U.S. Climate Resilience Toolkit

toolkit.climate.gov

Steps to Resilience

1 Explore Hazards

- *Gather a team of people who want to protect local assets.*
- *Check past weather events and future climate trends.*
- *List the things you value that could be damaged.*

After this exploration, you'll discover if weather and climate represent a hazard to things you value.

2 Assess Vulnerability & Risks

- *Determine which of your assets are exposed to harm.*
- *Assess each asset's vulnerability.*
- *Estimate the risk to each asset.*

When your assessment is complete, decide if you can accept the risk that climate presents to your assets.

3 Investigate Options

- *Consider possible solutions for your highest risks.*
- *Check how others have responded to similar issues.*
- *Reduce your list to feasible actions.*

At the end of your investigation, you'll have a list of solutions stakeholders are willing to support.

4 Prioritize & Plan

- *Evaluate costs, benefits, and your team's capacity to accomplish each action.*
- *Rank the expected value of each action.*
- *Integrate the highest-value actions into a stepwise plan.*

The result will be a comprehensive plan to implement your favored solutions.

5 Take Action

- *Move forward with the stakeholders who accept responsibility and bring resources to take action.*
- *Check to see if your actions are increasing your resilience.*

As you move forward, you'll monitor, review, and report on your project.

1 Explore Hazards

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After this exploration, you'll discover if weather and climate represent a hazard to things you value.

List the two or three most important or valuable assets that you are responsible for. "Assets" can include property, structures, infrastructure, natural resources, economy, or human population.

What hazards have affected / could affect these assets?

How might climate change influence those hazards?

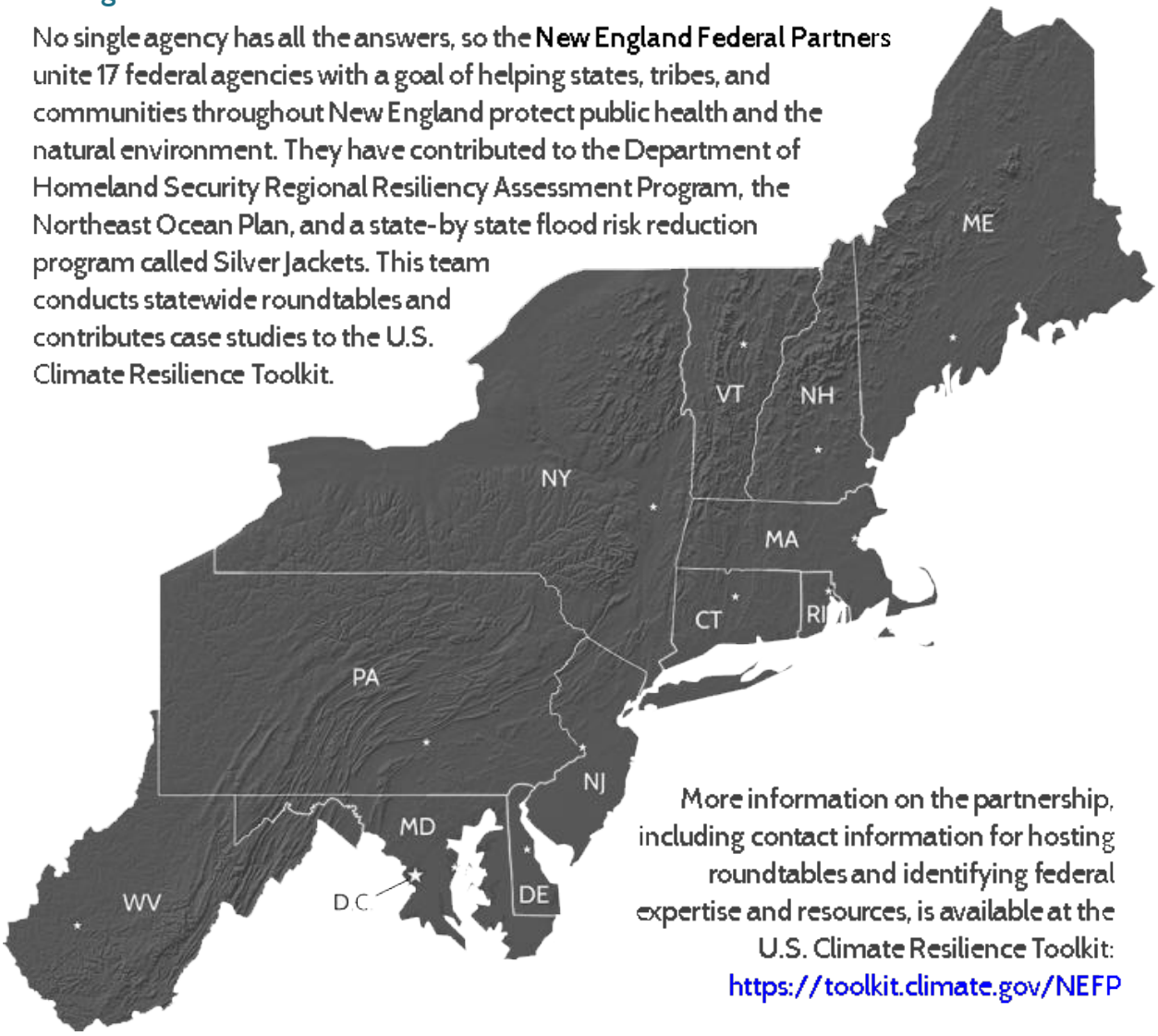
1 Explore Hazards

Gather a Team

A compilation of resources from the U.S. Climate Resilience Toolkit. Find experts at https://toolkit.climate.gov/help/partners

