Climate Adaptation Planning

Guidance for Emergency Managers

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1. Introduction

Communities across the nation are seeing a change in the hazards they face. Extreme weather events are becoming more frequent and more severe. Because certain disasters, such as floods and wildfires, are occurring in new places or during different times of the year, communities can no longer plan for future incidents solely based on what has happened in the past. The changing hazard landscape means emergency managers need to plan differently when assessing disaster risk and community resilience. To be more prepared, communities should examine the changing environment, understand how future hazards may impact their community, and factor that information into their planning efforts.

1.1. Purpose

The *Climate Adaption Planning Guidance for Emergency Managers* (this guide) is intended to help state, local, tribal, and territorial (SLTT) emergency managers incorporate climate adaptation into emergency management planning efforts. It discusses climate science in the context of disaster preparedness and explains how emergency managers can help communities develop effective climate adaptation strategies. Communities may use different terminology around climate resilience and climate adaptation efforts, but for the context of this guide, the terminology will be subsequently referred to as "climate adaptation planning."

Climate Adaptation Planning

For the purpose of this guide, climate adaptation planning is defined as a systematic approach used to identify the threats and hazards that might impact a community given plausible future climatic conditions. The process involves assessing the risk posed by these threats or hazards and positioning the community to avoid or minimize the consequences of climate-related disruptions.

This introductory section provides an overview of this guide and definitions of key terms. Section 2 provides an overview of climate science, regional impacts, and potential tools for climate modeling. Section 3 presents an overview of climate adaptation planning, Section 4 follows the six step planning process based on Comprehensive Preparedness Guide (CPG) 101: Building and Maintaining Emergency Operations Plans[1] and explains the information and actions for each step. Section 2 can be read as reference material whereas Sections 3 and 4 provide potential best practices emergency managers can take to plan around climate change, along with case studies. At the end of each section and step are key takeaways for emergency managers. The Appendices provide potential cascading impacts on response and recovery planning, more details on useful climate modeling tools, resources for financing climate resilience, and a glossary and acronym list.

[1] The Federal Emergency Management Agency (FEMA), *Comprehensive Preparedness Guide 101: Developing and Maintaining Emergency Operations Plans, Version 3.0* (2021). https://www.fema.gov/sites/default/files/documents/fema_cpg-101-v3-developing-maintaining-eops.pdf.

1.2. Key Terms and Considerations for Climate Adaptation Planning

- **Adaptation:** Adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.[2]
- **Climate mitigation (may also be called "mitigation" or "greenhouse gas mitigation"):** Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere.[3]
- **Community risk analysis:** Understanding potential risks and the actions needed to address those risks by answering: 1) Which threats and hazards may affect our community? 2) If they occur, what impacts would those threats and hazards have on our community? 3) Based on those impacts, what capabilities should our community have in place?[4]
- **Equity:** The consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.[5]
- **Hazard mitigation:** Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.[6]
- **Nature-based solutions (NBS):** The sustainable planning, design, environmental management, and engineering practices that weave natural features and processes into the built environment to promote adaptation and resilience.[7]
- **Resilience:** the ability to prepare for threats and hazards, adapt to changing conditions, and withstand and recover rapidly from adverse conditions and disruptions.[8]
- **Risk:** Threats to life, health and safety, the environment, economic well-being, and other things of value. Risks are often evaluated in terms of how likely they are to occur (probability) and the damages that would result if they did happen (consequences).[9]

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[2] U.S. Global Change Research Program, *Glossary: Adaptation.* https://downloads.globalchange.gov/strategic-plan/2022/USGCRP_2022-2031_Decadal_Strategic_Plan.pdf.

[3] Ibid.

[4] FEMA, *National Risk and Capability Assessment,* https://www.fema.gov/emergency-managers/national-preparedness/goal/risk-capability-assessment.

[5] The White House, EO 13985: , "Advancing Racial Equity and Support for Underserved Communities Through the Federal Government,", 86 FR 7009 (Jan. 25, 2021). https://www.govinfo.gov/content/pkg/FR-2021-01-25/pdf/2021-01753.pdf.

[6] FEMA, *44 C.F.R. § 201.2: Definitions* (2023). https://www.ecfr.gov/current/title-44/chapter-I/subchapter-D/part-201/section-201.2.

[7] FEMA, *FEMA Resources for Climate Resilience* (2021). https://www.fema.gov/sites/default/files/documents/fema_resources-climate-resilience.pdf.

[8] *National Resilience Plan* citation forthcoming when available.

[9] U.S. Global Change Research Program, *Glossary: Resilience.* The U.S. Global Change Research Program 2022-2031 Strategic Plan.

Effective planning takes time and includes anticipation of the future (e.g., conditions, infrastructure, impacts) and proactive integration with other plans. Too often, planning occurs in silos which leads to conflicting community plans, especially in light of planning for a future with climate change. An example of this would be an economic development plan that identifies a waterfront district for expansion, which may conflict with a climate adaptation plan calling for greenspace in the area due to sea level rise. Furthering these climate change planning challenges, communities may be resource constrained or have historically suffered from inequality. Through efforts such as hazard mitigation and disaster recovery planning, emergency managers are in a key position to help bring different parts of the community together to harmonize long term strategies that address climate adaptation as well as day-to-day planning challenges.

While emergency managers often shorten the phrase "hazard mitigation" to "mitigation," in the climate discipline, "mitigation" often refers to climate mitigation (see callout box below). Climate mitigation seeks to reduce future climate change by limiting greenhouse gas (GHG) emissions. However, climate adaptation and hazard mitigation share a common goal of minimizing impacts from natural hazards that are expected to increase in frequency and intensity due to climate change.

Climate adaptation is especially concerned with adjusting to future conditions and building resilience to withstand those changes. As the future climate is variable and may present new challenges, climate adaptation uses scenarios to help plan for uncertainty. Adaptation is also a process that continues over time, responding to new information or climate conditions. Successful climate adaptation solutions can vary depending on the scope of the action but often include changes in processes, behaviors, and infrastructure.

Hazard Mitigation versus Climate Mitigation

Hazard mitigation is *any* sustainable action to reduce or eliminate long-term risk to people and property from future disasters. Climate mitigation is the reduction of GHG emissions and levels in the atmosphere to reduce the severity of human-caused climate changes.

Hazard mitigation and climate adaptation help communities reduce the risk of damage caused by natural disasters. They can also shorten recovery time by building communities that are more resilient and prepared for current and future hazards. Hazard mitigation and climate adaptation are essential because the effects of climate change are happening now and are expected to worsen.[10]

As all-hazards planners, emergency managers may already consider the impacts of climate change through hazard mitigation planning.[11] By adding climate adaptation planning, emergency managers can help promote climate resiliency across plans while supporting underserved populations and the whole community (see Figure 1).

[10] National Aeronautics and Space Administration (NASA), *Global Climate Change: The Effects of Climate Change.* https://climate.nasa.gov/effects/.

[11] For more information on hazard mitigation planning, see https://www.fema.gov/hazard-mitigation.

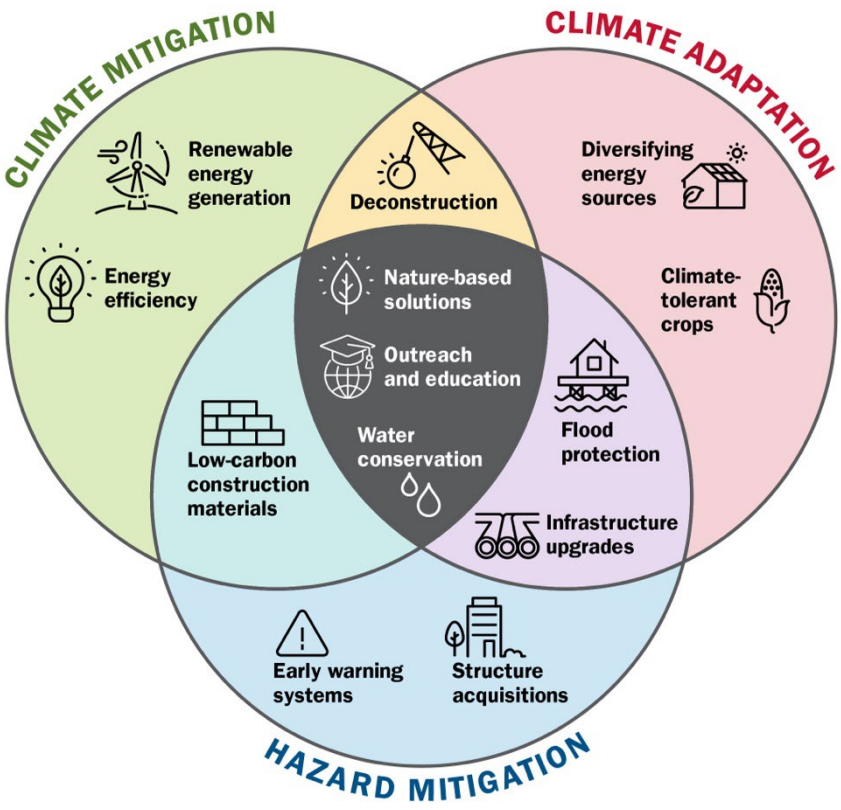


Figure 1: Climate Resilience through Climate Mitigation, Hazard Mitigation and Climate Adaptation

Key Takeaways for Emergency Managers: Introduction

- Extreme weather events are becoming more frequent and intense, and thereby costlier due to climate change.
- It is important to understand key terms commonly used in climate adaptation planning, specifically the differences between hazard mitigation, climate mitigation, and climate adaptation. Refer to key terms on page 2.
- Climate adaptation planning seeks to assess climate-related hazards, develop courses of action to mitigate risk, and devise strategies for responding to climate-related disruptions.
- Emergency managers can help communities develop effective hazard mitigation and adaptation strategies to become more resilient to the impacts of climate change. They are in a key position to help bring different parts of the community together to harmonize long term strategies that address climate adaptation as well as day-to-day planning challenges in a comprehensive way.

2. Climate Science for Emergency Managers

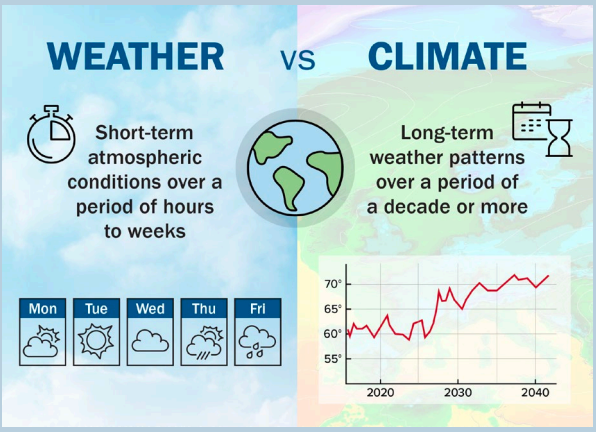
Climate science investigates the structure and dynamics of Earth's climate system. It seeks to understand global, regional, and local climate characteristics as well as the processes that influence change over time. Climate science is similar to the academic discipline of emergency management in that it draws on a number of scientific fields including meteorology, oceanography, physics, chemistry, environmental science, informatics, and computer science. Climate scientists are increasingly working with engineers and social scientists across disciplines to understand and explain how changing climatic conditions will impact individuals, communities, economies, and infrastructure systems. This section of this guide defines the science of climate change and its potential impacts, provides potential data tools for analyzing climate change, and introduces communication strategies needed to build climate-resilient communities.

2.1. Understanding Past and Potential Future Climate Conditions

Climate change is a broad term that can cover changes in multiple parts of the climate system, from temperature to precipitation to wind patterns. A region's climate provides the background conditions that give rise to a location's weather events. Thus, *climate* can be described as the "average weather" for an area; it refers to the average of the meteorological conditions and weather patterns that occur over long time periods.

Climate versus Weather

Weather refers to short-term atmospheric conditions while climate is the weather of a specific region averaged over a long period of time. Climate change refers to long-term changes.



Through geologic time, Earth's climate has varied, reflecting the complex interactions and dependencies of the solar, oceanic, terrestrial, atmospheric, and living components that make up Earth's systems. Earth experiences long cycles of warming and cooling that span tens of thousands to 100,000 years in length. The cycles are influenced by regular changes in Earth's orbit that alter the intensity of the solar energy that the planet receives, absorbs, and reflects. Earth's climate has also been transformed over a long timescale by changes in atmospheric chemistry and ocean circulation. It has also changed due to sudden events, such as massive volcanic eruptions.

