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# The U.S. Fourth National Climate Assessment: *Findings, Impacts, and Actions*

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*5 February 2019*



U.S. Global Change  
Research Program

# U.S. Global Change Research Program

- USGCRP began as a Presidential initiative in 1989
- Mandated by Congress in the U.S. 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 Principals representing the 13 member agencies of the Committee on Environment’s Subcommittee on Global Change Research (SGCR)





# Legislative Origins for the NCA

*Global Change Research Act of 1990, Section 106:*

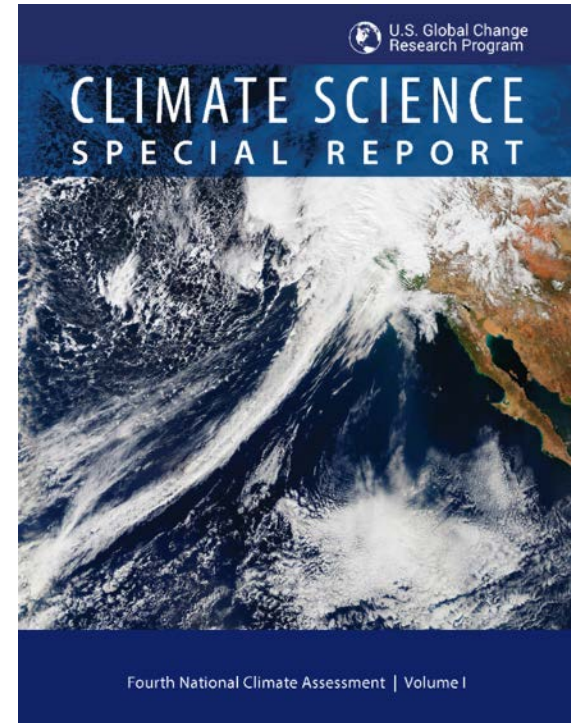
Not less frequently than every 4 years [USGCRP] shall prepare and submit to the President and Congress an assessment which:

- 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.



# NCA4 Vol I: *Climate Science Special Report*

- Released Nov 3, 2017
- Key advances:
  - Detection and attribution
  - Extreme events (tropical cyclones, tornadoes, atmospheric rivers)
  - Downscaled information (including sea level rise)
  - Potential surprises
  - Climate model weighting
- Summarized in Ch. 2 (Our Changing Climate) of NCA4 Vol II



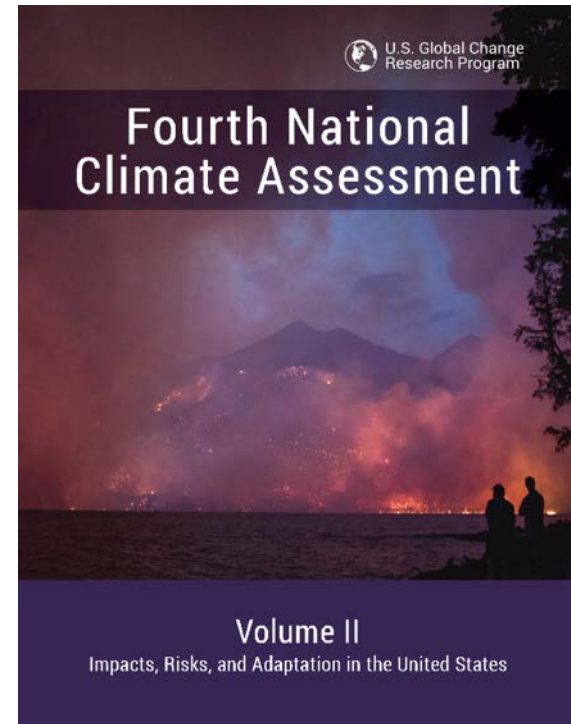
Read and download the report at  
[science2017.globalchange.gov](https://science2017.globalchange.gov)



# NCA4 Vol II:

## *Impacts, Risks, & Adaptation in the U.S.*

- Released Nov 23, 2018
- **Policy relevant**, but not policy prescriptive
- Places a strong emphasis on **regional information**
- Quantifies **impacts in economic** terms
- Integrates **international** considerations
- Assesses a **range of potential impacts**, helping decision makers better identify risks that could be avoided or reduced
- Uses **case studies** to provide additional context and to showcase community success stories



Read and download the report at  
[nca2018.globalchange.gov](https://nca2018.globalchange.gov)



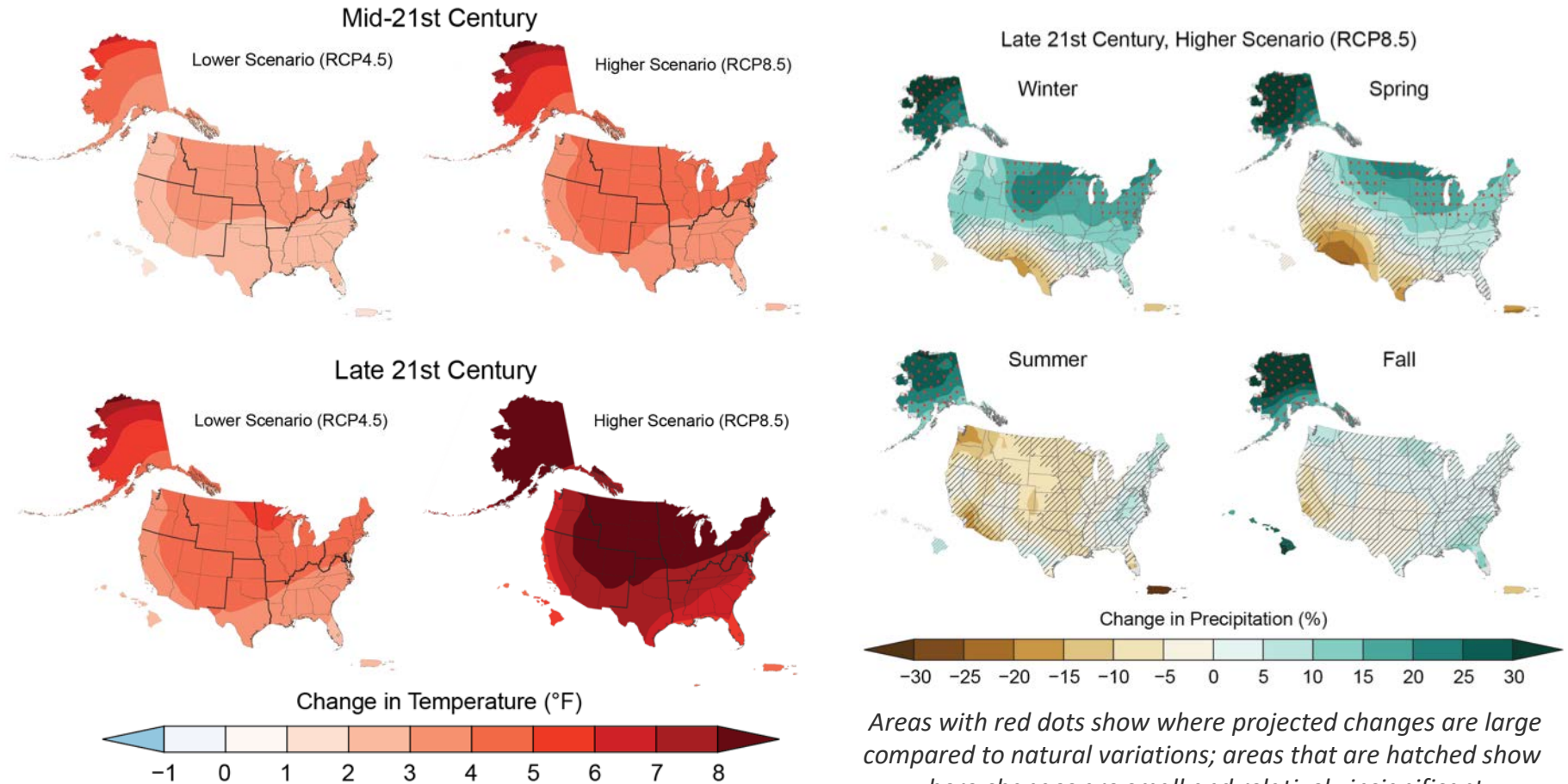
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# NCA4 Volume II in 5 Bullets