New England Federal Partners

No single agency has all the answers, so the **New England Federal Partners** unite 17 federal agencies with a goal of helping states, tribes, and communities throughout New England protect public health and the natural environment. They have contributed to the Department of Homeland Security Regional Resiliency Assessment Program, the Northeast Ocean Plan, and a state-by state flood risk reduction program called Silver Jackets. This team conducts statewide roundtables and contributes case studies to the U.S. Climate Resilience Toolkit.



More information on the partnership, including contact information for hosting roundtables and identifying federal expertise and resources, is available at the U.S. Climate Resilience Toolkit: https://toolkit.climate.gov/NEFP

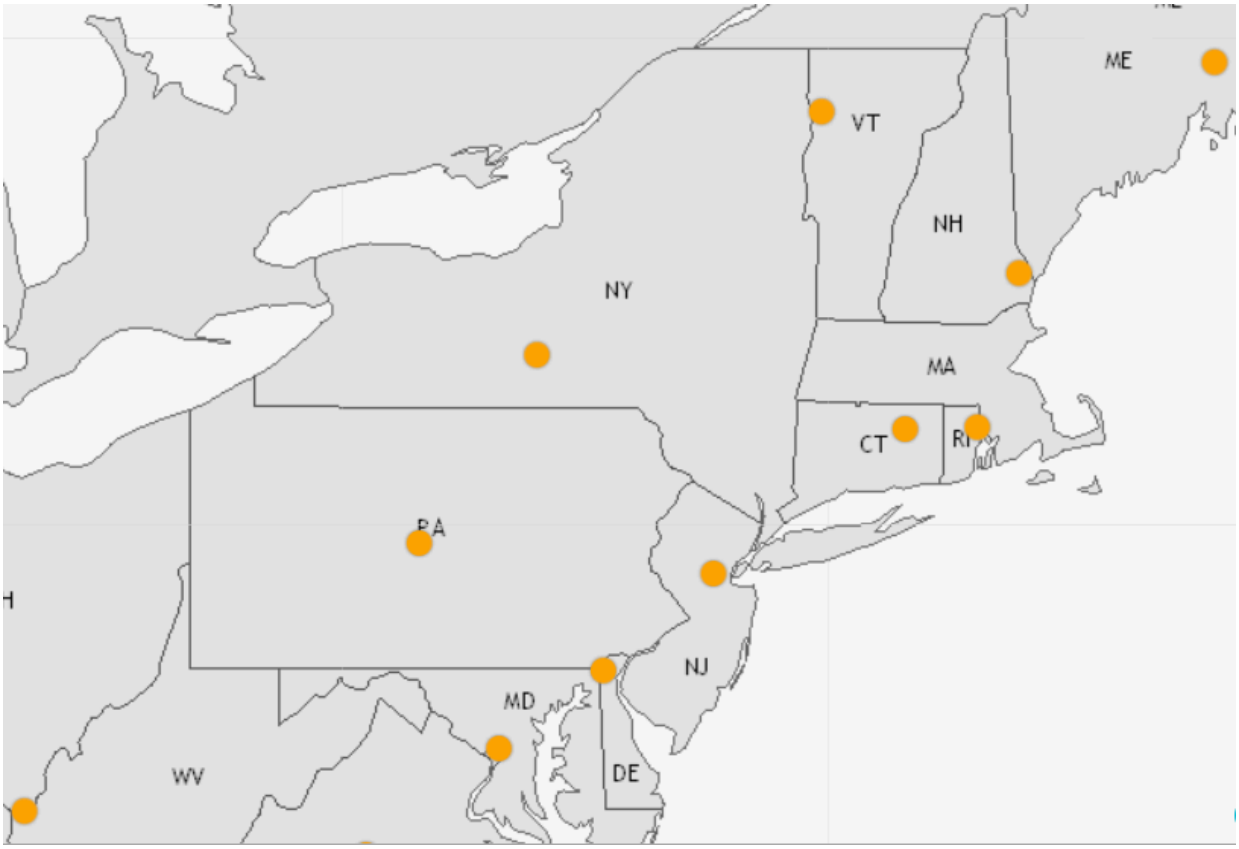
1 Explore Hazards

NOAA Regional Programs

Northeast Region Climate Services Director Ellen Mecray (ellen.l.mecray@noaa.gov)
National Weather Service Climate Services Program, Eastern Region, http://www.nws.noaa.gov/om/csd/index.php?section=programs
Northeast Fisheries Science Center, https://www.nefsc.noaa.gov
Office of Coastal Management Coastal Zone Management, https://coast.noaa.gov/czm/

Academic Partners

Northeast Regional Climate Center, http://www.nrcc.cornell.edu/
Consortium on Climate Risk in the Urban Northeast, http://www.ccrun.org/
State Climatologists are available in every New England state but Massachusetts (figure)



1 Explore Hazards

Topics

The U.S. Climate Resilience Toolkit's "Topics" section contains citable scientific information summarizing climate-related impacts in 10 different sectors.