The rate of climate change in the 20th century and early 21st century stands out in the geological record as extremely rapid, especially relative to the last 10,000 years. Since the year 1900, global

temperatures have risen by approximately 2°F, and climate scientists expect Earth's temperature will continue to rise at an increasing rate throughout the 21st century.[12]

The key driver of climate change is the emission of gases that trap heat in the atmosphere, commonly referred to as GHGs.[13] These gases create a "greenhouse effect," altering our climate by warming the atmosphere through absorbing and reemitting infrared radiation while allowing shortwave radiation to pass onto the Earth's surface.[14] Changes in land cover impact both weather and climate by altering the concentration of GHGs and the exchange of energy between land and the atmosphere. For example, reforestation can provide localized cooling, even as continued warming is expected for the planet as a whole and most regions on Earth. Furthermore, in urban areas, continued warming is expected to exacerbate due to the urban heat island effect.[15]

Greenhouse Gases

GHGs are gases that trap heat and solar radiation in Earth's atmosphere rather than allowing it to escape into space. This process of heating the atmosphere is known as the *greenhouse effect*. GHGs include carbon dioxide, methane, ozone, nitrous oxide, and industrial gases. Except for industrial gases, all are naturally occurring and are important for regulating Earth's temperature. Human activities have increased the amounts of carbon dioxide, methane, nitrous oxide, and industrial gases in the atmosphere, creating an imbalance in the complex system of feedback loops in Earth's warming atmosphere and leading to changes in the climate.

The types and severity of change in our climate depend on how much GHGs have built up in the earth's atmosphere. These gases have fluctuated over geologic time, yet human activities since the Industrial Revolution, most notably fossil fuel burning, have exponentially increased the release of CO_2 emissions, resulting in a higher concentration of heat-trapping GHGs and an increase in Earth's average surface temperature (see Figure 2).[16] As it is not possible to determine exactly what future GHG emissions will be, climate scientists create multiple estimates based on various assumptions to identify a range of possible human activity scenarios. These scenarios are called Representative Concentration Pathways (RCPs) and denote the estimated concentration of GHG that could build up in the atmosphere.[17]

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[12] National Oceanic and Atmospheric Administration (NOAA), *Climate Change: Global Temperature.* *https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature*.

[13] Environmental Protection Agency (EPA), *Greenhouse Gas Emissions: Overview of Greenhouse Gases.* https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

[14] NASA Earth Observatory, *Glossary: Greenhouse Gas Effect.* https://earthobservatory.nasa.gov/glossary/f/h.

[15] U.S. Global Change Research Program (USGCRP), *Fourth National Climate Assessment, Chapter 5: Land Cover And Land-Use Change* (2018). https://nca2018.globalchange.gov/chapter/5/.

[16] NASA, *Vital Signs of the Planet: What is Climate Change?* https://climate.nasa.gov/global-warming-vs-climate-change/.

[17] This guide contains references to non-federal resources. Linking to such sources does not constitute an endorsement by FEMA, the Department of Homeland Security, or any of its employees of the information or products presented.

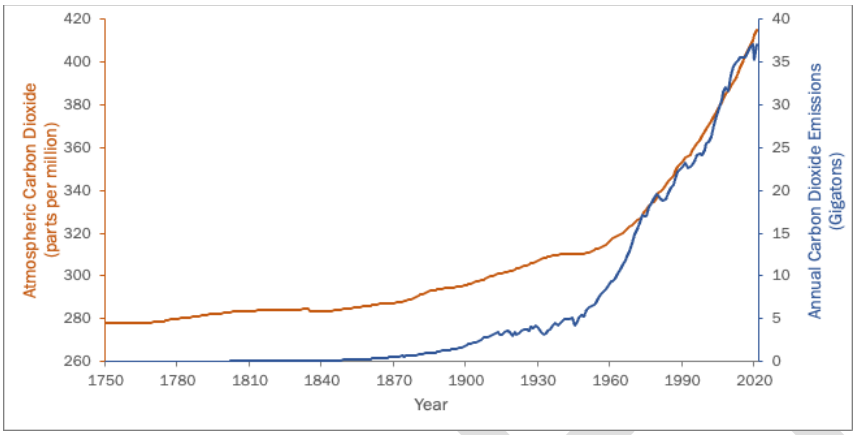

Figure 2: Atmospheric Carbon Dioxide Amounts and Annual Emissions (1750-2021)[18]

The Intergovernmental Panel on Climate Change (IPCC)[19] uses RCPs for climate modeling scenarios that reflect change since the pre-industrial era. Each RCP is based on different assumptions related to policy decisions and individual behaviors that will either decrease, maintain, or increase future GHG emissions.

Table 1 and Figure 3 show the estimated impact of three scenarios on global temperature.[20]

Table 1: Representative Concentration Pathway (RCP) impacts on Global Temperature by 2100

RCP	*Scenario*	*Global Mean Surface Temperature Increase in 2081-2100 Relative to 1986-2005 Time Period[21]*
RCP2.6	Lowest: Assuming carbon emissions from fossil fuels have already peaked.	0.5°- 3.0°F (0.3 - 1.7° C)
RCP4.5	Low or Intermediate: Fossil fuel carbon emissions peak mid-century then decrease.	2.0°- 4.7°F (1.1 - 2.6° C)
RCP8.5	Highest: Fossil fuel carbon emissions continue to increase throughout the century.	4.7°- 8.6°F (2.6 - 4.8° C)

[18] NOAA, *Climate Change: Atmospheric Carbon Dioxide.* https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

[19] The IPCC is an intergovernmental body of the United Nations responsible for advancing knowledge on climate change. It provides objective and comprehensive scientific information on climate change, including the natural, political, and economic impacts and risks as well as possible response options. It does not conduct original research nor monitor climate change, but rather undertakes a periodic, systematic review of all relevant published literature. Thousands of scientists and other experts volunteer to review the data and compile key findings into "Assessment Reports" for policymakers and the general public.

[20] The IPCC released its Sixth Assessment Report in 2023 (https://www.ipcc.ch/report/ar6/syr/), which offers an updated climate outlook and developed new GHG emissions scenarios called Shared Socioeconomic Pathways (SSP). The SSPs share many similarities with RCPs; however, since they are newer, many climate models still use the RCPs, including the resources listed in this document.

[21] IPCC, *Future Climate Changes, Risks and Impacts.* https://ar5-syr.ipcc.ch/topic_futurechanges.php.

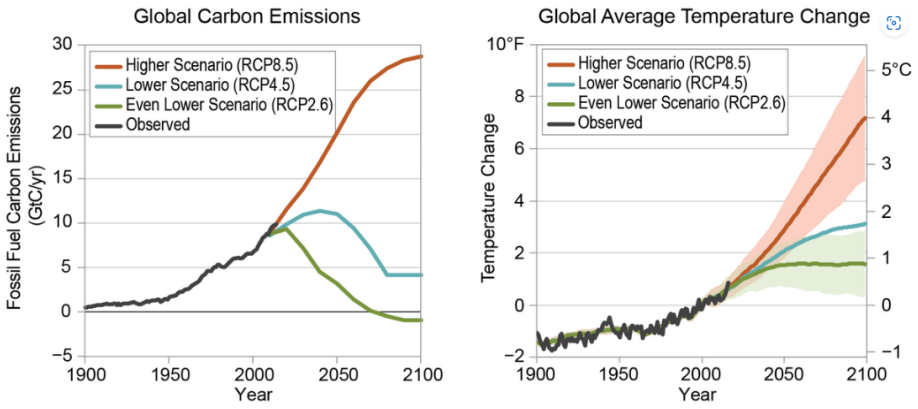

Figure 3: Carbon Emissions and Temperature Scenarios Based on RCPs[22]

Many factors will influence future GHG concentration including carbon capture and renewable energy technology advancements, governmental and organizational policy decisions, consumer behavior, and the pace of modernization in developing countries. Emergency managers are encouraged to remain up-to-date with the current science to undertake climate-informed risk analysis, especially as it relates to climate change impacts specific to a geographic region (see Regional Impacts Section).

The National Oceanic and Atmospheric Administration (NOAA) monitors how global climate data changes through time in its annual assessment and reports results through several Climate Change Indicators on its Global Climate Dashboard. Below are some of the NOAA Climate Change Indicators:

- **Annual Greenhouse Gas Index**: Tracks the combined warming influence of the long-lived trace gases in the atmosphere.
  - The amount of carbon dioxide in the atmosphere has risen by 25 percent since 1958 and by about 40 percent since the Industrial Revolution.[23]
- **Global Surface Temperature**: Tracks temperature measurements taken at locations around the globe, which are converted from absolute temperature readings to temperature anomalies.
  - Global temperatures rose approximately 2°F (~1°C) from 1900 to 2022.[24]
- **Global Sea Level**: Tracks sea level estimates provided through tide gauges and satellite altimeters.
  - Sea level rise has accelerated from 1.7 mm per year throughout most of the 20th century to 3.2 mm per year since 1993.[25]

[22] USGCRP, *Fourth National Climate Assessment: Volume II: Impacts, Risks, and Adaptation in the United States* (2018). https://nca2018.globalchange.gov/chapter/2/.

[23] NOAA, *Climate Change: Atmospheric Carbon Dioxide.* https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

[24] NOAA, *Climate Change: Global Temperature.* https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature.

[25] NOAA. Climate Change: Global Sea Level, https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level.

2.2. Climate Change Impacts

Climate change is affecting emergency management response and recovery actions due to the impacts of climate change on meteorological and climate-related hazards. Changing weather patterns will increase the severity, frequency, and impact of disasters. For example, the following list details hazards that are common in emergency management plans and provides examples of associated climate-related risk factors to consider:

- **Drought**: As temperatures climb, evaporation rates increase. In drought conditions, high evaporation rates will make droughts worse. Severe droughts can threaten drinking water supplies and supply chains, reduce industrial output, and disrupt agriculture.
- **Extreme Heat**: The annual number of very hot days is increasing. Extreme heat is now affecting areas of the country that are unfamiliar with this hazard. Of all weather-related hazards, extreme heat causes the highest number of deaths each year.[26]
- **Coastal Flooding**: Rising sea levels are contributing to more frequent and intense coastal floods and storm surges, as well as recurring nuisance flooding.
- **Inland Flooding**: In many regions, more frequent and intense rains are leading to more severe flooding, especially during the heaviest events. Heavy rain can also trigger flash flooding and make rivers overflow. Saturated soils also create ideal conditions for landslides and mudslides.
- **Hurricanes**: Warming ocean waters are fueling larger and stronger tropical storm systems and weather conditions and increasing the likelihood of rapid intensification. The Gulf Coast, Southeast, and Mid-Atlantic are seeing more destructive hurricanes.
- **Wildfires**: Warmer temperatures are now more common, and intense droughts are creating the conditions for larger wildfires. Wet growing seasons, paired with dry periods, can lead to high fuel loads; warmer winter temperatures have allowed pests to decimate forest health, leading to massive amounts of dead wood on forest lands. All these factors create conditions for larger and more frequent wildfires and cascading smoke impacts.

This guide does not address all possible climate-related concerns and their potential impacts. As climate science remains an evolving discipline, there will be unknown impacts and unresolved questions related to climate change.[27] For example, some climate research links extreme cold events to Arctic warming due to its influence on the jet stream; however, this finding is not yet well determined. Such cold air outbreaks have resulted in significant impacts to people and infrastructure and should still be factored into planning.[28]

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[26] NWS/NOAA, *Weather-related Fatality and Injury Statistics.* https://www.weather.gov/hazstat/.

[27] IPCC, *Fifth Assessment Report (WGII AR5): Technical Summary* (2014). https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-TS_FINAL.pdf.

[28] For more information on FEMA's Response and Recovery Climate Change Planning Guidance, see https://www.fema.gov/sites/default/files/documents/fema_response-recovery_climate-change-planning-guidance_20230630.pdf.

2.3. Regional Impacts

Changing hazards will impact communities and regions differently. The hazards that regions and communities have previously been occasionally exposed to will become more frequent and severe, with new areas being affected as well. Figure 4 outlines the top climate-related hazards for each region in the United States (U.S.). Note that this figure does not provide an exhaustive list of all climate-related hazards.

Figure 4. Regional Climate-Related Hazards[29]

[29] Ibid. (Adapted figure).

For a comprehensive summary of climate-related risk for each region, see the regional assessments in the *Fourth National Climate Assessment* and the 2022 State Climate Summaries.[30,31] The next section provides a breakdown of potential climate change impacts on communities by region.

2.3.1. POTENTIAL CLIMATE CHANGE IMPACTS BY REGION

Northeast:[32]

- The Northeast is experiencing warming temperatures and a large increase in the amount of rainfall measured during heavy precipitation events.
- Less distinct seasons, along with milder winters and earlier spring conditions, are already altering environments in ways that adversely impact tourism, farming, and forestry.
- More frequent heat waves in the Northeast are expected to increasingly threaten human health through more heat stress and air pollution.
- Sea level rise and more frequent heavy rains are expected to increase flooding and storm surges, threatening infrastructure.
- As temperatures rise, agriculture will likely face reduced yields, potentially damaging livelihoods and the regional economy.