- Earth's climate is now changing faster than at any point in modern civilization.
- These changes are primarily the result of human activities, the evidence of which is overwhelming and continues to strengthen
- The impacts of climate change are already being felt across the country, and climate-related threats to Americans' physical, social, and economic well-being are rising
- Americans are responding in ways that can bolster resilience and improve livelihoods
- However, neither global efforts to mitigate the causes of climate change nor regional efforts to adapt to the impacts currently approach the scales needed to avoid substantial damages to the U.S. economy, environment, and human health and well-being over the coming decades

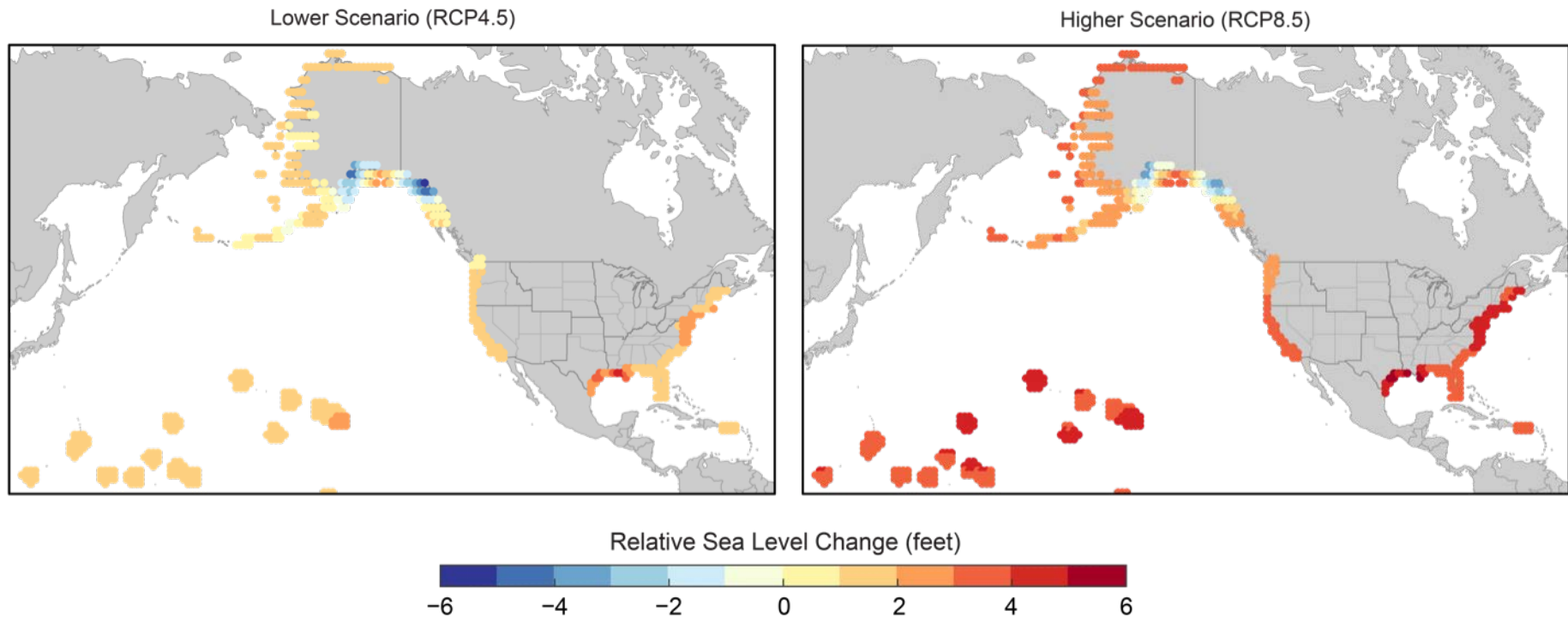


# Projected Change: *Temperature & Precipitation*





# Projected Change: *Sea Level Rise (in 2100 vs. 2000)*



Thermal Expansion + Land-Based Ice Melt + Vertical Land Movement + Ocean Circulation...