A few examples:

Energy: digital map resources at http://arcg.is/1jOLCb

Transportation: the Infrastructure and Climate Network, theICNET.org

Health:

- Heat Health, https://toolkit.climate.gov/nihhis/
- Centers for Disease Control Building Resilience Against Climate Effects program, https://www.cdc.gov/climateandhealth/BRACE.htm

Agriculture:

- USDA Northeast Climate Hub http://www.climatehubs.oce.usda.gov/northeast-hub
- U.S. Forest Service Eastern Region, https://www.fs.usda.gov/r9/

Natural Resources:

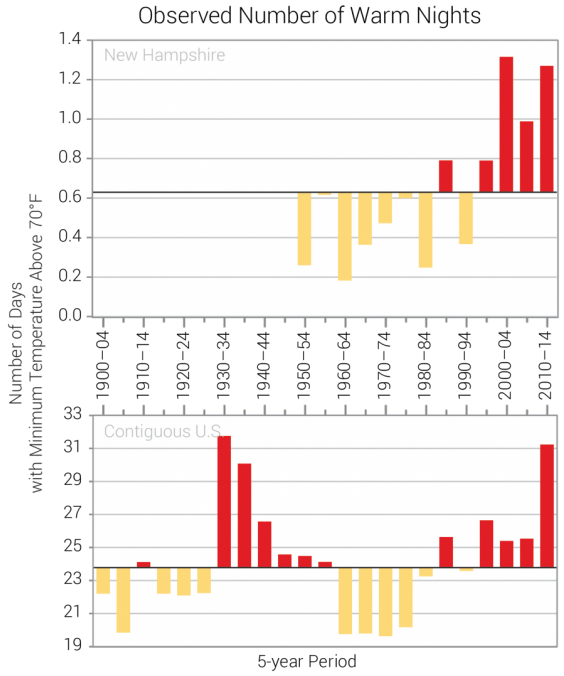
- Department of Interior Northeast Climate Science Center, http://www.doi.gov/csc/northeast/index.cfm
- North Atlantic Landscape Conservation Cooperative, http://northatlanticlcc.org/

Drought: National Integrated Drought Information System, https://www.drought.gov

1 Explore Hazards

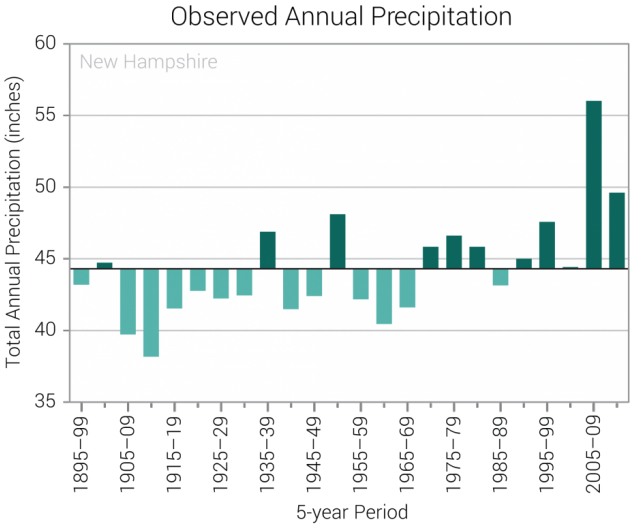
National Climate Assessment State Summary for New Hampshire

The following three "key messages" are direct quotations. For additional state results, see https://statesummaries.ncics.org/



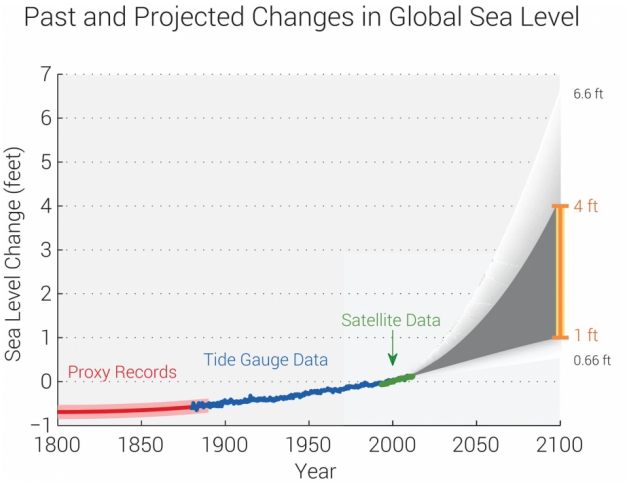
Key Message 1

Average annual temperature has increased approximately 3°F in New Hampshire since the early 20th century. Winter warming has been larger than any other season. Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century. Future winter warming will have large effects on snowfall and snow cover.



Key Message 2

Precipitation has increased in the past century, with the highest numbers of extreme precipitation events occurring over the last decade. Mean precipitation and precipitation extremes are projected to increase in the future, with associated increases in flash flooding.