Northwest:[33]

- Climate change is projected to increase the risks from extreme events, including flooding, landslides, drought, wildfire, and heat waves.
- Climate change will likely result in continued reductions in snowpack and lower summer stream flows in the Northwest, worsening the existing competition for water resources. Larger numbers of rain on snow events will also lead to additional flooding.
- Higher temperatures, changing stream flows, and an increase in pests, disease, and wildfires will threaten forests, agriculture, and salmon populations.
- Sea level rise is projected to increase the erosion of most coastlines, escalating infrastructure and ecosystem risks.

Southeast:[34]

- Coastal communities in the Southeast are already experiencing warmer temperatures as well as impacts from sea level rise, such as increased flooding.

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[30] USGCRP, *Fourth National Climate Assessment: National Climate Assessment Regions* (2018). https://nca2018.globalchange.gov/chapter/front-matter-guide/.

Note: Will update with Fifth National Climate Assessment for final publishing of this guide.

[31] NOAA, *State Climate Summaries (*2022). https://statesummaries.ncics.org/.

[32] USGCRP, *Fourth National Climate Assessment: Chapter 18: Northeast* (2018). https://nca2018.globalchange.gov/chapter/18/.

[33] USGCRP, *Fourth National Climate Assessment: Chapter 24: Northwest* (2018). https://nca2018.globalchange.gov/chapter/24/.

[34] USGCRP, *Fourth National Climate Assessment: Chapter 19: Southeast* (2018). https://nca2018.globalchange.gov/chapter/19/.

- Higher temperatures and greater demands for water will strain water resources.
- Incidences of extreme weather, increased temperatures, and flooding will likely impact human health, infrastructure, and agriculture.
- Sea level rise is expected to contribute to increased storm surges and will increase the salinity of estuaries, coastal wetlands, tidal rivers, and swamps.

Southwest[35]

- The most rapid observations of warming temperatures and reduced snowpack have been observed in recent decades in the Southwest.
- Increasing temperatures and more frequent and severe droughts are expected to heighten competition for water for urban/residential use, agriculture, and energy production.
- Indigenous populations are expected to experience difficulties associated with access to freshwater, the sustaining of agricultural practices, and declines in cultural plant and animal populations.
- Drought, wildfire, invasive species, pests, and changes in species' geographic ranges will increase threats to native forests and ecosystems.

Midwest[36]

- Temperature increases in the Midwest have accelerated in recent decades, particularly increases in nighttime and winter temperatures.
- This region will likely experience warmer and wetter winters, springs with heavy precipitation, and hotter summers that have longer dry periods.
- Risks to human health are expected to rise as a result of warming temperatures, reduced air quality, and increased allergens.

Great Plains[37,38]

- Warmer winters are altering crop growth cycles and will require new agriculture and management practices.
- Projected increases in temperature and drought frequency will further stress the High Plains Aquifer, the primary water supply of the Great Plains.
- Changes in water availability are likely to present challenges to agricultural irrigation and threaten key wetland habitats.
- Older residents in rural areas and Indigenous communities are especially vulnerable to the impacts of climate change.

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[35] USGCRP, *Fourth National Climate Assessment: Chapter 25: Southwest* (2018). https://nca2018.globalchange.gov/chapter/25/.

[36] USGCRP. *Fourth National Climate Assessment, Chapter 21: Midwest* (2018). https://nca2018.globalchange.gov/chapter/21/.

[37] USGCRP. *Fourth National Climate Assessment: Chapter 22: Northern Great Plains* (2018). https://nca2018.globalchange.gov/chapter/22/.

[38] USGCRP. *Fourth National Climate Assessment: Chapter 23: Southern Great Plains* (2018). https://nca2018.globalchange.gov/chapter/21/.

Hawaii and Pacific Islands:[39]

- Dependable and safe water supplies for Pacific Island communities and ecosystems are threatened by rising temperatures, changing rainfall patterns, sea level rise, and increased risk of extreme drought and flooding.
- Warmer and more acidic oceans are stressing coral reefs and fish habitats.
- Sea level rise is expected to threaten the water supplies, ecosystems, and infrastructure of U.S. tropical islands.
- Climate change is likely to affect the livelihoods of communities, as well as tourism and other important economic sectors, on tropical islands.

U.S. Caribbean: [40]

- Saltwater intrusion associated with sea level rise will reduce the quantity and quantity of freshwater in coastal aquifers.
- Sea level rise, combined with stronger wave action and higher storm surges will worsen coastal flooding and increase coastal erosion.
- Projected increases are expected in both average and extreme temperatures.

Alaska: [41]

- Extensive permafrost thaw is expected by the end of the 21st century, increasing the risk of infrastructure damage.
- Alaska is among the fastest warming regions on Earth, with temperatures warming twice as fast as the global average since the middle of the 20th century.
- Arctic sea ice is projected to continue to decline, with nearly ice-free periods possible by mid-century.
- Native Alaskans are expected to experience a declining availability of traditional foods and reduced access to sea ice hunting grounds.

2.4. Climate Change Impacts on People and the Economy

Climate change is increasing the complexity, intensity, and frequency of disasters. According to NOAA, there were 20 climate change-driven disasters with losses exceeding $1 billion within the U.S. in 2021.[42] These events happened across all parts of the country and included droughts, floods, severe storms, tropical cyclones, wildfires, and winter storms that resulted in the deaths of 724 people. 2021 was the third most costly year for weather and climate disasters in the U.S., with only 2005 (Hurricane Katrina) and 2017 (Hurricanes Harvey, Irma, Maria, and the California wildfires)

[39] USGCRP, *Fourth National Climate Assessment: Chapter 27: Hawai'i And U.S. Affiliated Pacific Islands* (2018). https://nca2018.globalchange.gov/chapter/27/.

[40] USGCRP. *Fourth National Climate Assessment: Chapter 20: U.S. Caribbean* (2018). https://nca2018.globalchange.gov/chapter/20/.

[41] USGCRP. *Fourth National Climate Assessment: Chapter 26: Alaska* (2018). https://nca2018.globalchange.gov/chapter/26/.

[42] NOAA: National Centers for Environmental Information, *U.S. Billion-Dollar Weather and Climate Disasters* (2022). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73.

causing more economic impact. As more people live in high-risk areas, climate adaptation planning can play a key role in reducing vulnerabilities of people, risk to the built environment, and economic impacts.

While climate change is expected to increase the frequency and severity of disasters over the coming century, its impacts are already being felt (see Figure 5). For example, in the 2010s there were on average 12.8 disasters per year in which damages reached at least 1 billion dollars. This is up from 6.7 "billion-dollar disasters" per year in the 2000s.[43], [44] The physical, economic, and social impacts from these disasters are not distributed evenly. Disadvantaged populations are more likely to be exposed to the worst disaster impacts and possess fewer resources to cope with the effects.

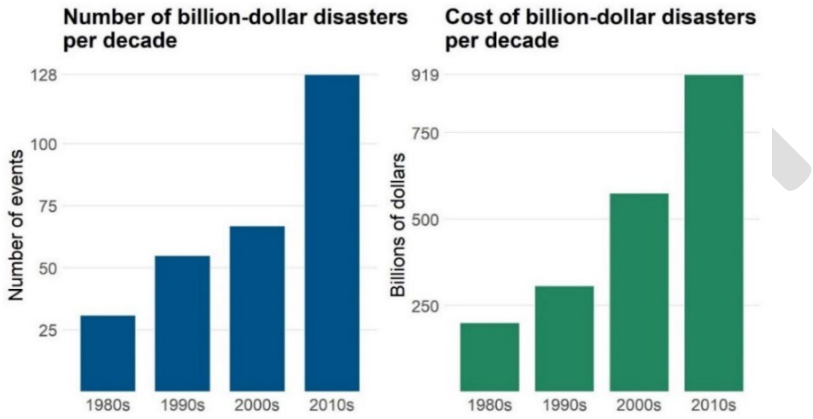


Figure 5: Trends in Billon-Dollar Disasters Events (Inflation-Adjusted)

Rising global temperatures are the most observable impact of a changing climate resulting in significant impacts on the frequency, severity, and geographical distribution of natural hazards. A warmer atmosphere means more intense storms. The warmer atmosphere can hold more water vapor, which results in increasing precipitation levels and higher risk of flooding. More heat in the atmosphere and warmer ocean surface temperatures can lead to increased wind speeds in tropical storms. Rising sea levels caused by melting glaciers and the thermal expansion of the ocean expose coastlines to tidal flooding and greater storm surge.

Shifting precipitation patterns can lead to more prolonged periods of drought while greater evaporation rates dry out soils and reduce surface water. Reduced snowpack limits the replenishment of reservoirs, creating water shortages and straining agriculture and livestock production. These conditions can cascade to produce an environment conducive to the spread of wildfire, with dry soils and vegetation as ample fuel for fires (for more in-depth examples of climate-related hazards with direct and cascading impacts, see Appendix A).

[43] Ibid.

[44] Annual billion-dollar events measurements are adjusted by the Consumer Price Index (CPI). The CPI is a measure of the average change overtime in the prices paid by urban consumers for a market basket of consumer goods and services. The CPI is a useful economic indicator, deflator of economic series, and a means to adjust dollar values.

Climate-related risks can compound with other hazards to create new threats or exacerbate existing ones. For example, long-term drought is accompanied by a greater risk of wildfire and wind erosion (e.g., the 1930s Dust Bowl). Coastal areas afflicted by riverine flooding as a result of intense rainstorms upstream may simultaneously experience a severe hurricane. This, in turn, could double the flooding impact and prolong the retreat of floodwater.

Climate change, together with other natural and human-made health stressors, also influences human health in numerous ways. Some existing health threats will intensify and new health threats may emerge. Not everyone is equally at risk and important considerations include age, economic resources, and location. Potential health effects of physical, biological, and ecological disruptions include increased respiratory and cardiovascular disease, injuries and premature deaths related to extreme weather events, changes in the prevalence and geographical distribution of food- and water-borne illnesses and other infectious diseases, and threats to mental health (see Figure 6).[45]

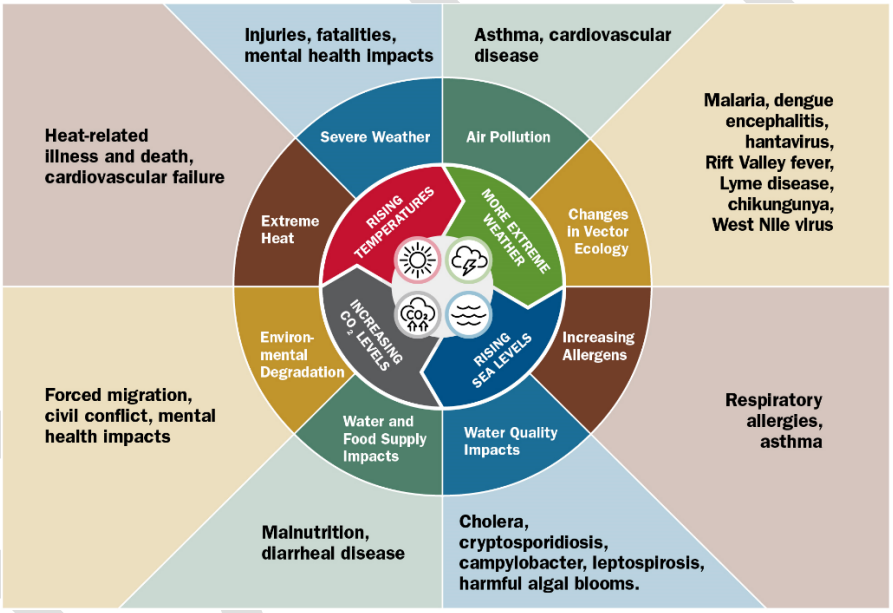


Figure 6: Impact of Climate Change on Human Health

These compounded climate threats may co-occur with other biological, technological, or economic threats. For example, extreme heat can reduce outdoor labor activities or damage infrastructure exposed to conditions beyond its design standards (e.g., melting roads, weakened bridges). All these hazards can directly and indirectly affect a community or region's economy, creating new risks for agricultural or natural resource-dependent industries (e.g., skiing, fishing). Individuals and businesses can also suffer from direct climate hazard impacts. This can include damaged workplaces; lost income; reduced tax base; disrupted supply chains; destroyed infrastructure, including power or internet; and inability to access the job site due to a flooded or damaged road.

[45] Centers for Disease Control and Prevention (CDC), Climate Effects on Health. https://www.cdc.gov/climateandhealth/effects/default.htm.