**USGCRP Scenario Products:** [scenarios.globalchange.gov/sea-level-rise](https://scenarios.globalchange.gov/sea-level-rise)

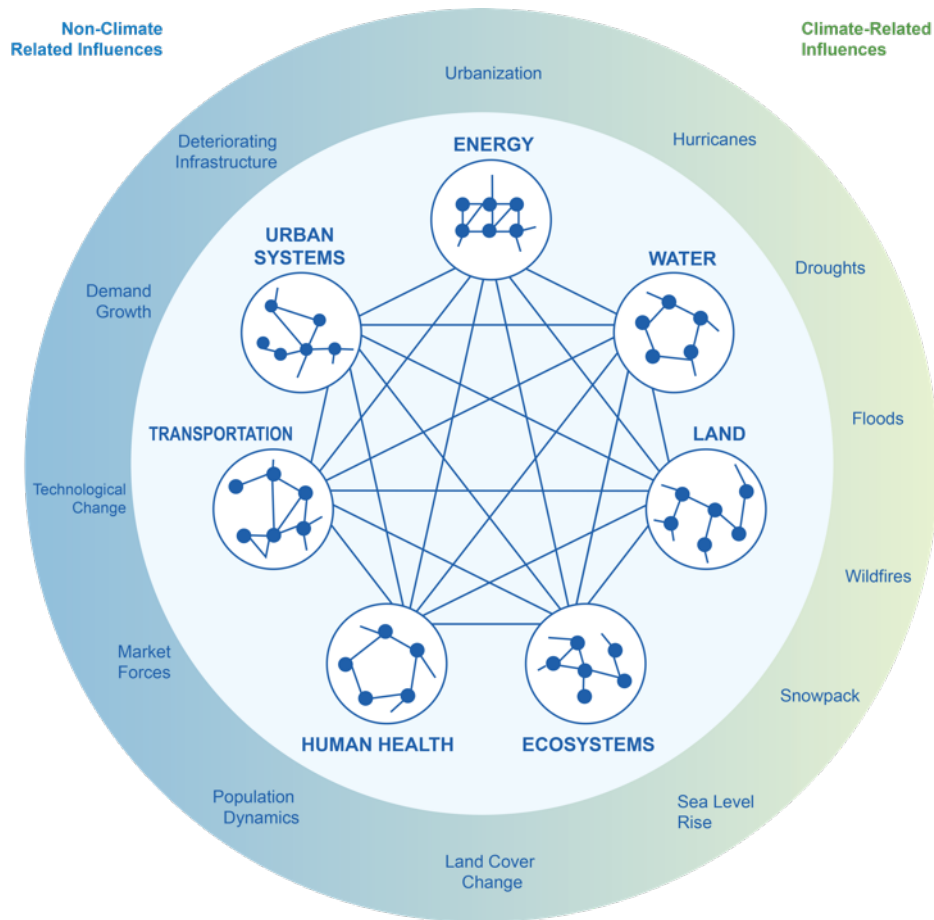
**NCA4 Vol. I (CSSR), Ch. 12:** [science2017.globalchange.gov/chapter/12/](https://science2017.globalchange.gov/chapter/12/)



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# Interconnected Systems



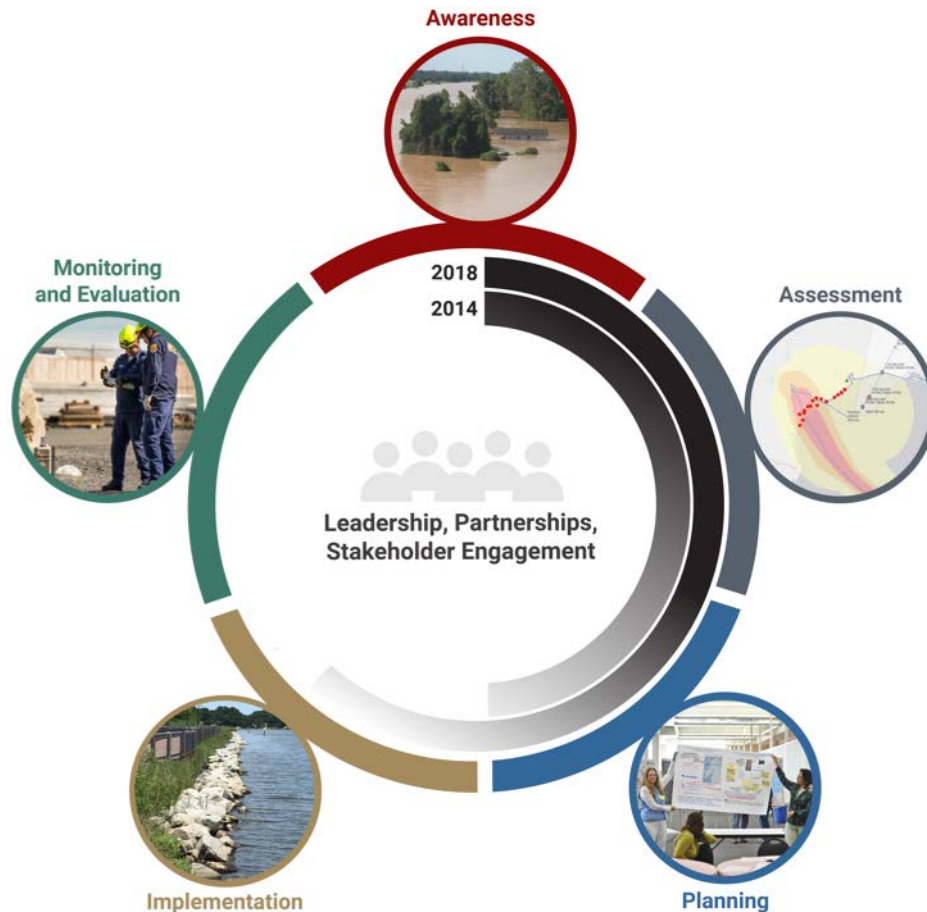
- Sectors are interacting and interdependent through physical, social, institutional, environmental, and economic linkages.
- These sectors and the interactions among them are affected by a range of climate-related and non-climate influences.

## Example

1. Wildfire chars California hillside
2. Atmospheric river dumps heavy rain
3. Rainfall induces a landslide
4. Landslide cuts off roadways
5. Services and economic activity are disrupted



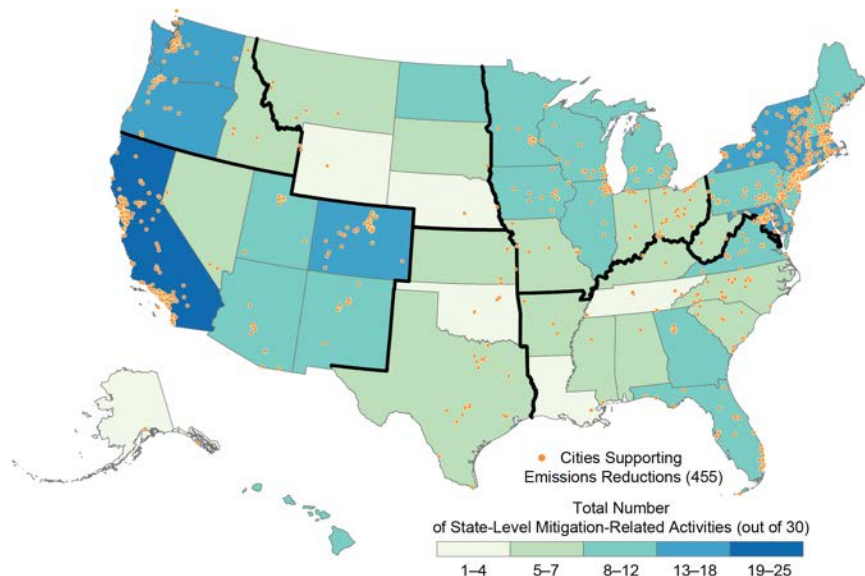
# Reducing Risks: Through Adaptation Action