Key Message 3

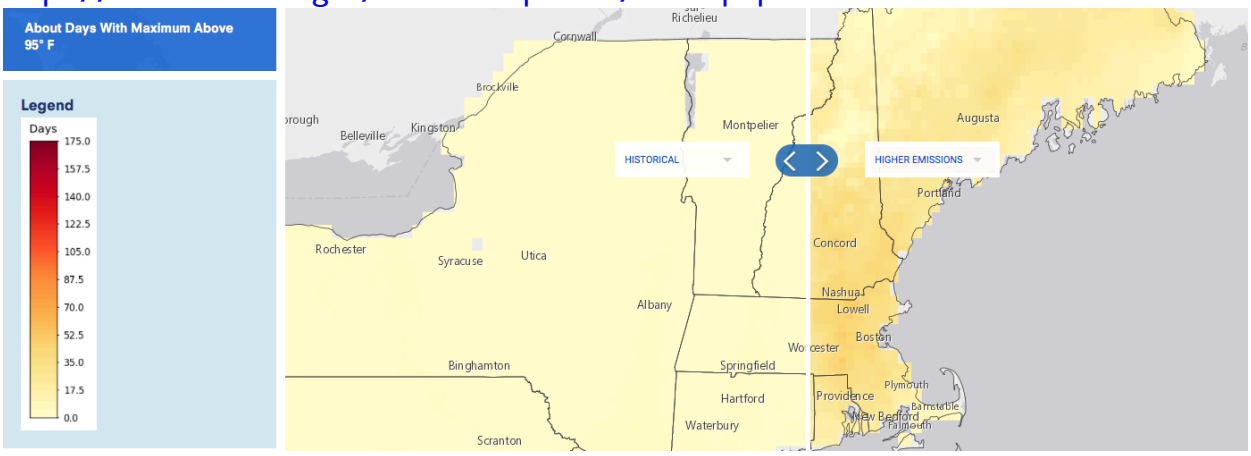
Global sea level has risen about 8 inches since reliable record keeping began in 1880. Sea level is projected to increase another 1 to 4 feet by 2100. Rising sea levels pose significant risks to coastal communities and structures, such as inundation, land loss due to erosion, greater flood vulnerability due to higher storm surge, and more frequent / severe "nuisance flooding."

1 Explore Hazards

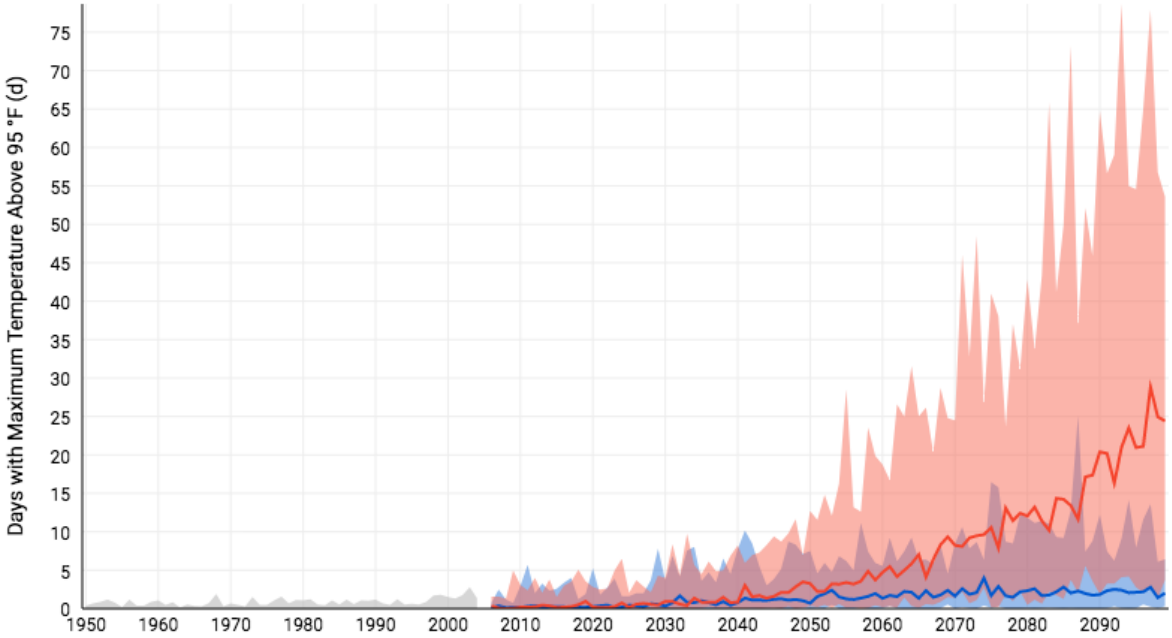
Exercise: Use Climate Explorer to Evaluate Heat

This exercise teaches you how to use the Climate Explorer to examine historical and projected extreme heat events in the county where you live (within the lower 48 United States). If you have a device connected to the Internet, start at the U.S. Climate Resilience Toolkit homepage (toolkit.climate.gov). Follow the link to "Use the Climate Explorer," launch the tool, click "Search by Location," and enter the zip code, city, or county that interests you.

You have now launched the Climate by Location module. The first set of graphs displays temperature information. Choose the "Days with Maximum Above 95°F" label on the left hand menu of this section to display a graph showing historical reconstructions of temperature for the county that contains the zip code or municipality you chose (gray shaded area and bar graph) as well as the range of projected values from downscaled global climate models for a higher and a lower emissions scenario (RCP 4.5 and RCP8.5). More details about the data are available at https://toolkit.climate.gov/climate-explorer2/about.php



1 Explore Hazards



If you do not have a device connected to the Internet, you may use the graph above, which displays data for Manchester, New Hampshire.