Climate and Equity: Keeping Equity at Center of Climate Adaptation Planning

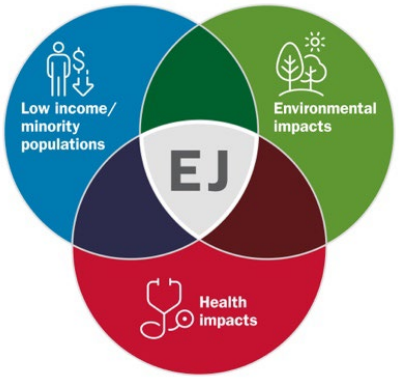
Underserved communities are disproportionately impacted by climate change and climate-driven hazards. For example, Black, Indigenous, and People of Color (BIPOC) are more likely to reside in a highly vulnerable flood zone due to years of discriminatory housing policy.[46] Lower income communities are more likely to work jobs with direct exposure to climate hazards (e.g., farmworkers and extreme heat) and suffer greater harm from hazard-driven job disruptions or loss. Put simply, those with the fewest resources to cope with climate change are often the most vulnerable to its impacts.

Keeping equity at the center of climate adaptation planning is key to ensuring the entire community – not just a small subset – has access to the resources needed to adapt to climate change. More importantly, it means ensuring underserved communities can meaningfully participate in decision-making, planning, and implementation of adaptation strategies. Action at the local level is vital in this regard, as building resilience occurs within a local, site-specific context. Emergency managers, along with elected and appointed officials and other decision-makers, have a responsibility to address climate impacts and the distribution of adaptation benefits by viewing the issue through an equity lens during every step of the planning process.

The range of climate-related hazards underscores the complexity of climate change. Climate impacts will affect many aspects of everyday life and may cause people and businesses to relocate. This relocation process will create both challenges and opportunities for communities, with some areas losing population and others needing to accommodate an influx of new residents.[47,48] Emergency managers, with their expertise in hazard mitigation and adaptation, can help to improve resilience for a community, and reduce the risk of relocation, through local climate adaptation planning.

Environmental Justice

Environmental justice (EJ) is the fair treatment and meaningful involvement of all people. This goal will be achieved when everyone enjoys 1) The same degree of protection from environmental and health hazards, and 2) Equal access to the decision-making process to have a healthy environment in which to live, learn, and work.[49]



[46] Fang, Clara, Jessica Hench, Christa Daniels, and Abigail Abrash Walton, *Centering Equity in Climate Resilience Planning and Action: A Practitioner's Guide*. Climate-Smart Communities Series 3 (2022). https://doi.org/10.25923/765q-zp33.

[47] Sherbinin, A. de, M. Castro, F. Gemenne, M. M. Cernea, S. Adamo, P. M. Fearnside, G. Krieger, et al. "Preparing for Resettlement Associated with Climate Change," *Science* 334, no. 6055 (2011): 456–57. http://www.jstor.org/stable/41351300.

[48] FEMA, *FEMA Efforts Advancing Community-Driven Relocation*. https://www.fema.gov/fact-sheet/fema-efforts-advancing-community-driven-relocation.

[49] EPA, *Environmental Justice.* https://www.epa.gov/environmentaljustice.

2.5. Climate Informed Decision-Making for Emergency Managers

Emergency managers routinely influence and make decisions in highly uncertain situations. For instance, emergency managers may be asked to recommend protective actions for a hurricane that has a 70 percent chance of making landfall in their community in the next 72 hours, or for a chemical release with wind conditions that may shift in the next 30 to 90 minutes. In responding to these scenarios, emergency managers seek to minimize the risk, while also arranging for the contingency that conditions may change. As the situation evolves and new information becomes available, emergency managers help leaders adjust risk management actions to cope with the evolving situation.

The decision-making approach used in planning and responding to disasters under uncertain conditions is similar to that applied to climate adaptation planning, albeit with a much longer timeline. Rather than operating over a period of hours or days, climate change operates over years, decades, and even centuries. Adaptation plans are often implemented over similar timescales and usually reap rewards (e.g., risk reduction) over longer periods. Yet these plans also need to be revised and updated regularly as new information is gathered (such as updated projections of climate impacts). Climate adaptation planning should recognize that several potential outcomes can occur, especially related to GHG emissions, but also that non-environmental factors will influence the objectives and strategies of the plan.

Non-environmental factors that could impact jurisdictional climate adaptation planning include local economic growth and demographic change, urban development patterns, and transportation needs. Outside jurisdictional planning, individuals and businesses themselves may contribute to adaptation, such as an individual installing solar panels or businesses upgrading buildings to be increase energy efficiency and more resilient to potential climate change impacts. By taking a broad approach to planning for an uncertain future, emergency managers can help to ensure that climate adaptation plans address a range of potential outcomes.

Emergency Management and Policy Change

Some emergency management policy changes come **AFTER** large disasters, such as after Hurricane Katrina or Superstorm Sandy.[50] Yet, local emergency managers may be in a unique position to address policy changes **BEFORE** disasters since they may be working with the elected or appointed officials as well as the whole community.[51] A jurisdiction's climate adaptation plan may be used to support future policy changes that consider climate adaptation and resilience.

[50] FEMA, Post-Katrina Emergency Management Reform Act of 2006, Pub. L. No. 109-295, Tit. VI, 120 Stat. 1394 (2006), https://www.congress.gov/bill/109th-congress/house-bill/5441/text; FEMA, Sandy Recovery Improvement Act of 2013, Pub. L. No. 113-2, Div. B, 127 Stat. 39 (2013), https://www.congress.gov/bill/113th-congress/house-bill/152/text.

[51] FEMA, *Local Elected and Appointed Officials Guide*, https://www.fema.gov/sites/default/files/documents/fema_local-elected-officials-guide_2022.pdf.

2.6. Potential Tools for Climate Modeling

Many tools exist for potential climate modeling needs. Table 2 below provides information on tools applicability regarding social vulnerability, future conditions and some potential specific hazards. Climate Resilience Toolkit also provides an easy website to start filtering for potential climate tools in relation to specific regions, hazards or the needs of a community.[52] Using these tools, consistent with applicable laws, emergency managers can further engage with the public and various planning partners on potential decision making for climate resilience. For summaries on some of these tools, see Appendix B for more information.

Table 2: Climate Resource Capability Inventory[53]

Dataset / Application / Tool	Social Vulnerability	Future Conditions	Wildfire	Flood	Hurricane
Climate and Economic Justice Screening Tool (CEJST) - White House	Yes	Yes	No	Yes	No
Coastal Flood Exposure Mapper – NOAA	Yes	Yes	No	Yes	Yes
Community Resilience Estimates - Census Bureau	Yes	No	No	No	No
Low-Income Energy Affordability Data Tool - Department of Energy	Yes	No	No	No	No
Social Vulnerability Index (SVI) – CDC	Yes	No	No	No	No
Wildfire Risk to Communities - U.S. Department of Agriculture/U.S. Forest Service	Yes	No	Yes	No	No
Climate Mapping for Resilience and Adaptation (CMRA) - White House/NOAA	Yes	Yes	Yes	Yes	No
Environmental Justice Screening and Mapping Tool (EJScreen) – Environmental Protection Agency (EPA)	Yes	Yes	Yes	Yes	No
National Risk Index (NRI) - FEMA	Yes	No	Yes	Yes	Yes
Neighborhoods at Risk - Headwaters Economics	Yes	Yes	No	Yes	No
Resilience Analysis and Planning Tool (RAPT) - FEMA	Yes	Yes	Yes	Yes	Yes
Sea Level Rise Viewer - NOAA	No	Yes	No	Yes	No
Climate Risk and Resilience Portal (ClimRR) - Argonne National Laboratory/AT&T/FEMA	Yes	Yes	Yes	Yes	Yes
Hazus - FEMA	No	No	No	Yes	Yes

[52] NOAA, *U.S. Climate Resilience Toolkit: Tools.* https://toolkit.climate.gov/tools.

[53] This list is not all-inclusive and represents the most commonly available and used tools for emergency management. Tools listed are often updated without notice. Capabilities identified are as of May 2023 by the FEMA Climate Team.

2.7. Communicating Climate Change

Communicating climate change, the degree of uncertainty associated with climate projections, and information about ongoing hazard events is a key activity for emergency managers. They may think of public information activities primarily in the context of impending or ongoing disasters and emergencies. However, risk communications and public information can also include efforts to build awareness about how one or more hazards can affect a community. This includes communicating climate change for different contexts, such as ensuring that future flood risk is considered during the zoning and building permitting processes for new developments. More broadly, public outreach efforts can help community members understand that certain hazards may become more frequent and severe, and that all members of the community can adopt a solutions-based approach to these changing conditions.

Scientific Consensus on Climate Change

The U.S.'s foremost scientific agencies and organizations have recognized climate change as a human-caused problem that should be addressed. The U.S. Global Change Research Program (USGCRP) has published a series of scientific reports documenting the causes and impacts of global climate change. NOAA, NASA, and the EPA have all published reports and fact sheets stating that Earth is warming mainly due to the increase in human-produced heat-trapping gases.

Source: https://www.climate.gov/news-features/climate-qa/isnt-there-lot-disagreement-among-climate-scientists-about-global-warming

Best Practices for Communicating Climate Change Across Diverse Audiences[54]

- Use terms that resonate with the target audience and find common ground. "Future risk" and "future conditions" may be good alternative terms to "climate change."
- Leverage the power of story, such as through video.[55] Data can be presented when woven within the context of an engaging story. Without a locally relevant story, focusing too much on the data may cause people to retreat from the conversation. Stories can make climate change more relatable.
- Focus on resiliency as well as climate change. Be sure to convey opportunities and a positive outlook. Get the audience excited about a climate resilient nation and let them know they have the power to be a changemaker.
- Collaborate with partners who the audience trusts and can carry the message for you.
- Avoid stereotypes. Members of the whole community, of all capacities, capabilities, and beliefs, are taking action against climate change.

[54] NOAA, *Isn't there a lot of disagreement among climate scientists about global warming?* https://www.climate.gov/news-features/climate-qa/isnt-there-lot-disagreement-among-climate-scientists-about-global-warming.

[55] Climate stories NC, Click on individual stories at https://www.youtube.com/@climatestoriesnc6891/videos.

Climate change can be a politically charged topic. Discussions around climate change impacts can produce reactions ranging from denial to anxiety or depression.[56] Therefore, it is important to ensure that information is based on science and evidence-based research from trusted sources, that statements avoid political agendas, and that discussions emphasize concrete actions to minimize climate change impacts. As stated in the callout box above, emergency managers can avoid political discussions by framing the impacts of climate change as "future risks" or "future conditions." These terms highlight the frequency and severity of extreme weather events that may increase such as hurricanes, heatwaves, wildfires, droughts, floods, and precipitation.[57] The goal is to encourage individuals and businesses to actively help decrease climate-related risk exposure.

Some public meetings may allow for discussions of longer-lasting, transformational adaptations that can lead to long-term community resilience and sustainability. For example, a discussion could be held on how local land use and zoning processes might mitigate climate change risks and provide additional social, economic and environmental benefits. Alternatively, local meetings might provide opportunities to talk about how infrastructure and building projects could be designed to address climate-related vulnerabilities.

Key Takeaways for Emergency Managers: Climate Science

- The key driver of climate change is the emission of gases that trap heat in the atmosphere, commonly referred to as greenhouse gases (GHG). Since it is not possible to determine exactly what future GHG emissions will be, climate scientists create multiple scenarios based on assumptions often referred to as representative concentration pathways (RCPs).
- To be prepared for an uncertain future, emergency management planners should consider a broad variety of RCP scenarios and potential cascading disaster impacts on people and the economy in their geographic region. This includes keeping equity at the center of climate adaptation planning efforts as underserved communities are disproportionately impacted by climate change and climate-driven hazards.
- Emergency managers can use a combination of climate modeling and social vulnerability tools to support planning for and decision making in uncertain future climate conditions.
- To communicate climate change threats to the public, emergency managers can employ terms such as "future risk" or "future conditions" to show how climate impacts may affect individuals and the whole community.

[56] Uppalapati, S., Ballew, M., Campbell, E., Kotcher, J., Rosenthal, S., Leiserowitz, A., and Maibach, E., *The prevalence of Climate Change Psychological Distress among American adults*, Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication (2023).

[57] NASA, *Vital Signs of the Planet: What's the Difference Between Climate Change and Global Warming?* What's the difference between climate change and global warming?.

3. Climate Adaptation Planning: An Overview

Climate adaptation planning requires planners to think in terms of decades rather than months or years. While there is uncertainty regarding the severity of climate change impacts, there is little doubt that emergency managers can plan for more frequent and more severe climate-driven incidents. Emergency managers will have a leading role in preparing communities for new risks that will be driven by climate change.