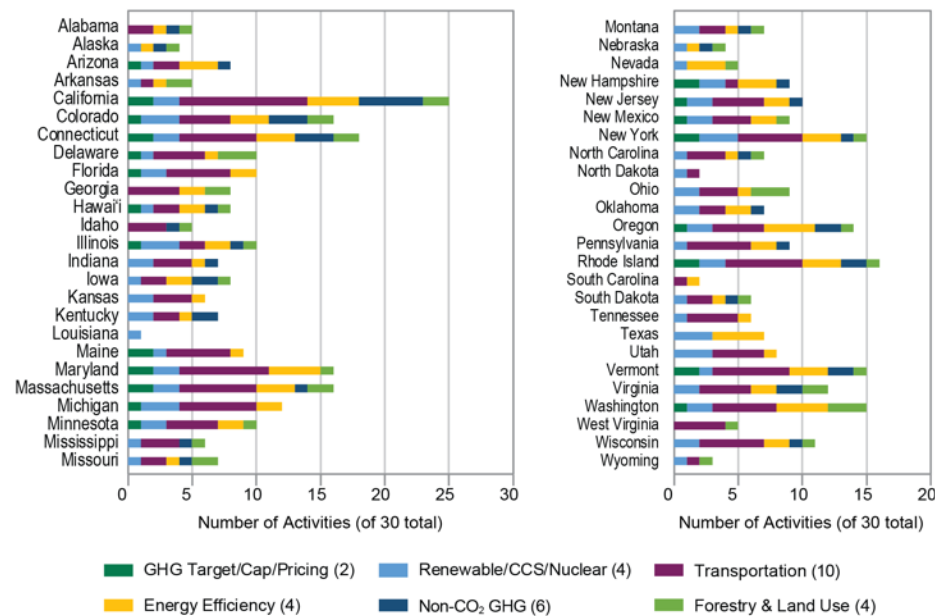
- Adaptation is an ongoing, iterative process
- Since NCA3, the scale and scope of adaptation implementation has increased
- It remains difficult to tally the extent of adaptation implementation since there are no common reporting systems, and many actions that reduce climate risk are not labeled as climate adaptation
- Enough is known, however, to conclude that adaptation implementation is neither uniform nor commonplace across the U.S.



# Reducing Risks: Through Emissions Mitigation



Source: EPA



Source: America's Pledge 2017

- Sub-national mitigation-related activities are growing across all sectors of the economy
- The magnitude and rate of these activities (both domestically and abroad) do not yet approach the scale needed to avoid the worst impacts



# Value of the regional chapters: Facts needed to take action

- What do communities value about the places they live?
- How are those values impacted for better or worse by climate change?
- Local governments need information NOW to help guide future policy frameworks
- Cities and states need authoritative climate projections
- Legitimate debate about how best to adapt to impacts, make tradeoffs
- Regional chapters provide examples of communities and organizations across the country adapting



# To Support Local Management Decisions, the NCA Must Be:

- Authoritative
- Comprehensive
- Transparent
- Inclusive



CH. 18: King tide flooding in Annapolis, Maryland in 2012



CH. 24: No-till fields in Oregon build climate resilience



# Highly Influential Scientific Assessment (HISA)

White House Office of Management & Budget (OMB):

*“Scientific information that will have or does have a clear and substantial impact on public policy or private sector decisions”*

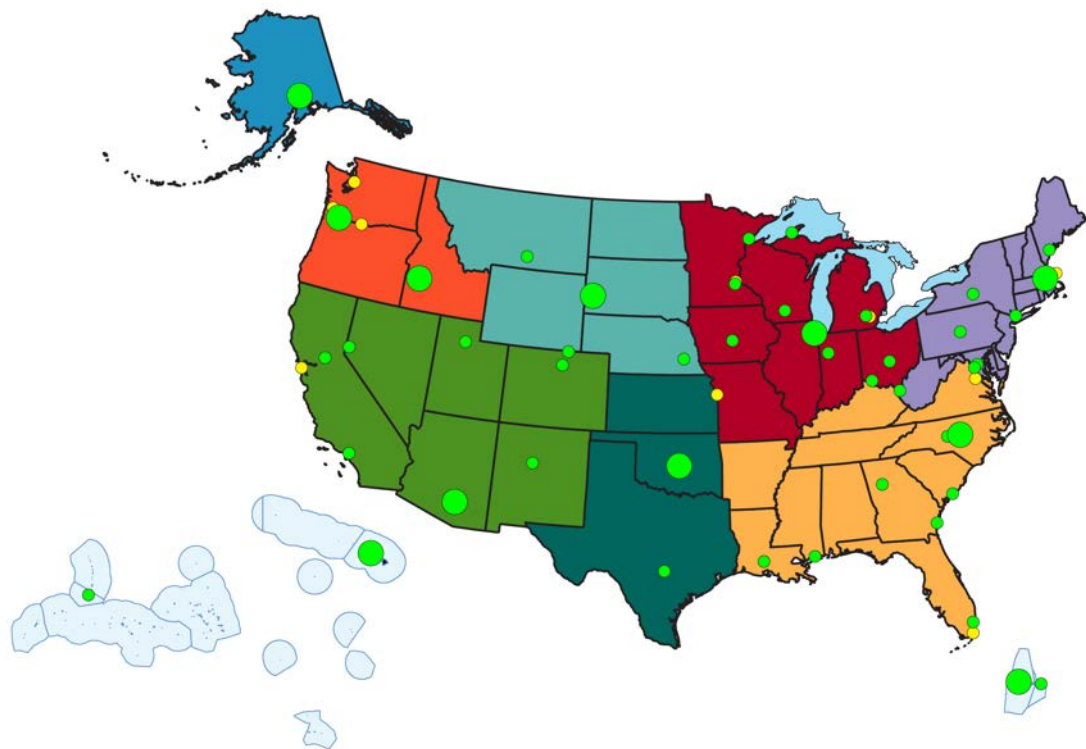
- Stringent peer-review requirements
- Meets legal federal guidelines for information quality
- Synthesizes multiple sources of information and bridges uncertainties
- All data, authors, & reviews must be public