Discuss with your neighbor the implications of the two sets of climate projections (RCP 4.5 and RCP 8.5) for heat events. Make notes or questions below about these scenarios.

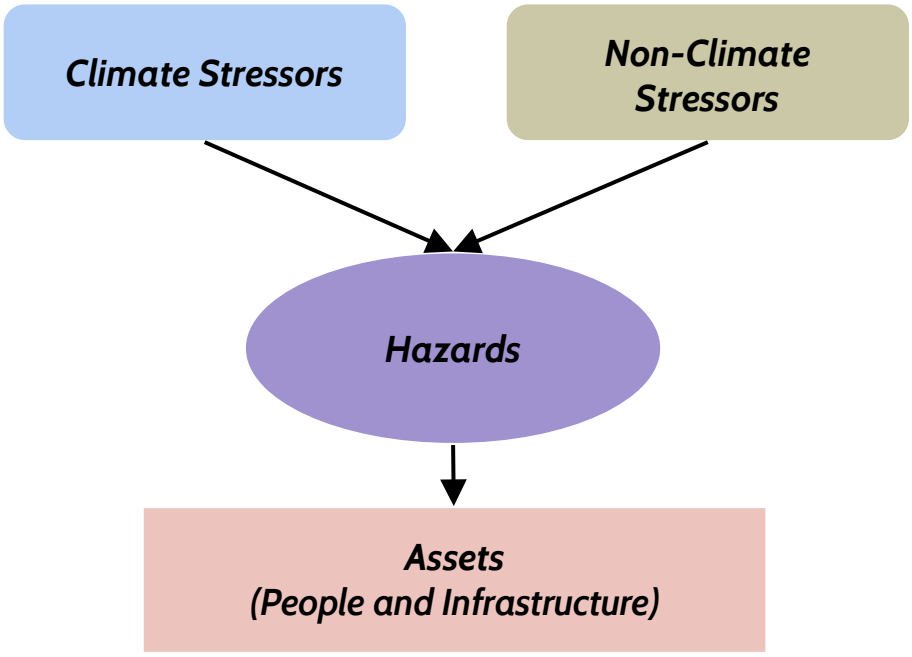
Does it seem likely that heat waves will decrease or increase?

Note other questions you may have about implications of these data.

Peruse additional data sources included within the "Climate by Location" module. Do you have questions? Note them here, ask them at the break, or send a note to us at noaa.toolkit@noaa.gov

1 Explore Hazards

If time permits, draw a diagram linking one or more of the hazards above to assets where you live or work. If possible, show many-to-many relationships, i.e., multiple hazards affecting multiple assets. Are there climate and non-climate stressors that might affect the hazards you are concerned about?