3.1. Principles of Climate Adaptation Planning

Climate adaptation planning starts with understanding the types of climate-related hazards and risks a community will face. This begins with reviewing weather-related disasters that have occurred in the past and then projecting how future climatic conditions may change traditional hazards and create new climate-related risks. Consideration of future climate conditions can be integrated into existing risk analysis and planning activities, such as the Threat and Hazard Identification and Risk Assessment (THIRA), Hazard Identification and Risk Assessment (HIRA), and the development of mitigation and recovery strategies, plans, and exercise materials. Once a community has this information, they can identify how they are likely to be affected by all hazards. Specifically, they can estimate which geographic areas, population groups, community services, and critical infrastructure elements are vulnerable to extreme weather events.

In collaboration with a diverse set of community members, planners can then identify strategies and actions for adapting to these new risks. An inclusive, community-wide approach is essential to ensure that both the planning process and the goals, objectives, and strategies are equitable. This means identifying and prioritizing the needs of underserved groups and ensuring equal access to the benefits of adaptation. A climate planning process that is both equity-focused and informed by science will help produce a quality climate adaptation plan. Ultimately, climate adaptation principles should be incorporated into all community planning processes.

Climate and Equity: Portrayal of Underserved Communities

The United Nations states “Poorer countries and underserved communities, including indigenous peoples who have protected the environment for generations, are often portrayed solely as victims of climate change, rather than positive agents of change. The same is often the case for women and girls. Make sure to highlight the voices, expertise, innovations, positive action, and solutions by people from all walks of life and communities from all parts of the world.”

While climate adaptation planning is a heavily technical process due to its reliance on risk data and climate models, it will be most successful when it is people-centered, collaborative, and equitable. This includes building partnerships across the whole community, collectively proposing creative strategies and sharing decision-making to reduce risk from climate change while preserving what the community most values.

3.1.1. FOUR KEY PRINCIPLES

Preparing for climate-related disruptions is a key part of creating climate-resilient communities; however, climate adaptation planning goes beyond preparedness and disaster response. Adaptation planning involves implementing policies, management strategies, and long-term investments as part of a community-wide approach to reduce climate-related risk. Adaptation also uses a long-term planning horizon (e.g., decades), and plans should be reviewed and updated to include the latest advancements in climate science. More so, climate adaptation efforts can be shared and incorporated into all community planning processes and into policies that guide community development. The following four principles are fundamental to climate adaptation planning:

Focus on the Future: Even though recent disasters have raised awareness of the impacts of extreme weather, future climate conditions are likely to be different than what communities have experienced in the past. Planning for climate resilience involves planning periods of decades or longer and should factor in how changing climate conditions might interact with other aspects of a community. These non-environmental factors include development patterns, population demographics, and emerging technologies (e.g., new methods of transportation). This inherent uncertainty is an important aspect of climate adaptation planning. Moreover, focusing on the future acknowledges the duty that current generations have to take action to ensure a livable planet for future generations, even if this includes taking hard actions in the short-term.

Link to Community Planning Processes: Most communities have well-established planning processes that provide the infrastructure, services, land use, and economic development foundations for a community to thrive and prosper over time. Effective climate planning can be integrated into these planning efforts so that strategies are put into place to adapt such services and infrastructure to withstand future climate-related challenges.

Leverage Partnerships and Relationships: Just as community planning processes strive to be transparent and provide opportunities for public and stakeholder engagement, it is particularly important for outreach and engagement to be part of climate adaptation planning. Adapting to future climate stresses (e.g., long-term trends that increase vulnerability) is a relatively new concept, and it is important to ensure community members and key stakeholders are aware of the threats posed by a changing climate and the ways in which these impacts could affect different parts of the community. Adaptation planning provides both a challenge to engage all groups within a community and an opportunity to establish new relationships and strengthen existing ones.

Use a Multidisciplinary Approach: Climate adaptation planning involves the integration of social, environmental, and economic considerations to promote innovative solutions that are socially acceptable, viable, equitable, sustainable, and increase resilience. Climate adaptation planning is most effective when it incorporates strategies based in natural science-, social science-, and engineering-based strategies to increase the communities' resilience climate-related as well as other types of disruptions. Examples include:

A field undergoing wetland restoration

Natural sciences help in understanding the risks caused by climate change, particularly those important to habitat and biodiversity. This information can be used to mitigate impacts on wildlife, such as fisheries. Nature-based solutions (NBS) can also increase resilience through the integration of natural features into the built environment, helping to reduce flood risk, lower urban heat, and more. Examples include wetland restoration, permeable pavement, green roofs, and living shorelines.[58]

Helping an elderly neighbor after Hurricane Harvey (2017)

Social sciences provide important context for understanding and responding to the public health, economic, and equity impacts of climate change. Social sciences can provide information about the impacts that climate change will have on people and encourage sustainable practices that best fit the needs and culture of the community.

Combining solar panels with a green roof

Engineering offers effective and innovative strategies for adapting to the impacts of climate change and the possibility of novel approaches in the future. For example, there are opportunities to integrate the engineering of stormwater infrastructure (e.g., flood levees, drainage systems, rainwater retention measures) and natural systems into a mutually reinforcing and cost-effective approach for environmental management.[59] These approaches can also benefit climate mitigation, such as by reducing building energy use.

Many communities also undertake pre-disaster recovery planning[60] that establishes strategies to lessen disruptions following a disaster. These recovery strategies can be a useful foundation for climate resilience in traditional planning. Aligning strategies and leveraging funding opportunities can also contribute to a cohesive community climate adaptation strategy.

[58] For more information on NBS, see https://www.fema.gov/emergency-managers/risk-management/nature-based-solutions.

[59] NOAA, *Engineering With Nature: USACE, NOAA, and the Value of Partnership.* Engineering with Nature: USACE, NOAA, and the Value of Partnership - Podcast: Episode 55.

[60] FEMA, *Planning Guides: Pre-Disaster Recovery Plans for Tribal, Local, and State Governments.* https://www.fema.gov/emergency-managers/national-preparedness/plan#pre-disaster.

3.2. Emergency Management Funding and Adaptation Solutions for Climate Change

An important question to ask is: "Are established planning processes flexible enough to consider adaptation and associated equity concerns, or do the processes need to change?" If processes need change, leveraging funding opportunities through emergency management may provide potential solutions.

Before Disasters: Emergency managers work with—and invest funds in—communities to build a nation able to withstand the climate hazards of today and those we can anticipate for tomorrow.

- FEMA programs like the Building Resilient Infrastructure and Communities (BRIC) and the Flood Mitigation Assistance (FMA) grant programs provide resources so communities are better prepared before disasters or extreme weather events strike.[61]
- The National Exercise Program provides support to federal and SLTT government partners to assess and enhance response and recovery capacities.[62]
- FEMA grants allow for investment in the infrastructure, including NBS and adoption of hazard-resistant building codes, and response and recovery capabilities.[63]

After Disasters: Emergency managers provide information and funding to help SLTT officials strategically invest in building back to increase climate resilience.

- FEMA's Hazard Mitigation Grant Program, including 406 Public Assistance Grants and Post-Fire assistance, goes beyond just rebuilding; these grants fund efforts for building back stronger and more resilient to future threats.[64]
- The Inflation Reduction Act (IRA) enables FEMA to fund costs associated with low-carbon materials to help cut carbon pollution (GHGs) to support climate resilience in communities.[65]

[61] For more information on BRIC and FMA, see https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities and https://www.fema.gov/grants/mitigation/floods.

[62] For more information on the National Exercise Program, see https://www.fema.gov/emergency-managers/national-preparedness/exercises/about.

[63] For more information on FEMA grants and Building Codes, see https://www.fema.gov/grants and see https://www.fema.gov/emergency-managers/risk-management/building-science/building-codes-strategy.

[64] For more information on FEMA's Hazard Mitigation Grant Program and Post Fire Program, see https://www.fema.gov/grants/mitigation/hazard-mitigation and https://www.fema.gov/grants/mitigation/post-fire.

[65] For more information on low-carbon goals, see https://www.fema.gov/grants/policy-guidance/low-carbon-goals.

Resources Available to Support Communities

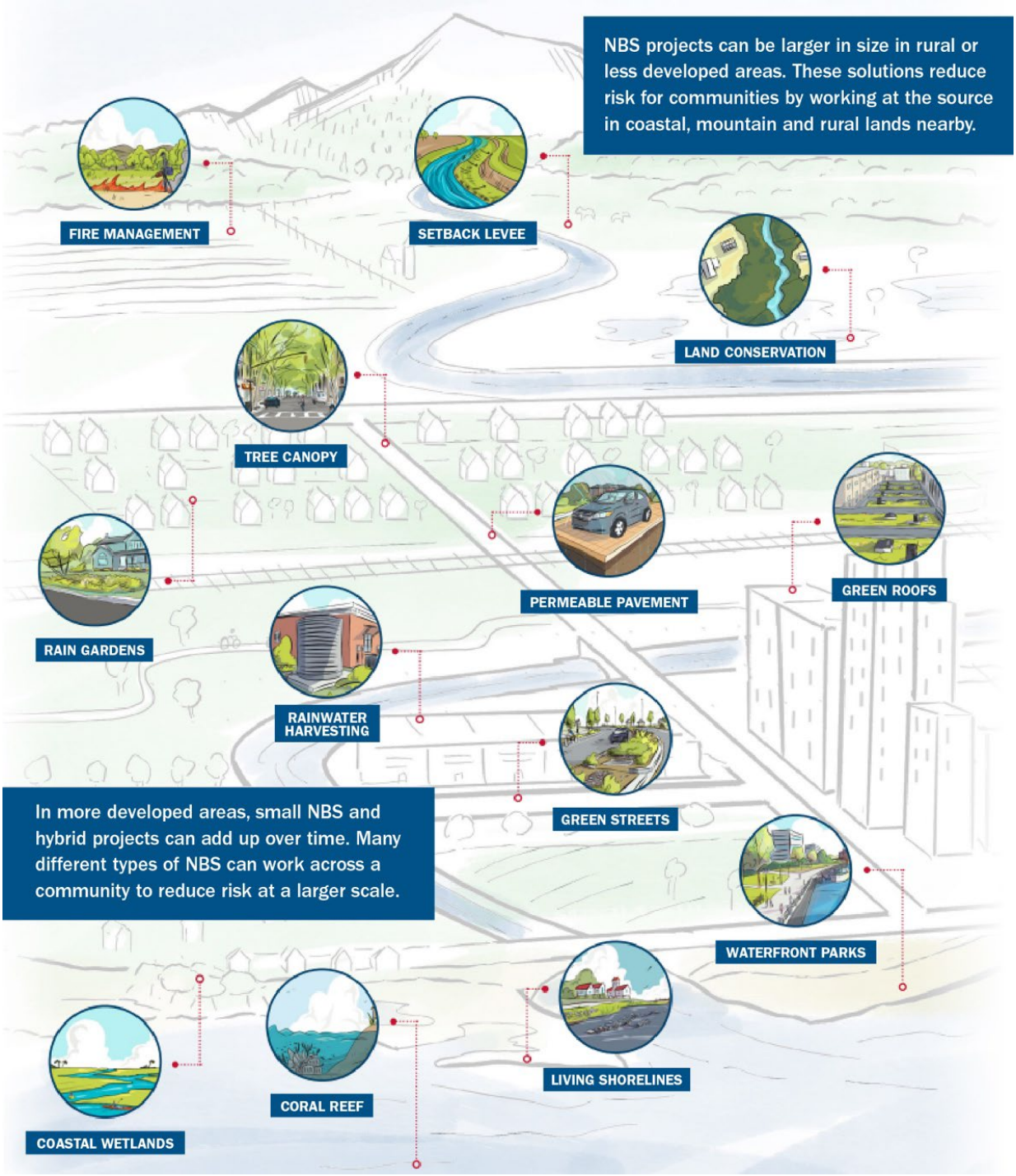
FEMA Resources for Climate Resilience provides a comprehensive explanation of FEMA programs planning for climate change.[66] Furthermore, Appendix C highlights other potential federal, state, local, private, and philanthropic funding sources.

Climate adaptation strategies often have short- and long-term benefits beyond enhancing community resilience. For example, using NBS to expand the flood water-carrying capacity of lands adjacent to a river could provide recreational, aesthetic, biodiversity, and quality of life benefits to a community (see Figure 7). Benefits for other types of strategies might be linked to economic development, public health, air and water quality, and improved housing. In some situations, climate adaptation strategies could also contribute to reductions in GHG emissions.

Incorporating climate resilience principles throughout community planning can help reduce the likelihood of engaging in maladaptation. Examples of maladaptation include building seawalls that then shift vulnerability to people elsewhere or eliminating floodplains, which in turn reduces the nutrients in soils previously provided by flood water.[67] Officials who are often tasked with budgeting for community services and capital investments should incorporate climate-related risk and sustainability considerations into their decision-making processes.