# Inclusivity: Outreach and Engagement

- Public feedback on the draft prospectus
- Public call for author nominations
- Public call for technical inputs
- A series of Regional Engagement Workshops (REWs) and sector-specific webinars
- Public call for Review Editors
- A 90-day public review & comment period



*Large green dots illustrate the hub locations for the 11 REWs in early 2017. Small green dots indicate satellite locations for those workshops. Small yellow dots show locations of some additional engagement activities, such as presentations or listening sessions at professional society meetings.*

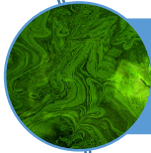




# Key Message Themes Across Regions



10/10 regions discuss adaptation actions



9/10 regions mention the economy, ecosystems, and human health



8/10 talk about rural livelihoods, natural resources, and infrastructure

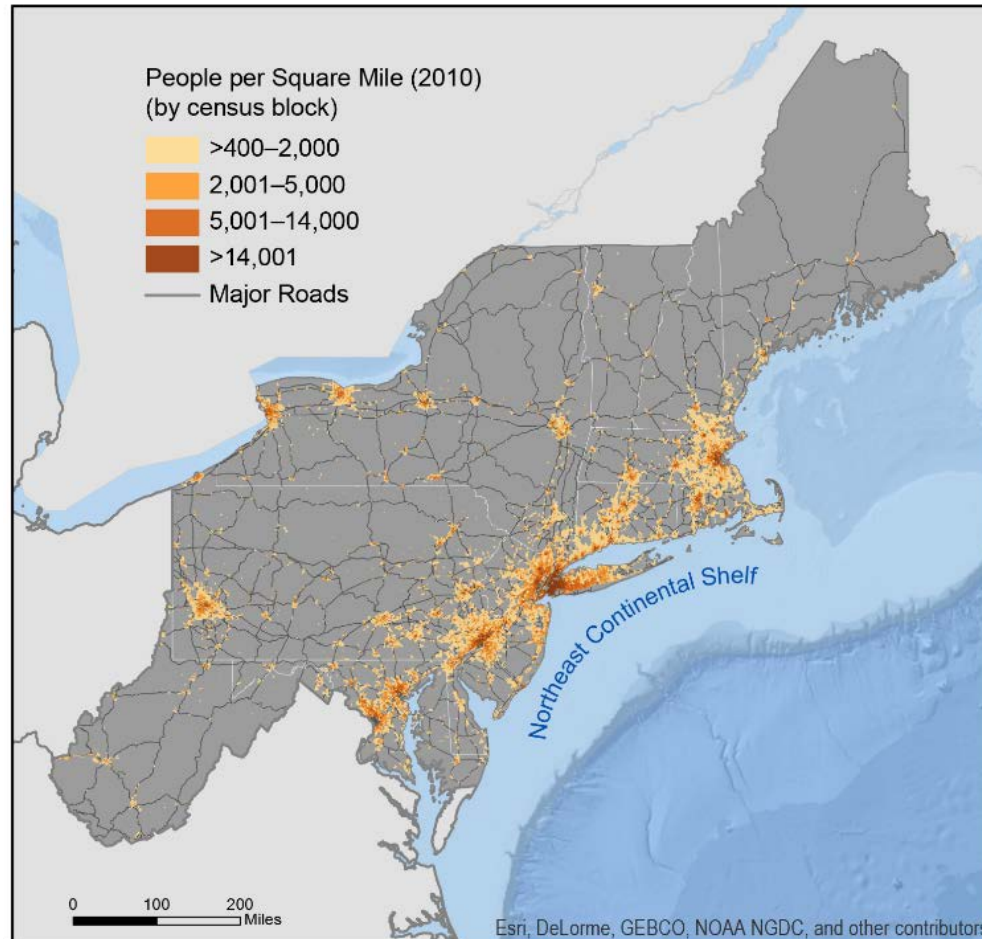


7/10 regions discuss vulnerable communities, extremes, or heat



# Regions:

## Zoom in on Northeast



# Key Message #1:

## *Rural Industries and Region's Identity*

### Changing Seasons Affect Rural Ecosystems, Environments, and Economies

- The seasonality of the Northeast is central to the region's sense of place and is an important driver of rural economies.
- Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry.
- The region's rural industries and livelihoods are at risk from further changes to forests, wildlife, snowpack, and streamflow.

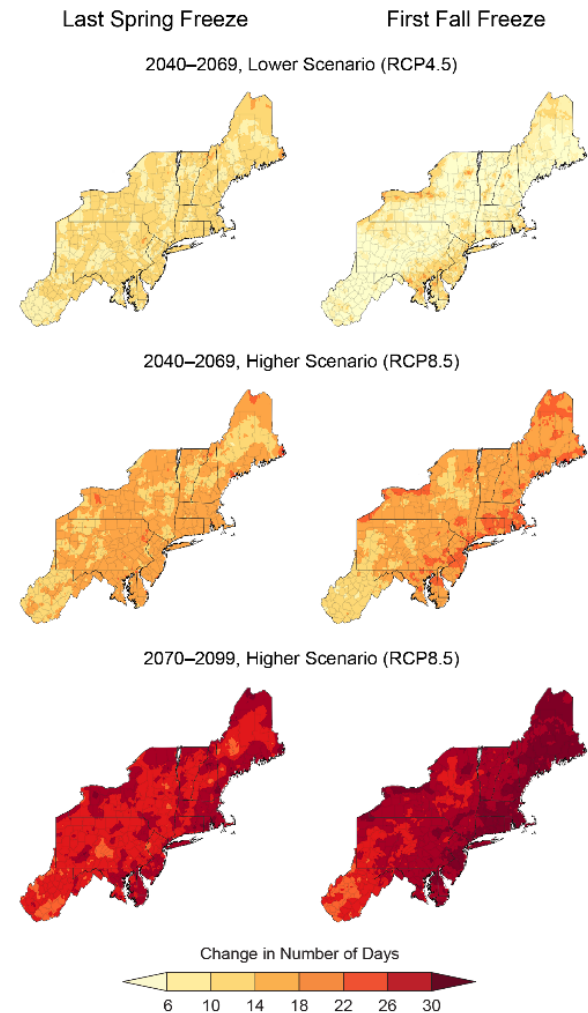


Fig 18.3- Lengthening of the freeze-free period



# Key Message #2: *Marine and Coastal Environments*

## Changing Coastal and Ocean Habitats, Ecosystem Services, and Livelihoods

- The Northeast's coast and ocean support commerce, tourism, and recreation that are important to the region's economy and way of life.
- Warmer ocean temperatures, sea level rise, and ocean acidification threaten these services.
- The adaptive capacity of marine ecosystems and coastal communities will influence ecological and socioeconomic outcomes as climate risks increase.