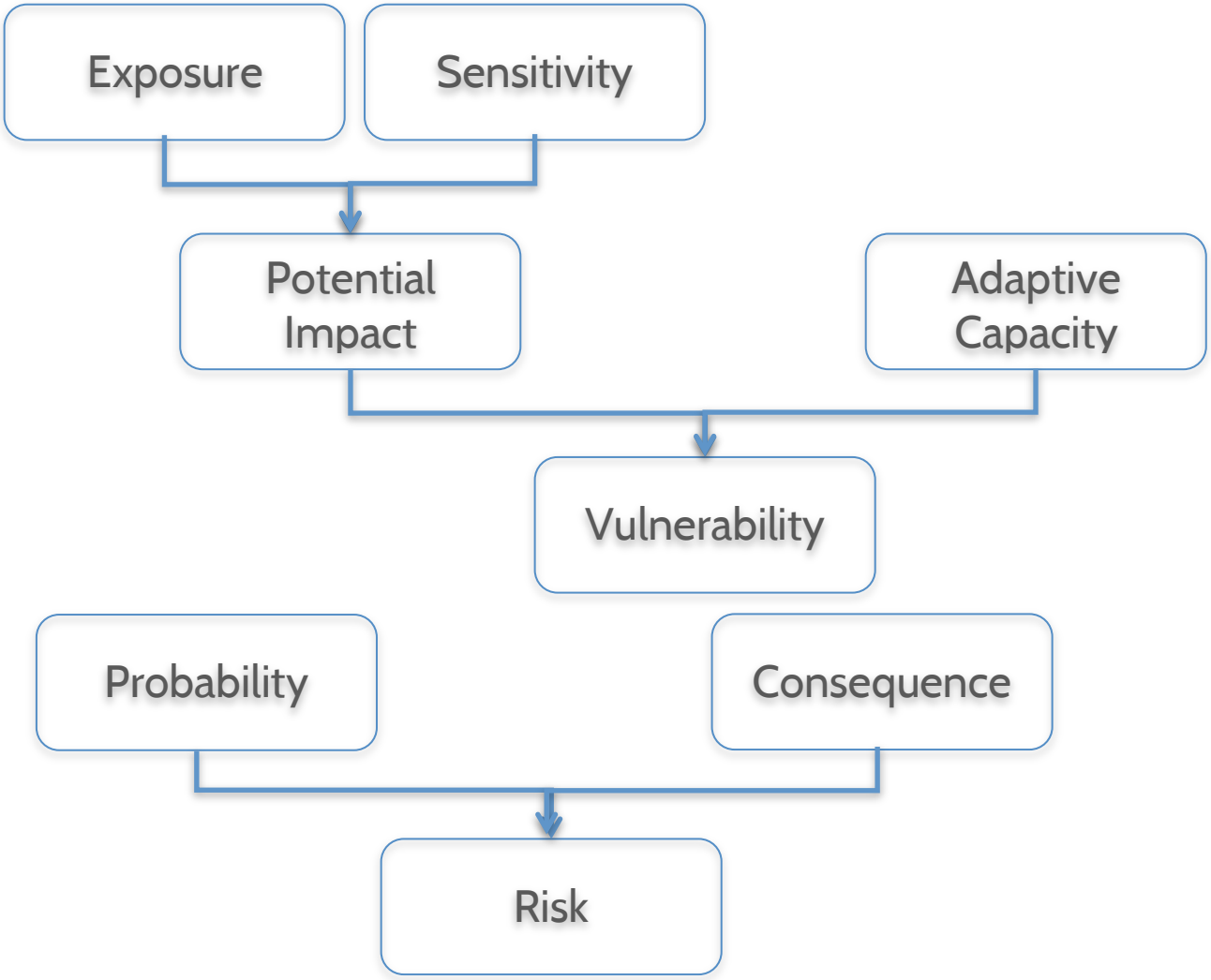


2 Assess Vulnerability & Risks

- *Determine which of your assets are exposed to harm.*
- *Assess each asset's vulnerability.*
- *Estimate the risk to each asset.*

When your assessment is complete, decide if you can accept the risk that climate presents to your assets.

It is imprecise to say 'Hand me that rope' on a sailboat. It's important to use terms precisely, both when sailing and when planning resilience. The terminology pertaining to vulnerability and risk in the CRT draws from the Intergovernmental Panel on Climate Change and peer-reviewed literature.



One may reduce vulnerability through changes to Adaptive Capacity. Risk incorporates both probability and potential consequences. Climate change may alter changes to probabilities of hazards through time. Potential consequences include assessment of changes to value (economic, social, ecosystem services, or other values) if a hazard strikes, for example through property destruction.

Exercise: Sensitivity and Vulnerability

To analyze vulnerability, one of the primary steps is to rate the sensitivity to selected hazards of each asset in your inventory. Following are (1) a completed rule set for Commercial Properties & Flooding and (2) three additional sets of considerations for asset & hazard pairs.

Commercial Properties & Flooding

- High — Business in floodplain
- Medium — Non-critical property (parking lot, storage, etc.) in floodplain
- Low — Surrounding property in floodplain

Homes & Wildfire

- Roof Type — Wood, metal, stone, composite
- Construction Material — Brick, wood, etc.
- Defensible Space — Flammable materials close to the house

Agriculture & Drought

- Access to multiple sources of water for irrigation
- Age of wells (ability to perform)

Structures & Coastal Hazards

- Type of construction and its ability to withstand wind damage
- Proximity to damaging trees that fall during storm
- Location in relation to storm surge inundation zones

Work in Small Groups

How might you define a rule set, comparable to those for Commercial Properties & Flooding, for the three additional asset & hazard pairs? Work through at least one example, such as how Roof Type (wood, metal, stone, composite) affects sensitivity of homes to wildfires. How would you rank these material types with respect to sensitivity?

Record one asset & hazard pair you are concerned about (possibly from an earlier exercise, but you may use one of the examples from this page, as well).

Asset_____ Hazard_____

What rules would you apply to determine sensitivity at a **local** level, e.g., for a particular asset?

High: _____

Medium: _____

Low: _____

Group Discussion

At a community, city, or state level, how might sensitivity be evaluated differently than at a local level?

Based on informal discussions in the room, to what hazard(s) do your assets have the greatest vulnerability?

Assign low, medium, and high ranks to the risk to several asset/hazard pairs. Which asset/hazard pairs pose the greatest risk to you?

Probability of Hazard	Magnitude of Consequence		
Medium	High	High	
Low	Medium	High	
Low	Low	Medium	

3 Investigate Options

- *Consider possible solutions for your highest risks.*
- *Check how others have responded to similar issues.*
- *Reduce your list to feasible actions.*

At the end of your investigation, you'll have a list of solutions stakeholders are willing to support.

Once your team agrees on the assets that have the highest risk, you may consider possible solutions. Recalling the flow diagram that defines Vulnerability (see above), recall that you may reduce exposure (e.g., managed retreat from shorelines or moving infrastructure), reduce sensitivity (e.g., use alternative building methods or strengthen social systems), or build adaptive capacity (e.g., implement public education campaigns to enhance safety or improve response and recovery operations).

Use this space to note how you might improve the climate resilience of the asset, resource, or population that you are most concerned about.