[66] For more information on FEMA's Resources for Climate Resilience, see https://www.fema.gov/sites/default/files/documents/fema_resources-climate-resilience.pdf.

[67] Schipper, Lisa, *Maladaptation: When Adaptation to Climate Change Goes Very Wrong*. One Earth (2020). https://pubag.nal.usda.gov/catalog/7171690.



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664 **Figure 7: Nature-Based Solutions (NBS) Across Landscapes[68]**

[68] For more information on Building Community Resilience with Nature-Based Solutions, see https://www.fema.gov/sites/default/files/documents/fema_nature-based-solutions-guide-2-strategies-success_2023.pdf.

Types of Adaptation

- **Low-Regrets:** Low-regrets actions are cost-effective now and under a range of future climate scenarios and do not involve hard trade-offs with other policy objectives. These actions are relatively low cost and provide relatively large benefits under predicted future climates. They contribute to adaptation while also having other social, economic, and environmental policy benefits, including benefits related to mitigation. Examples include efforts to improve water efficiency and/or building energy efficiency; preserving landscapes in support of biodiversity; and land use planning to minimize flood hazard exposure.
- **Incremental:** This adaptation pathway involves discrete actions that minimize present-day climate impacts. Typically, these actions follow a climate-related disruption and target solutions to a specific event or vulnerability. Examples include increasing stormwater/wastewater capacity; building flood protection; designing buildings to meet future climate demands; and increasing water reservoirs.
- **Transformational:** Transformative adaptation involves large-scale changes that contribute to long-term societal resilience and sustainability. This can emerge from both individual and collective action and takes a long-term perspective while recognizing diverse constituent interests. Transformational adaptation may involve institutional reform, structural changes, and coordination across multiple levels of governance. Examples include funding the relocation of underserved communities; changing land use patterns to restrict use in high-risk areas (e.g., wildland fires, flood prone areas); and prioritize protecting ecosystems.
- **Maladaptation:** Maladaptive responses to climate-driven events are those that end up increasing vulnerability and reducing community resilience. Such actions may address short-term risks but in the long run increases disaster exposure. Examples include building seawalls in highly vulnerable areas; planting trees in wildfire-prone areas; investing in protection for valuable assets; and neglecting underserved communities.

Climate adaptation strategies are also often more effective when implemented across many different communities without pushing the impacts into other jurisdictions. Regional coordination can lead to:

- Consensus on which future climate scenarios should be used in vulnerability analyses;
- Identifying the types of mitigation and adaptation strategies that would be most cost effective;
- Sharing of data, tools, and other resources for climate as well as response and recovery operations; and
- Identifying the types of mitigation and adaptation strategies that require collaboration across the region's communities to reach their full benefits.

Case Study: Southeast Florida Regional Climate Change Compact

The Southeast Florida Regional Climate Change Compact[69] began in 2009 when local officials in Broward, Miami-Dade, Monroe, and Palm Beach counties met to discuss how they could "work collaboratively to reduce regional GHG emissions, implement adaptation strategies, and build climate resilience within their own communities and across the Southeast Florida region." The Compact has three major objectives:

- Share regional tools and knowledge, including developing new analysis tools and standards, with an aim of enhancing local government capacity to implement regional climate solutions.
- Increase public support and political will by providing nonpartisan credibility, legitimacy and continuity necessary for meaningful government action.
- Coordinate action in accelerating the pace and impact of efforts to increase the region's climate resilience.

The Compact has created bipartisan support for climate action, developed new partnerships with key stakeholders, and created a vision for regional strategies for addressing climate change risks.

Key Takeaways for Emergency Managers: Climate Adaptation Planning

- Consider integrating future climate conditions into existing risk analysis and planning activities, such as the THIRA, HIRA, and the development of mitigation and recovery strategies, plans, and exercise materials.
- Climate adaptation planning is most effective when it incorporates strategies based in natural science-, social science-, and engineering-based strategies such as NBS.
- Leverage diverse funding opportunities (emergency management grants, other government funds, or public and private sources) and work across different communities and jurisdictions to be most effective.

[69] Southeast Florida Regional Climate Change Compact, *What is the Compact?* (2022), https://southeastfloridaclimatecompact.org/about-us/what-is-the-compact/.

4. Climate Adaptation Planning: Six Step Planning Process

This section provides a step-by-step process for integrating climate adaptation principles into emergency management planning. While this section presents the planning process from the perspective of developing a stand-alone plan, the process and its outputs can also be used to incorporate adaptation concerns into other community plans such as:

- Hazard mitigation plans (comprehensive and specialized examples such as flood control plans);
- Emergency operations plans (EOPs) and appendices;
- Recovery plans and strategies;
- Local comprehensive and land use plans;
- Economic development plans;
- Transportation and capital improvement plans;
- Sustainability and climate action plans;
- Community health assessments and community health improvement plans; and
- Water and land management plans.

This section builds upon the scientific and analytical approaches addressed in Section 2. It also proposes guidance on the integration of climate-related risks and adaptation principles into a community's broader planning processes and institutional structure.

U.S. Climate Resilience Toolkit

The U.S. Climate Resilience Toolkit[70] has a user-friendly Practitioner's Guide for Implementing Steps to Resilience.[71] While there are some differences between the Toolkit's Steps to Resilience (Figure 8 at right) and this FEMA guide, which is specific for emergency managers, the fundamental approach and actions are similar. This guide aligns the key climate adaptation planning actions included in the in the U.S. Climate Resilience Toolkit to the six-step planning process outlined in FEMA's CPG 101, as shown in Figure 9 on next page.

Figure 8: U.S. Climate Resilience Toolkit's Steps to Resilience

[70] NOAA, *U.S. Climate Resilience Toolkit* (2014). http://toolkit.climate.gov.

[71] For more information on the Practitioner's Guide for Implementing Steps to Resilience, see https://toolkit.climate.gov/content/practitioners-guidance-implementing-steps-resilience.

Figure 9: Steps in the Planning Process

Traditional emergency planning and climate adaptation planning share many similarities; however, there are a few differences:

- **Climate adaptation planning has a higher degree of uncertainty and should consider multiple future climate scenarios.** Traditional emergency planning often relies largely on historical data. However, climate change necessitates a shift to focusing primarily on future climate scenarios. As it is not possible to know what future emissions levels and climate mitigation policies will be, adaptation planning should consider multiple climate scenarios (e.g., intermediate emissions, high emissions) and recognize that some impacts may be difficult to predict.

- **Climate adaptation planning is an iterative process.** It cannot be completed once and then set aside for 15 years. Knowledge of climate science and climate-related vulnerabilities is constantly evolving. Likewise, community factors such as demographics and key institutions change over time. Therefore, climate adaptation plans need to be monitored and adjusted regularly to ensure adaptation strategies are effective.

- **Climate adaptation planning should be a key part of all community planning.** While stand-alone climate adaptation plans are important, climate adaptation planning and strategies should be woven into all emergency and community planning efforts. For example, a decentralized energy system using solar power can be taken down before big storms and then reinstalled after to reduce potential loss of power.

Despite its differences, climate adaptation planning should take advantage of relevant existing planning. All 50 states, the District of Columbia, and U.S. territories have FEMA-approved hazard mitigation plans, as do more than 24,700 local and 224 tribal governments.[72] These plans and the information developed for them can provide a useful launching point for climate adaptation planning.

[72] At the time of publication.

Emergency managers' experience in hazard mitigation planning is an opportunity to assume a leadership or coordinator role in climate adaptation planning. Updated hazard mitigation planning policies reinforces resilience as a whole community effort. State, tribal and local hazard mitigation plans must now address current and future risks, including those from climate change, land use and population change. The policies support mitigation planning's integration with other complementary community actions, such as climate adaptation, resilience and sustainability planning initiatives. These efforts build state and local capabilities and help jurisdictions plan for long-term risk reduction, climate change and more-equitable outcomes.[73]

CPG 101 Planning Principles Critical to Climate Adaptation Planning

Planning should:

- Be community-based, representing the whole population and its needs.
- Emphasize caring for people with disabilities and individuals with access and functional needs, infants, children, and older adults.
- Include all stakeholders in the community.
- Address equity in all phases of the planning process. This includes prioritizing the needs of underserved communities and ensuring no population is disproportionately impacted by decisions.
- Engage the private sector.
- Have elected and appointed officials invest political will throughout the process.
- Consider all hazards and threats.
- Recognize that time, uncertainty, risk, and experience influence planning.
- Inform those with agency responsibilities what to do and why.

The following sections walk through each step of the planning process, highlighting the key actions for climate adaptation planning.

4.1. Step 1: Form a Collaborative Planning Team

The first step of the planning process is to form a collaborative planning team. This begins with identifying the core planning team members who are responsible for the bulk of the analysis and

[73] For more information on Hazard Mitigation Planning Policy updates, see https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning.

planning activities. Efforts are then expanded to identify the broader collaborative planning team members and processes to ensure whole-community engagement.

Climate adaptation planning touches on all aspects of community life and requires the engagement of a broad range of stakeholders. Emergency managers have expertise in areas that are essential to adaptation planning, such as hazard identification and risk management. They also have knowledge of community resources and local characteristics. Depending on the jurisdiction, the emergency manager may serve in a coordinating role for the planning effort.

Climate and Equity: Environmental Justice (EJ) Based Decision Making

Emergency managers can make more equitable EJ-based decisions by targeting resources and grants to the underserved and integrating EJ into communications and directives. Emergency managers can also collaborate with historically underserved communities to ensure their perspectives and knowledge are included in climate adaptation planning and decision making.

Climate adaptation planning is most successful when people with skills and expertise in many areas are part of the effort. The specific expertise needed for the planning team will depend on the geographic scope of the planning effort, the characteristics of the jurisdiction, and the scope of activities. Examples of expertise that may be needed on the planning team include climate science, engineering (e.g., structures, transportation, water resources), community planning, public engagement strategies, social impact assessment, economic development, and finance. The core planning team may also establish advisory committees (e.g., technical, public) to assist on issues such as the preservation of historic resources or to ensure the interests of underserved and marginalized communities are heard with meaningful engagement.

During this initial step of the planning process, the planning team may also find it helpful to discuss and document some preliminary planning goals and considerations to help guide the effort.

Questions to Consider When Forming the Collaborative Planning Team

- How does the jurisdiction define a climate-resilient community?
- What does success look like for this effort and what are possible barriers or challenges to achieving this success? What is the target timeframe for developing the plan?
- How can the planning team take advantage of existing planning and preparedness activities (such as hazard mitigation planning and community preparedness efforts) to inform the planning effort?
- What types of education, outreach, and advisory structures should be established to encourage awareness and participation in the planning effort?
- How will the products of this effort be used to inform community/governmental decision-making?

Key Takeaways for Emergency Managers: Step 1

- Lead or participate in scoping efforts to identify preliminary goals and considerations.
- Identify key participants in hazard mitigation and community preparedness planning who could participate in climate adaptation planning.
- Describe funding opportunities for mitigation, community preparedness, and adaptation strategies, programs, and projects.
- Advocate for broad representation on the planning team to include individuals with disabilities and others with access and functional needs as well as those that have been historically underserved.

4.2. Step 2: Understand the Situation

The second step of the planning process focuses on developing a solid understanding of the community and its needs, resources, and risks. This information will inform the identification of goals and objectives in Step 3 and identification of adaptation strategies in Step 4. After forming the collaborative planning team, this second step is important in identifying common language to use prior to prioritizing goals and objectives. While this step focuses on identifying the community's climate-related risks, it is also important to document key community characteristics and needs.

Questions to Consider When Examining Risk and Vulnerability

- What are the demographics of the community?
- What populations have been historically underserved and what challenges do they face?
- What infrastructure, facilities, assets, community services, and cultural or historical features are important to the community and need to be protected?
- What other voices are needed in this planning process?

Regarding the community's climate-related risks, there are two key actions: 1) collecting and evaluating data and information on historical and projected climate conditions, along with the resulting threats and hazards, and 2) assessing current and future levels of risk to the community's people, assets, infrastructure, and services.

Evaluate Historical and Future Climate Conditions

Identifying and understanding past extreme weather-related events is an important starting point. Many of these hazards are likely already identified in the community's hazard mitigation plan. This historical data provides a useful backdrop for evaluating how climate change will amplify current hazards, as well as potentially create new ones; however, it is not sufficient to rely on historical data alone. Planners should be familiar with widely used climate projections and understand how they may impact local conditions.

The selection of which RCP scenario(s) to use in climate adaptation planning is a critical decision. Jurisdictions may choose to select:

1) A single scenario—for example, the most likely future condition or the worst-case scenario.