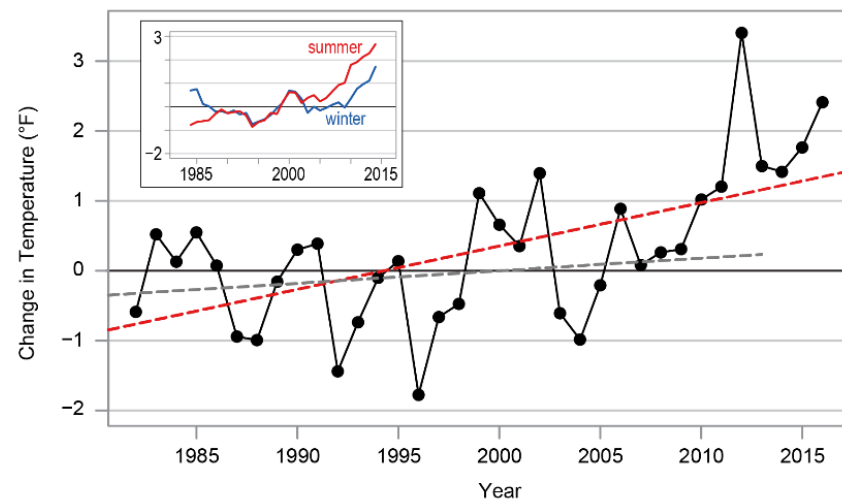


Fig 18.4- Change in SST on the Northeast Continental Shelf





# Key Message #3:

## *Urban Activities and Infrastructure*

### **Maintaining Urban Areas and Communities and Their Interconnectedness**

- The Northeast's urban centers and their interconnections are regional and national hubs for cultural and economic activity.
- Major negative impacts on critical infrastructure, urban economies, and nationally significant historic sites are already occurring and will become more common with a changing climate.



Fig 18.10- Subway Air Vent Flood Protection



# Key Message #4:

## *Threats to Human Health*

- Changing climate threatens the health and well-being of people in the Northeast through more extreme weather, warmer temperatures, degradation of air and water quality, and sea level rise.
- These environmental changes are expected to lead to health-related impacts and costs, including additional deaths, emergency room visits and hospitalizations, and a lower quality of life.
- Health impacts are expected to vary by location, age, current health, and other characteristics of individuals and communities.

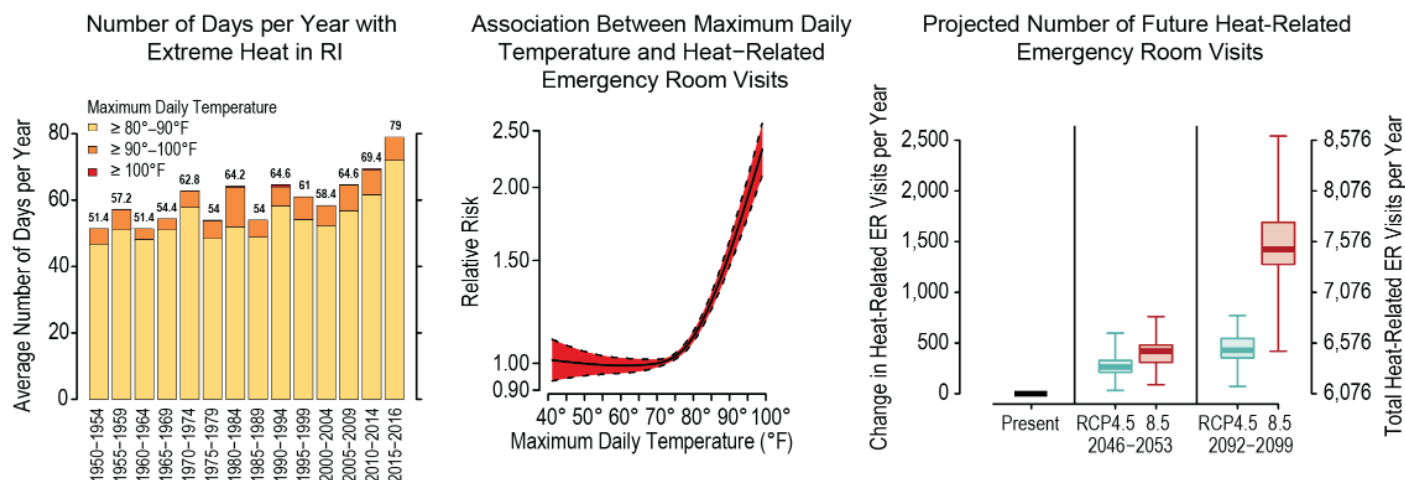


Fig. 18.11: Observed and Projected Impacts of Excess Heat on Emergency Room Visits in Rhode Island





# Key Message #5:

## *Adaptive Capacity*

### Adaptation to Climate Change is Underway

- Communities in the Northeast are proactively planning and implementing actions to reduce risks posed by climate change.
- Using decision support tools to develop and apply adaptation strategies informs both the value of adopting solutions and the remaining challenges.
- Experience since the last assessment provides a foundation to advance future adaptation efforts.



Fig 18.12- DC Water and Sewer Authority's Clean Rivers Project





# Key Takeaways



- The Northeast economy and the quality of life of its residents are vulnerable to climate change
- Climate change is already impacting the region Northeast and these changes are likely to continue through the end of century
- Rural and urban communities face distinct challenges
- The region is engaged in a variety of adaptation efforts and has a high adaptive capacity for future efforts.



# THANK YOU!

[nca2018.globalchange.gov](http://nca2018.globalchange.gov)

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*Thank you to the hundreds of volunteer federal  
and non-federal authors, editors, and technical  
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# 5. Additional Resources