Reduce exposure:

Reduce sensitivity:

Build adaptive capacity:

3 Investigate Options

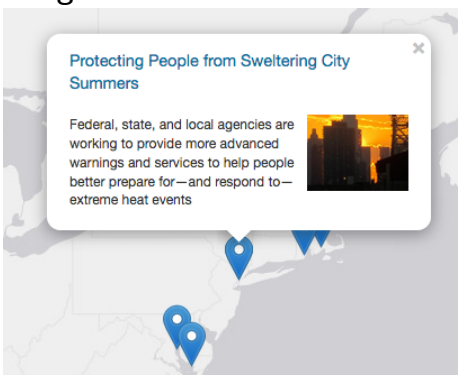
A number of toolkits provide case studies from which you can get ideas or benchmark progress toward reaching your own goals.

A growing number of websites provide case studies and reference material aimed at improving resilience to climate-related hazards.

3 Investigate Options

You may choose to browse all of the CRT's Case Studies, but here are four ways to find case studies that narrow the hundreds of results to a more manageable number.

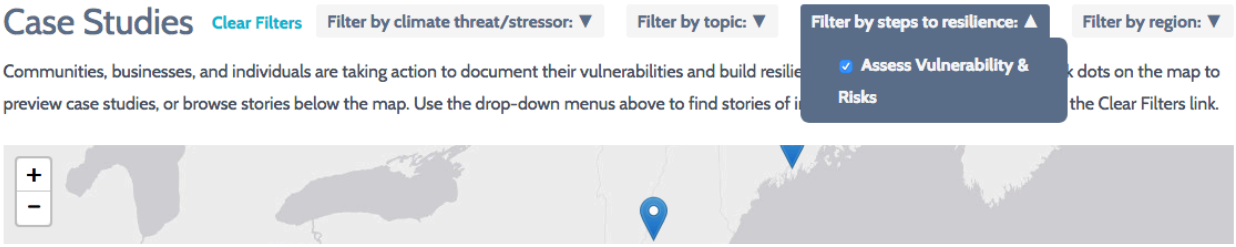
1. Browse the Case Studies Map.



Use the map interface provided on the CRT home page and/or Case Studies page to focus on a region of interest. Preview case studies by clicking on the pins shown for each location on the map. Click the title to jump to the case study.

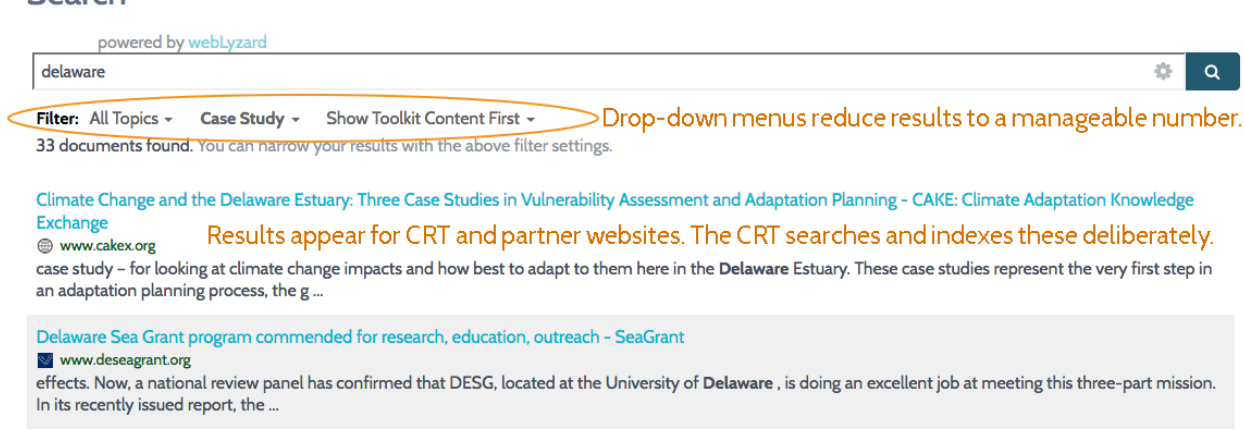
2. Use filters on the Case Studies landing page.

Pop-down menus at the top of the Case Studies page allow you to filter your search and focus on the stressor, topic, step, or region that most interests you. These menus are "Boolean," meaning you can filter for any number of terms in any / all of the menus.



3. Use the search tool.

The search bar appears on every page of the CRT. Results can be honed based on your particular interests. You may refine results based on topic or resource type using drop-down menus. The CRT search function is based on an index of sites with affiliated content both within and outside the U.S. Federal Government. The default behavior is to show CRT content before other sites, but this behavior may be turned off or on.



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- *Evaluate costs, benefits, and your team's capacity to accomplish each action.*
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The result will be a comprehensive plan to implement your favored solutions.

5 Take Action

- *Move forward with the stakeholders who accept responsibility and bring resources to take action.*
- *Check to see if your actions are increasing your resilience.*

As you move forward, you'll monitor, review, and report on your project.

The last two steps of the Steps to Resilience are familiar to most people in business or government, so we do not include exercises for them at this time. If the previous steps are followed carefully, planning and taking action follow smoothly. Be sure to monitor progress so you are able to iteratively take corrective action, if needed.