2) Multiple scenarios—such as a low scenario, medium and high-case scenario—to establish a range of possible outcomes. For example, Louisiana's 2017 coastal master plan used three climate scenarios to project future land changes (land lost in red or gained in green) over the next 50 years (see Figure 10). Using multiple scenarios best captures future climate uncertainties.

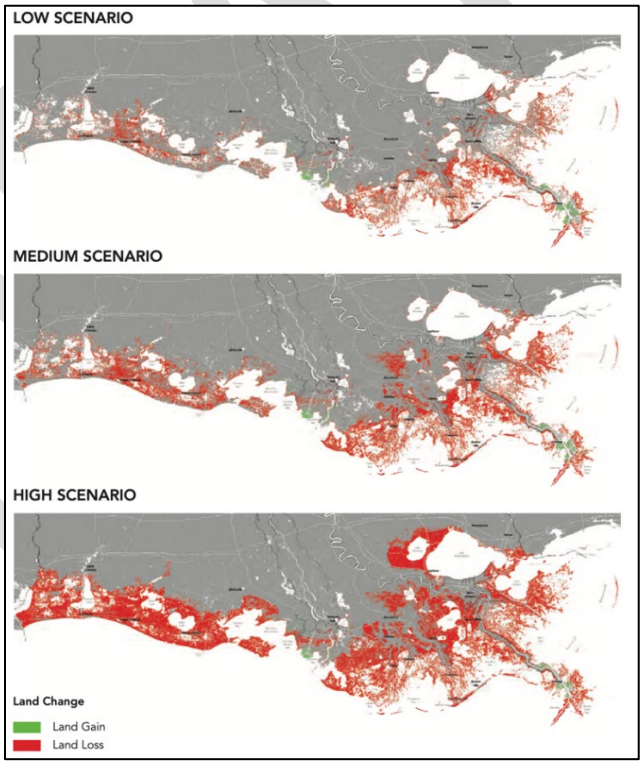

Figure 10: Example of Climate Scenarios Used in Louisiana's Coastal Master Plan[74]

[74] Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (2018). http://coastal.la.gov/wp-content/uploads/2017/04/2017-Coastal-Master-Plan_Web-Book_CFinal-with-Effective-Date-06092017.pdf.

The plan should also communicate the uncertainties associated with the key variables being used to create plan objectives and strategies. For example, coastal communities that need to plan for sea level rise should consider and communicate the difficulty of modeling rapid ice cap melting, which makes projecting the upper bounds of sea level rise difficult.[75]

Once the planning team has selected a climate scenario(s), they can use climate modeling resources, such as those covered in Section 2.6, to evaluate predicted future impacts. Comparing these impacts to historical data (e.g., historical heat wave, flood levels) will enable the planning team to estimate the type and severity of future climate impacts.

Assess Vulnerability and Risk to Community Assets and Services

Once the planning team has predicted the types and severity of future hazards, they can conduct a risk assessment. The risk assessment examines how vulnerable the community, or a particular facility, asset, service, or population is to the impacts of predicted climate hazards. Risk assessments are the basis for determining which adaptation strategies will provide the greatest risk avoidance and reduction.

In some cases, risk can be determined with a relatively high level of accuracy. For example, with projected flooding impacts to infrastructure, a simple engineering analysis can determine if a highway, bridge, building, electrical grid component, or element of the telecommunications infrastructure will be compromised and possibly damaged. The planning team can then use this information to estimate the level of damage that might occur and thus the costs of replacing or fixing the damaged components. However, for other types of vulnerabilities, such as with human populations, it is more difficult to quantify damage or loss, including the loss of life.[76] For example, people displaced from their homes due to floods or extreme temperatures may also face emotional, psychological, physical, and social stress due to the disruption to their lives.

Risk assessments need to account for the probability or likelihood of these events occurring and the likelihood of damage. The costs associated with damage or loss to the facility or asset are often factored in as well. Yet, risk analysis differs under climate change because the environment is not static, meaning that the risk of an event occurring will shift over time. For example, what has historically been a 1 percent flood event (1-in-100 years) may now be a 1.25 percent flood event (1-in-80 years), given recent climate changes. The same event might have a 2 percent (1-in-50 years) probability of occurrence by 2050 and a 5 percent (1-in-20 years) probability of occurrence by 2100.

Similarly, the amount of damage or loss from an event may change over time as the impacts become more severe under climate change (e.g., higher floodwaters). The use of emission scenarios is one way of capturing a range of possible values for key climate conditions, such as temperatures and

[75] USGCRP, *Fourth National Climate Assessment: Volume II: Impacts, Risks, and Adaptation in the United States* (2018). https://nca2018.globalchange.gov/chapter/2/.

[76] For more information on the value of statistical life, see https://hazards.fema.gov/nri/data-glossary#VSL or https://www.epa.gov/environmental-economics/mortality-risk-valuation.

precipitation. The scenarios then enable planners to evaluate how different amounts of change impact risk outcomes.

Lastly, planners must consider the cost due to damage or loss, which is more than simply the replacement or repair cost. It often includes the societal costs of losing the functionality of the asset or facility. For example, a damaged bridge will have costs associated with repair or replacement, but there will also be costs to those having to find other paths to their destinations (e.g., detour time) and to those who now have more limited options for moving people and goods.

FEMA's Job Aid "Increasing Resilience using THIRA/SPR and Mitigation Planning" describes the similarities and differences between hazard mitigation planning and the THIRA/Stakeholder Preparedness Review (SPR) process and provides an overview of an optional approach to streamline state, territory, and tribal submissions of the hazard mitigation plan and the THIRA/SPR. This optional approach may reduce duplication and maximize efficient use of these processes.

Source: https://www.fema.gov/sites/default/files/2020-09/fema_thira-hmp_jobaid.pdf

In evaluating risk, it is important to:

- **Consider the vulnerability of different populations** to the predicted hazard(s) and the populations' ability to adapt to the impacts (e.g., adaptive capacity). In adaptation planning, most effort is spent on identifying the level of exposure to different climate hazards. For example, the extent of future flooding given a climate scenario indicates the populations, facilities and structures, and other community resources that will be exposed to this hazard. How disruptive this hazard is to individuals and groups is driven by underlying social, economic, demographic, and physical factors.[77] While not a dedicated part of risk analysis, considering vulnerability and associated equity impacts is critical for this stage of the planning process.

- **Identify and focus on critical community facilities, assets, and services**. FEMA's concept of Community Lifelines[78], the most fundamental services in the community that, when stabilized, enable all other aspects of society to function, is useful in identifying key infrastructure and assets (for more on the cascading climate impacts to Community Lifelines, see Appendix A). Other institutions, including historical buildings, social or religious institutions, and unique community features (e.g., monument, county park), may be identified as priorities for investment or protection. Planners may consider the cascading impacts of potentially losing those services in the prioritization process and they should note that economic valuation may be insufficient to capture community concerns.

- **Identify geographic areas in the community that are at high risk to climate threats**. Focus on assets that could be particularly vulnerable to climate-related hazards and risks, so they can be documented in the plan and factored into the adaptation actions. FEMA's description of assets of concern for local hazard mitigation planning is a good starting point for identifying those that

[77] FEMA, 2022. Op cit.

[78] For more information on Community Lifelines, see https://www.fema.gov/emergency-managers/practitioners/lifelines.

should be part of the adaptation planning process. As noted in the Local Mitigation Planning Policy Guide,[79]

> *"Assets are determined by the community and include, but are not limited to 1) people (including underserved communities and socially underserved populations). 2) structures (including facilities, lifelines and critical infrastructure). 3) systems (including networks and capabilities). 4) natural, historic, and cultural resources and 5) activities that have value to the community."*

An important component of this definition is the phrase "determined by the community." Infrastructure networks, for example, already have criteria that indicate their importance (e.g., level of demand, provision of access to other important community activities). Experience with adaptation planning has shown that community residents can often provide important insights on which facilities and services are critical to their everyday activities. Examples of essential community facilities include hospitals and other medical facilities, police and fire stations, emergency operations centers, evacuation shelters, resilience hubs, cooling centers, cultural centers, and schools. Transportation, water, wastewater, telecommunication, and power grid networks are good examples of critical infrastructure networks.

In a real-world example, the following callout box describes the prioritized threats and risks the Jamestown S'Klallam Tribe (WA) identified in their climate adaptation plan. Note that while impacts to critical infrastructure are included, the community placed a higher priority on climate-related risks to cultural, spiritual, socioeconomic, and nutritional health.

Case Study: Jamestown S'Klallam Tribe (WA) Climate Change Risks

Excerpts from the Jamestown S'Klallam Tribe's (WA) climate adaptation plan.[80]

- Higher average temperatures will generate more extreme heat events and increased heat stress for plants, animals, infrastructure, and humans.
- Water usage from the Dungeness River is already considered critical due to multiple competing uses, especially during low flow conditions in the late summer and early fall. Shifting seasonal precipitation will lead to wetter winters and drier summers; winter snowpack has decreased, and spring snowmelt occurs earlier, increasing spring flows and decreasing summer and fall flows.
- Rising sea levels will increase coastal flood risk.

[79] FEMA, *Local Mitigation Planning Policy Guide* (2023). https://www.fema.gov/sites/default/files/documents/fema_local-mitigation-planning-policy-guide_042022.pdf

[80] Jamestown S'Klallam Tribe, *Climate Vulnerability Assessment and Adaptation Plan*. *Adaptation International* (2013). https://jamestowntribe.org/wp-content/uploads/2018/09/3-JSK_Climate_Change_Adaptation_Report_Final_Aug_2013s.pdf

- Higher acidic ocean waters will make it more difficult for some organisms to build their shells, potentially affecting their survivability and the abundance of predator species, such as salmon.
- The Northwestern portion of the Olympic Peninsula is projected to become drier, shifting tree species away from primarily western hemlock to primarily Douglas fir and causing coincident declines in western red cedar.
- Climate change impacts human health directly (e.g., storm events) and indirectly through intermediate environmental factors (e.g., air pollution).
- Population-wide changes to tribally valued plants and animals have the potential to disrupt cultural, spiritual, socioeconomic, and nutritional health.
- Through a community-driven process, tribal members identified the following as the priority areas of concern relating to climate change:

Very High Priority

- Salmon, clams, and oysters
- Shellfish biotoxins
- Wildfires
- Cedar harvests

High Priority

- Casino and Longhouse market
- State Highway 101
- Tribal campus water supply infrastructure

Medium Priority

- Jamestown Beach water supply infrastructure
- Laboratory and Planning Department buildings
- Tribal wastewater infrastructure

Key Takeaways for Emergency Managers: Step 2

- Identify data and information sources on past extreme weather-related events.
- Lead or participate in the process of:

- Understanding past extreme weather events and their impacts to the community, Community Lifelines, and identify lessons for the future.

- Identifying and evaluating climate scenarios and the types of impacts and consequences these conditions may have on the community.

- Identifying underserved population groups, as well as critical community facilities, assets, and services that could be affected by changing climatic conditions.

- Collaborate with others to provide information and outreach to the community so different groups understand the potential risks posed by climate-related hazards.

4.3. Step 3: Determine Goals and Objectives

The next step in the planning process focuses on using the information gathered during Step 2 to develop goals, objectives, and performance metrics for the climate adaptation plan. These are then used to guide the identification of the adaptation strategies and actions that the jurisdiction will choose to undertake during Step 4 of the process.

Set Goals and Objectives

Goals and objectives describe the desired outcomes of the effort and inform the steps needed to achieve them. The process of setting goals and objectives for climate adaptation planning is similar to the process used for general and emergency planning. Given that climate adaptation planning can incorporate a broad array of objectives over long timeframes, it is important to ensure that each stated objective is targeted and actionable. Equally important, the process of setting goals and objectives should incorporate a wide range of community partners, including both individuals and organizations, to ensure a high level of buy-in with the plan and investment in its implementation.

Examples of Goals and Objectives Include:

Goal: Reduce the exposure or sensitivity (degree to which exposure impacts the system) of critical structures, infrastructure, populations, and habitats to climate change risks.

- **Objective:** Reduce the number of households exposed to floods with a 1 percent annual chance of occurrence – at mid-century – by at least 50 percent.
- **Objective:** Require the adoption of energy efficient home cooling technology and design features in all newly built residential housing and encourage their adoption in existing housing units.
- **Objective:** Partner with civic centers and other key community institutions to develop hazard response networks (e.g., planned check-ins with underserved households during a heat wave, establishment of accessible cooling and warming stations).

Goal: Reduce the sensitivity of stormwater infrastructure to extreme rainfall events.

- **Objective:** Make community-wide infrastructural investments and operational changes so the community can cope with rainfall events that are 40 percent larger than the historical annual maximum event by mid-century.
- **Objective:** Encourage the adoption of green (e.g., bioswales) or gray (e.g., water reuse) stormwater/wastewater infrastructure by individual landowners.