# New USGCRP Tools to Inform NCA4

## Greater regional focus *[next slides]*

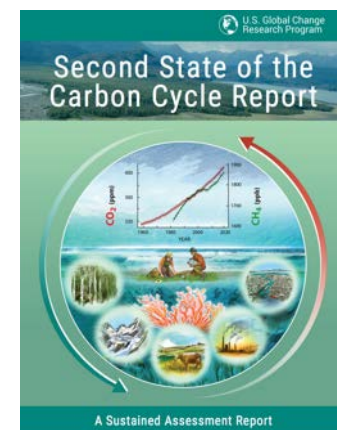
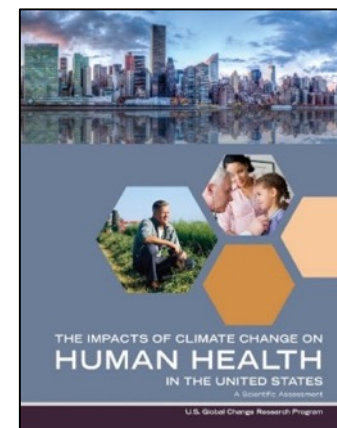
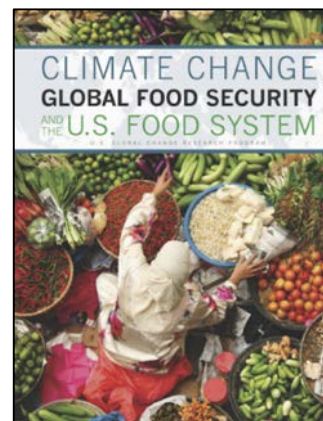
- NOAA State Climate Summaries
- EPA State Climate fact sheets
- Case studies

## Science advances

- Special Reports *[at right]*
- Scenario products (SLR, Land Use & Population): [scenarios.globalchange.gov](https://scenarios.globalchange.gov)
- Downscaled LOCA projections: [scenarios.globalchange.gov/loca-viewer/](https://scenarios.globalchange.gov/loca-viewer/)
- Indicators: [globalchange.gov/explore/indicators](https://globalchange.gov/explore/indicators)

## Economic impacts by sector & region

- CIRA2.0: [www.epa.gov/cira](https://www.epa.gov/cira)

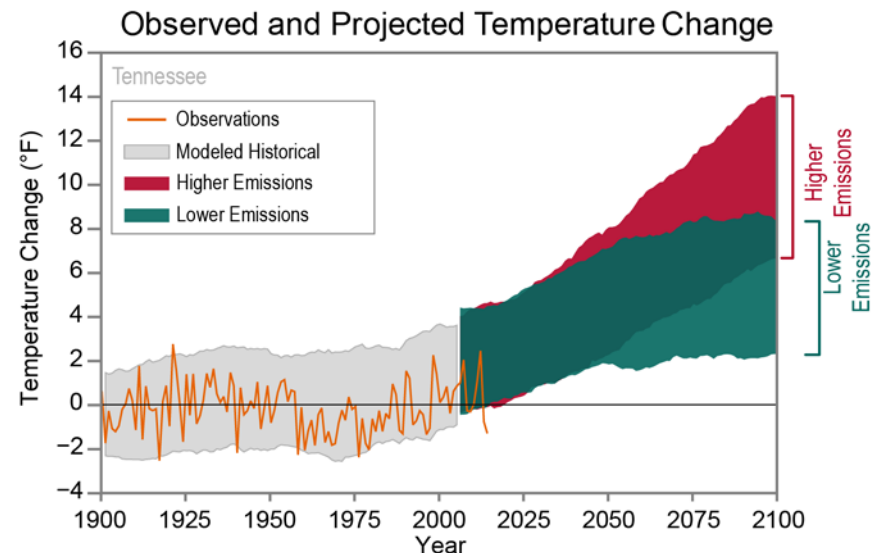
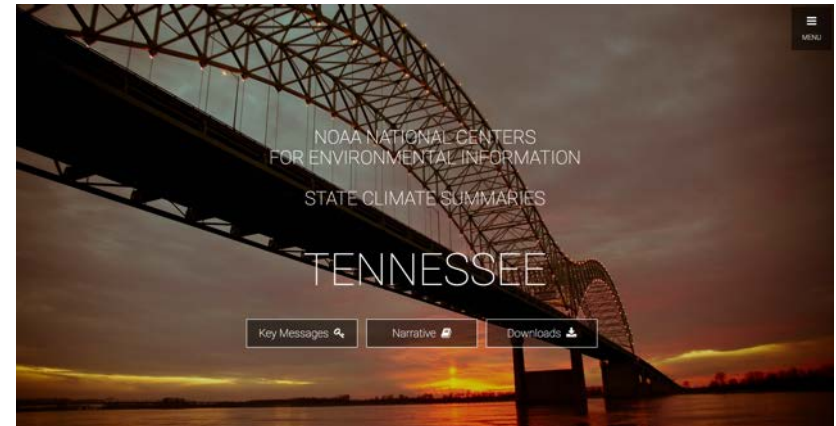




# NOAA State Climate Summaries

- Developed in response to demand for more local information after NCA3
- Three Key Messages for each state on observed and projected climate trends
- Also includes 7-10 figures tailored to each state
- Available for all 50 states, as well as Puerto Rico & the U.S. Virgin Islands
- Supplemental figures (n = ~1500) also available online (e.g., hot days, warm nights, days below freezing, etc.)

[stateclimatesummaries.globalchange.gov](http://stateclimatesummaries.globalchange.gov)





# EPA State Climate Fact Sheets



United States  
Environmental Protection  
Agency

August 2016  
EPA 430-F-16-044

## What Climate Change Means for Tennessee

Tennessee's climate is changing. Although the average temperature did not change much during the 20<sup>th</sup> century, the state has warmed in the last 20 years. Average annual rainfall is increasing, and a rising percentage of that rain is falling on the four wettest days of the year. In the coming decades, the changing climate is likely to reduce crop yields, threaten some aquatic ecosystems, and increase some risks to human health. Floods may be more frequent, and droughts may be longer, which would increase the difficulty of meeting the competing demands for water in the Tennessee and Cumberland rivers.

Our climate is changing because the earth is warming. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s. Other heat-trapping greenhouse gases are also increasing. These gases have warmed the surface and lower atmosphere of our planet about one degree (F) during the last 50 years. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others.

Natural cycles and sulfates in the air prevented much of Tennessee from warming during the last century. Sulfates are air pollutants that reflect sunlight back into space. Now sulfate emissions are declining, and the factors that once prevented Tennessee from warming are unlikely to persist.



Rising temperatures in the last century. Tennessee has warmed less than most of the United States. Source: EPA, Climate Change Indicators in the United States.

### Changing Water Availability

Annual precipitation in Tennessee has increased approximately 5 percent since the first half of the 20<sup>th</sup> century. But rising temperatures increase evaporation, which dries the soil and decreases the amount of rain that runs off into rivers. Although rainfall during spring is likely to increase during the next 40 to 50 years, the total amount of water running off into rivers or recharging ground water each year is likely to decline 2.5 to 5 percent, as increased evaporation offsets the greater rainfall. Droughts are likely to be more severe, because periods without rain will be longer and very hot days will be more frequent.