References

- Preparing for Climate Impacts: Lessons from the Front Lines (Kresge Foundation)
- The Collaboratory for Adaptation to Climate Change (University of Notre Dame and National Science Foundation)
- United Kingdom Climate Impacts Programme (University of Oxford)
- Value Chain Climate Resilience: A Guide to Managing Climate Impacts in Companies and Communities (Oxfam America and Acclimatise)
- California Adaptation Planning Guide: Planning for Adaptive Communities (FEMA and California Agencies)
- Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments (ICLEI)
- Climate Change & Extreme Weather Vulnerability Assessment Framework (USDOT Federal Highway Administration)
- The Economics of Climate Change Adaptation in EU Coastal Areas (European Commission)
- Climate Change 2014: Impacts, Adaptation, and Vulnerability (IPCC)
- Adaptation to Climate Change (Third National Climate Assessment)
- Climate Adaptation Knowledge Exchange (CAKE/Ecoadapt)
- What Climate Change Means for Regions across America: State Reports (White House)

Hyperlinks for these resources are available on the toolkit:
https://toolkit.climate.gov/content/references-steps-resilience

Glossary

Term	Definition	Example
Adaptation	The process of adjusting to new (climate) conditions in order to reduce risks to valued assets.	Relocating buildings out of flood plains or further inland from rising seas are examples of physical *adaptations*. Using smaller amounts of water during times of drought is an example of behavioral *adaptation*.
Adaptive capacity	The ability of a person, asset, or system to adjust to a hazard, take advantage of new opportunities, or cope with change.	Increasing the diameter of culverts that channel storm-water away from assets enhances the *adaptive capacity* of places that face flooding from increasingly heavy rainfalls.
Assets	People, resources, ecosystems, infrastructure, and the services they provide. Assets are the tangible and intangible things people or communities value.	The infrastructure of roads, airports, and seaports are *assets*. The service of supply chain stability (supported by transportation infrastructure) is an *asset*. A community's local "charm" is an example of an intangible *asset*.
Climate stressor	A condition, event, or trend related to climate variability and change that can exacerbate hazards.	Increasing frequency and intensity of drought conditions can be a *climate stressor* for forests and crops. Rising sea level is another *climate stressor*.
Consequence	A subsequent result (usually negative) that follows from damage to or loss of an asset. Quantifying potential consequences is an important part of determining risk.	The destruction of commercial buildings in a flood event could result in the *consequence* of a reduced tax base for a community.
Ecosystem services	Benefits that humans receive from natural systems.	Humans draw food and fiber from ecosystems. Ecosystems also filter water and air, sequester carbon, and provide recreation and inspiration for people.
Exposure	The presence of people, assets, and ecosystems in places where they could be adversely affected by hazards.	Homes and businesses along low-lying coasts are *exposed* to coastal flooding from storms.
Hazard	An event or condition that may cause injury, illness, or death to people or damage to assets.	Extended periods of excessive heat are likely to be an increasingly common *hazard* in the coming decades.
Impacts	Effects on natural and human systems that result from hazards. Evaluating potential impacts is a critical step in assessing vulnerability.	In the West, wildfires are among the *impacts* of hotter and drier conditions and earlier snowmelt.
Mitigation	Processes that can reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing them from the atmosphere.	Carbon-neutral energy sources such as solar and wind represent *mitigation* efforts.
Non-climate stressor	A change or trend unrelated to climate that can exacerbate hazards.	Altering drainage patterns and replacing open land with roads and buildings are *non-climate stressors* for flooding hazards. Population growth along exposed coasts is another *non-climate stressor*.

Glossary

Term	Definition	Example
Probability	The likelihood of hazard events occurring. Probabilities have traditionally been determined from the historic frequency of events. With changing climate and the introduction of non-climate stressors, the probability of hazard events also changes.	Locations within a 100-year flood zone have a greater *probability* for a flood hazard than locations in the same region's 500-year flood zone.
Projections	Potential future climate conditions calculated by computer-based models of the Earth system. Projections are based on sets of assumptions about the future (scenarios) that may or may not be realized.	Climate *projections* indicate that if human emissions of heat-trapping gases continue increasing through 2100 (a scenario, or possible future), most locations will see substantial increases in average annual temperature (potential future conditions).
Resilience	The capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption.	Installation of backflow preventers in the stormwater systems of a coastal city increased their *resilience* to flooding from extreme high tides.
Risk	The potential total cost if something of value is damaged or lost, *considered together with* the likelihood of that loss occurring. Risk is often evaluated as the probability of a hazard occurring multiplied by the consequence that would result if it did happen.	Warehouses sited on a floodplain represent a higher *risk* for flooding when they are filled with products than when they are empty.
Sensitivity	The degree to which a system, population, or resource is or might be affected by hazards.	The yield of crops with a high *sensitivity* may be reduced in response to a change in daily minimum temperature during the pollination season.
Uncertainty	A state of incomplete knowledge. Uncertainty about future climate arises from the complexity of the climate system and the ability of models to represent it, as well as the inability to predict the decisions that society will make.	Though climate model projections are *uncertain* about how much precipitation will change in the future, they generally agree that wet places are likely to get wetter, and dry places are likely to get drier.
Vulnerability	The propensity or predisposition of assets to be adversely affected by hazards. Vulnerability encompasses exposure, sensitivity, potential impacts, and adaptive capacity.	Despite the thick walls of the aging lighthouse, its location on a barrier island made it *vulnerable* to shoreline erosion.