distributors to continue servicing rural regions.

## Health

Health risks are projected to increase this century under all future emissions scenarios, but the magnitude and severity of impacts depends on the implementation and effectiveness of adaptation strategies. Warming is projected to increase heat related mortality and morbidity.

**Adaptation** – Anticipate need for health services in heat waves. New Hampshire can deal with the cold; it's the heat that will hurt us most.



# Greatest challenges ahead - interactive, compounding effects of multiple risks

Resource managers, town planners, first responders and residents face direct and indirect risks from all these simultaneous stressors:

- ✓ Warming trends
- ✓ Invasive species
- ✓ Disease
- ✓ Shoreline erosion
- ✓ Land use change and loss of ecosystem benefits
- ✓ Urbanization
- ✓ Nutrient loading
- ✓ Pollution

## **Example:**

Drought, low water levels in surface reservoirs, and a broken water main during a heat wave in Odessa, TX 2023 – compounded problems.

*Possible NH version – heat wave, electrical outage, motorcycle week ....*

# Here are some examples of compound risks:



**Drought and sandstorm:** can devastate farming in an area



**Acid rain and increasing temperatures:** can damage waterways



**Housing developments on steep slopes:** can exacerbate landslide hazards



**Informal refuse dumping:** can contribute to urban flood risk



**Landslides caused by biomass fires followed by intense rainfall or flooding:** can be a compound event



**Megafires across multiple western states:** can be a spatially compounding event



**Back-to-back Atlantic hurricanes:** can cause unprecedented demand on federal emergency response resources



## Simultaneous Extreme Events Create Compound Risks



# Anticipated Future Global Climate Risks



## Heat stress

Exposure to heat waves will increase with additional warming.



## Water scarcity

At 2°C, regions relying on snowmelt likely to experience 20% decline in water for agriculture by 2050.



## Food security

Climate change will increasingly undermine food security.



## Flood risk

About a billion people in low-lying cities by the sea and on Small Islands at risk from sea level rise by mid-century.

# Barriers to action on a national level

(possibly less so locally)

- ✓ Politicization of climate change science still effectively limits climate action (*lagging scientist recommendations by 30+ years*)
- ✓ Warnings about climate risk and the urgent needs are not translating into actions – this includes adaptation planning and implementation.
- ✓ Responsibilities for climate-based planning, disaster management, mitigation and adaptation actions are fragmented across governmental levels, agencies and community action groups.

# Community Adaptation Options

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- Approaches that incorporate climate change into near-term and long-term decision-making will reduce (not eliminate) future risks. Plan now, but don't expect a risk-free future.
- Develop new, creative policies that focus on sustainability and resilient land use, nature-based solutions (shade trees versus air-conditioning), and economies that support lower consumption and reduced growth. Find a way for your community to thrive without continued dependence on growth.
- Anticipate that Murphy's Law will be the norm – every small disaster may escalate into a bigger one, so plan for the bigger, more complex event.
- Support each other with encouragement and ideas – resilience is not a competition.



# Transportation – stop complaining about the cost of gas – need less of it!



- ✓ Encourage smart growth – less sprawl, walkable/ridable/bus able development.
- ✓ Opt for cleaner transportation or shorter commutes (live closer to work, shopping, schools/activities).
- ✓ Shift away from fuel-heavy recreation (less often, not the default activity)
- ✓ Combine errands to reduce "cold starts" of your car, avoid idling. Don't run your car just to charge your phone!
- ✓ Improve your miles per gallon – keep tires inflated, engine tuned, choose the least heavy vehicle (sedan versus truck)

Reliable  
websites with  
scientific  
evidence-  
based climate  
information

- **General Climate Sites:**

- <https://svs.gsfc.nasa.gov/>
- <https://climate.nasa.gov/>
- <https://www.usgs.gov/programs/climate-adaptation-science-centers>

- **Mitigation Sites:**

- <https://www.ipcc.ch/report/ar6/wg3/>
- <https://cmi.princeton.edu/resources/stabilization-wedges/>
- <https://iopscience.iop.org/article/10.1088/1748-9326/8/1/011001/meta>

- **Adaptation Sites:**

- <https://climate.nasa.gov/solutions/adaptation-mitigation/>
- <https://climate.nasa.gov/news/1026/just-5-questions-community-initiatives-against-climate-change/>
- <https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/>
- <https://www.epa.gov/arc-x/strategies-climate-change-adaptation>

**We are part of the problem;  
therefore, we are part of the  
solution. We just need time  
to get there, so every small  
delaying action is  
important.**



**Thank you!**

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