### Increased Flooding

Flooding is becoming more severe in the Southeast. Since 1958, the amount of precipitation falling during heavy rainstorms has increased by 27 percent in the Southeast, and the trend toward increasingly heavy rainstorms is likely to continue. To prevent serious floods, the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers release water from the reservoirs behind dams they operate before the winter flood season. Doing so lowers water levels and provides a greater capacity for the reservoirs behind those dams to prevent flooding. Nevertheless, the dams cannot prevent all floods. In May 2003, for example, heavy rains exceeded TVA's dam capacity, flooding low-lying areas in Chattanooga and other parts of Hamilton County; in 2010, high flows in the Cumberland River flooded Nashville.



The Cumberland River flooded parts of Nashville in 2010, damaging many businesses, including the Grand Ole Opry. Credit: USGS.

### Droughts, Navigation, and Hydroelectric Power

Droughts also pose challenges for water management. If the spring is unexpectedly dry, reservoirs may have too little water during summer. During droughts, TVA and the Corps of Engineers release water from dams to keep the Tennessee and Cumberland rivers navigable. These rivers support \$35 billion in annual shipping. The agencies try to keep channels at least eleven feet deep, because lower river levels can force barges to carry smaller loads, which increases transportation costs. During the drought of 2007, however, TVA could only release enough water to keep some channels nine feet deep. This release meant that lake levels were lowered tens of feet, which caused problems for recreational swimming and boating. If droughts become more severe, TVA and the Corps of Engineers will face this type of problem more often.

Dry years diminish the amount of electricity that TVA can produce from its 19 hydroelectric dams in Tennessee, which provide 12 to 15 percent of the electricity produced in the state. During the 2007 drought, TVA's hydroelectric plants produced 30 percent less than normal, which forced TVA to meet demand by using more expensive fuel-burning power plants.



Two views of a boat ramp in Douglas Lake during the 2007 drought. The lake is nearly dry and the 330-foot ramp is completely out of the water. Credit: NOAA.

### Aquatic Ecosystems

Changing the climate can harm aquatic ecosystems. Warmer water lowers the level of dissolved oxygen in surface water, which can severely limit fish populations. Because fish cannot regulate their body temperatures, warmer water can make a stream uninhabitable for fish that require cooler water. Warmer temperatures can also increase the frequency of algal blooms, which can be toxic and further reduce dissolved oxygen. Summer droughts may amplify these effects, while periods of extreme rainfall can increase the impacts of pollution on streams.

### Agriculture

Changing the climate will have both beneficial and harmful effects on agriculture. Longer frost-free growing seasons and increased concentrations of atmospheric carbon dioxide tend to

increase yields for many crops during an average year. But more severe droughts and more hot days are likely to reduce yields, especially in the western half of Tennessee. 70 years from now, that part of the state is likely to have 15 to 30 more days with temperatures above 95°F than it has today. Even on irrigated fields, higher temperatures are likely to reduce yields of corn, and possibly soybeans. Warmer temperatures are also likely to reduce the productivity of dairy and other cattle farms.

### Forest Resources

Higher temperatures and changes in rainfall are unlikely to substantially reduce forest cover in Tennessee, but the composition of those forests may change. Forests cover about half the state, dominated by oak and hickory trees, and the forest products industry employs 180,000 people. Although more droughts would reduce productivity, longer growing seasons and increased carbon dioxide concentrations could more than offset those losses. Nevertheless, climate change is likely to increase the damage that certain insects and diseases cause in Tennessee's forests.

### Human Health

Hot days can be unhealthy—even dangerous. High air temperatures can cause heat stroke and dehydration, and affect people's cardiovascular and nervous systems. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. Warmer air can also increase the formation of ground-level ozone, a key component of smog. Ozone has a variety of health effects, aggravates lung diseases such as asthma, and increases the risk of premature death from heart or lung disease. EPA and the Tennessee Department of Environment and Conservation have been working to reduce ozone concentrations. As the climate changes, continued progress toward clean air will become more difficult.



The Smoky Mountains have always had a natural blue haze. But air pollution has increased that haze, and higher ozone levels could increase it further. This photo shows how haze obscures the view from the Look Rock Tower in Great Smoky Mountains National Park. Credit: National Park Service.

The sources of information about climate and the impacts of climate change in this publication are: the national climate assessments by the U.S. Global Change Research Program, synthesis and assessment products by the U.S. Climate Change Science Program, assessment reports by the Intergovernmental Panel on Climate Change, and EPA's Climate Change Indicators in the United States. Mention of a particular season, location, species, or any other aspect of an impact does not imply anything about the likelihood or importance of aspects that are not mentioned. For more information about climate change science, impacts, responses, and what you can do, visit EPA's Climate Change website at [www.epa.gov/climatechange](http://www.epa.gov/climatechange).

<https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-tn.pdf>



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# Case Studies – Learning by Doing

- Mitigation and adaptation activities in various sectors or regions
- Give national visibility to local-level actions
- Facilitate community-to-community learning

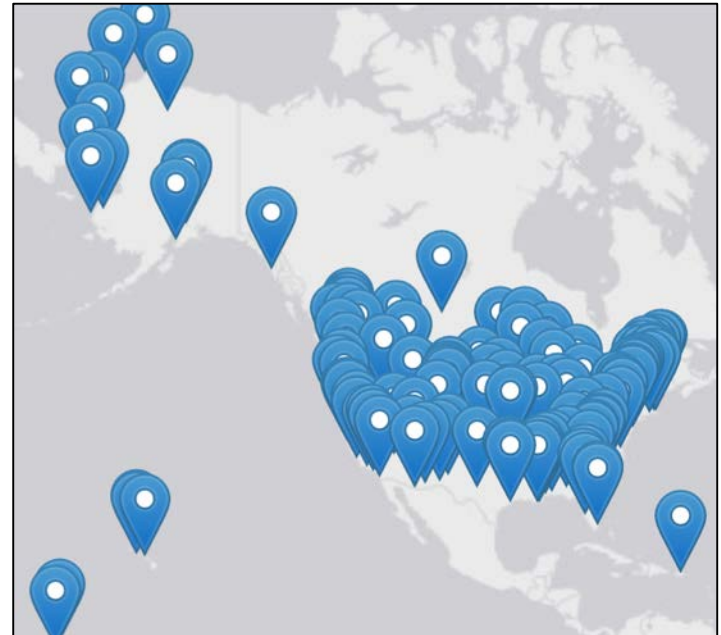
Climate Resilience Toolkit

<https://toolkit.climate.gov/#case-studies>

***Note, this website is inaccessible when the  
USG is shutdown!***

## CASE STUDIES

*Users can explore case studies to see how people are building resilience for their businesses and in their communities.*



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