To ensure the goals and objectives help create a more resilient community with greater adaptive capacity, it is important to develop metrics that can be used to evaluate progress. Metrics fall into two categories: *process* measures and *outcome* measures. See Table 3 for a comparison of these measures.

Table 3: Process Measures versus Outcome Measures

Process Measures	Outcome Measures
▪ **Process measures** assess adaptation efforts or operations, as well as the allocation of resources. ▪ Examples include the number of staff trained in resilience procedures, the number of systems (e.g., communication, data management, disaster response) updated for greater resilience, the level of planning coordination across agencies or governments, etc.[81]	▪ **Outcome measures** evaluate performance under specific circumstances, often within the context of the stress or hazard for which they were designed. ▪ Examples include event response and recovery; biodiversity indicators of ecosystem conditions; measures of equity in recovery from an event or stress; local measures of climate and environmental changes; etc. Outcome measures may also be tied to evaluation tools used to prioritize actions (see Step 4).

Most climate adaptation plans require a combination of process measures and outcome measures. When developing measures, the planning team should determine which measures require the identification of a baseline (e.g., current conditions) to compare with later conditions. Additionally, performance metrics, like many parts of the plan, may need to be developed iteratively and re-evaluated after strategies have been planned. In some cases, the planning team may find it necessary to develop strategy-specific performance metrics. The case study below from Broward County, FL provides example objectives found in a Climate Action Plan.

Case Study: Main Objectives for Broward County's (FL) Climate Action Plan[82]

- Prioritize and support effective coordination and collaboration between agencies and stakeholders.
- Use dynamic approaches to address uncertain and evolving conditions.
- Utilize the Unified Sea Level Rise Projection for Southeast Florida for sea level rise adaptation planning and support adaptation of at-risk infrastructure and facilities.

[81] Boltz, Frederick, Elizabeth Losos, Rachel Karasik, and Sara Mason, Resilience Roadmap: Developing Key Performance Indicators for Climate Change Adaptation and Resilience Planning," Nicholas Institute for Environmental Policy Solutions, (Duke University 2022), https://nicholasinstitute.duke.edu/sites/default/files/publications/developing-key-performance-indicators-for-climate-change-adaptation-and-resilience-planning.pdf.

[82] Broward County, *Broward Climate Action: Resilience Under the Sun* (2020). https://www.broward.org/Climate/Documents/CCAP_2020_ADA.pdf.

- Reduce waste and consumption of non-renewable energy.
- Strengthen communication and advocacy efforts to increase community resilience; establish and reinforce principles of equity and secure funding for adaptation.
- Actively protect natural areas and promote green infrastructure.
- Educate residents on climate-related risk.

For a broad inventory of resilience metrics, see the National Institute of Standards and Technology's (NIST) Inventory of Community Resilience Indicators and Assessment Frameworks.

Key Takeaways for Emergency Managers: Step 3

- Collaborate with community partners to outline the desired outcomes of the plan and the objectives that can frame individual actions or strategies.
- Ensure that objectives are targeted and actionable and incorporate the perspectives and priorities of the collaborative planning team established in Step 1.
- Lead or participate in the development of performance metrics that can be used to measure the effectiveness of the goals and objectives.

4.4. Step 4: Develop the Plan

Step 4 of emergency operations planning described in *CPG 101* focuses on developing courses of action to accomplish goals and objectives established during Step 3. In climate adaptation planning Step 4, this step focuses on identifying and prioritizing the strategies and actions that the jurisdiction will take to address climate-related risks, and the resources and information necessary to implement those actions. The outputs of this step are then used to write and review the plan in Step 5.

Develop and Analyze Resilience Strategies

Steps 2 and 3 identified the community's climate-related risks, their impacts, and the community's goals and objectives. Using this information, the planning team now identifies strategies and actions to avoid or mitigate those risks and achieve the identified goals and objectives. This process involves not only technical staff and subject matter experts, but also includes community outreach to collect public input on strategies and actions. Adaptation plans typically include a broad range of strategies and actions, some strategies or actions may be mutually exclusive (e.g., disaster waste management or electric car charging stations along evacuation routes).

Although the identification of adaptation strategies and actions is a locally led process, there are many resources that present information on different types of adaptation strategies. For example:

- SLTT communities now have more access to cleaner (low carbon) materials through eligible FEMA programs as communities rebuild or take initiatives to become more resilient. This ensures communities can help advance the clean energy economy as the they confront the impacts of the climate crisis.[83]

- The U.S Climate Resilience Toolkit provides a wide range of possible adaptation strategies and actions relating to the built environment, coasts, ecosystems, energy, food, health, marine, transportation,[84] tribal organizations, and water. The Drought and Infrastructure - A Planning Guide can be used to anticipate and prepare for the consequences of drought on infrastructure services. The toolkit also includes filterable case studies by climate threat (or stressor), topic, resilience step, or region.[85]

- The EPA's Strategies for Climate Change Adaptation identifies strategies that can be applied to the natural environment (e.g., air, water, waste and public health).[86]

Many climate adaptation plans focus on physical (engineered) improvements to structures and infrastructure or emphasize the importance of education and raising awareness of climate-related risks. In addition to the physical improvements, ecosystem or nature-based adaptation strategies use biodiversity and ecosystems as a means of reducing climate-related risks. An example of this is extending or enhancing coastal wetlands to protect the land located behind them.

Most adaptation strategies and actions focus on achieving one or more objectives. For example, a plan might have twin objectives of reducing the sensitivity of stormwater infrastructure to extreme rainfall events and reducing biodiversity loss throughout the community. Broader use of "green" infrastructure design concepts could be an applicable adaptation strategy for both objectives.

Adaptive capacity, on the other hand, is the ability of individuals or systems (e.g., infrastructure, a community, an ecosystem) to adjust to climate stresses. One objective might be to increase the adaptive capacity of critical infrastructure. A corresponding strategy might be building redundancy into network operations so that functionality lost through damage to one portion of a network is automatically replaced with functionality from another portion of the network. Consider the pros and cons along a green to gray infrastructure continuum (see Figure 11 for a coastal shoreline).

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[83] For more information on *Building a Clean, Climate-Resilient Economy through FEMA's Grant Programs*, see https://www.fema.gov/grants/policy-guidance/low-carbon-goals.

[84] USGCRP Op. cit.

[85] For more information on Drought Guide, see https://toolkit.climate.gov/reports/drought-and-infrastructure-planning-guide and for case studies, see https://toolkit.climate.gov/case-studies.

[86] USEPA, *Strategies for Climate Change Adaptation*, (2022), https://www.epa.gov/arc-x/strategies-climate-change-adaptation.

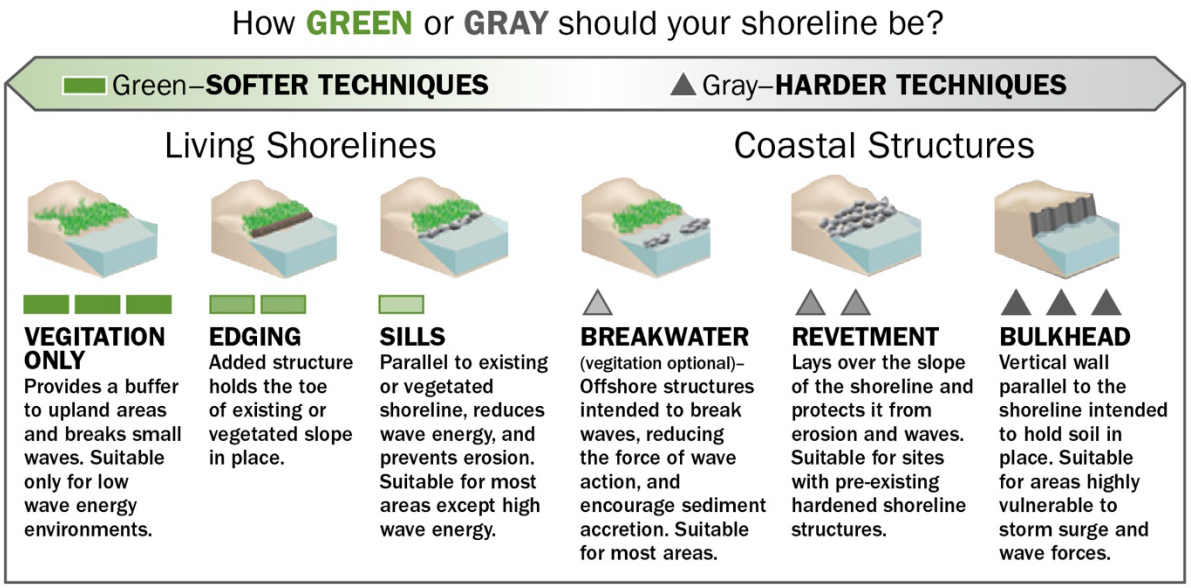

Figure 11: Coastal Shoreline Continuum[87]

Different types of strategies can be used to implement adaptation actions. In some cases, existing institutional mechanisms or structures, such as changing building codes,[88] may make implementation straightforward. In other instances, implementation may need to be tailored to current institutional structures (e.g., government agencies, organizations), or a new structure put in place.

Examples of Implementation Strategies[89]

- **Legal/Regulatory**: Useful for ensuring a minimum standard of performance or condition but often difficult to use politically.
- **Market**: Includes such tools as financial incentives, grants, interest-free loans, taxes and fees. Fairly flexible in implementation, but desired outcome is not guaranteed due to uncertainty in individual, household, organization, or agency behavior. Often used to create a niche market for certain types of adaptation strategies.
- **Partnerships**: Voluntary agreements or compacts among agencies and organizations to achieve desired outcomes. Effectiveness depends on the ability of participants to assign

[87] For more information on *Understanding Living Shorelines*, see https://www.fisheries.noaa.gov/insight/understanding-living-shorelines.

[88] For more information on FEMA's Building Code Strategy, see https://www.fema.gov/emergency-managers/risk-management/building-science/building-codes-strategy.

[89] Adapted from: European Commission, *Guidelines on developing adaptation strategies*, Commission Staff Working Document SWD, 134 final, (2013).

the staff and funding resources to make the partnership work. Pooled resources of participants often raise questions of appropriate contributions to the partnership.

- **Persuasion and Awareness**: Usually implemented through web-based communication and exchange capabilities, in-person outreach, newsletters and awareness campaigns. Helps to develop support for plan and individual strategy implementation but rarely successful by itself in resulting in implementation.
- **Hybrid Planning***:* Combination of different implementation strategies based on a systematic understanding of how the different strategies interconnect and interoperate to achieve community climate resilience.

When identifying strategies and actions, it is important to consider and document implementation needs. These needs affect strategy/action selection and prioritization. The planning team should identify or establish an entity (e.g., agency, organization) to be responsible for the implementation of each strategy/action. The team should also outline the relationships that will provide leadership in the implementation phase. This includes making sure stakeholders have 1) a common understanding of desired outcomes and how individual strategies contribute to achieving them, 2) an understanding of the timeframe for implementation of each strategy, and 3) awareness of the key stakeholders and partners who might help implement the strategy.

Prioritize Actions

Once strategies have been identified, the next step is to determine which strategies and actions to prioritize. These priority strategies and actions then become the basis for the climate adaptation plan. Prioritization is driven by one primary question: which of the options best help achieve the adaptation plan goals and objectives given a range of possible climate futures? In other words, prioritization identifies robust actions that achieve optimal results across a range of climate scenarios. From an emergency management perspective, actions may include but are not limited to:

- Evacuation planning;
- Sheltering facilities;
- Floodplain management;
- Public information campaigns;
- Cooling and heating centers; and
- Mutual aid assistance.

Prioritization is usually based on a set of criteria that reflect the most important community concerns relating to desired plan outcomes. The planning team should determine which criteria to use with the input of whole-community stakeholders. In some cases, quantitative criteria, such as monetary risk estimates or the population considered underserved to a particular hazard, are used. In other cases, the criteria could include subjective assessments of overall effectiveness or risks associated with each option. For example, some climate adaptation planning efforts use subjective values of low, medium or high, based on the collective opinions of experts, staff, decision-makers, or the general

public. And in some cases, such efforts have used a combination of quantitative and qualitative assessments.

Examples (in alphabetical order) of criteria that are often found in prioritization efforts include:

- **Benefit-Cost analysis:** In some cases, it is possible to estimate the cost of implementing a particular action as well as to assign monetary values to the expected benefits of implementation. This could be done in a straightforward manner, such as measuring the benefits of reduced damage to buildings, or may require a more nuanced approach, such as assigning a monetary value to social and environmental benefits (e.g., positive health impacts). Using benefit-cost analysis examines strategies through a monetary lens, weighing whether the benefits exceed the cost. Such analyses can also be used to determine the extent to which one action is more beneficial than another.

- **Co-benefits:** Does the strategy or action have additional, perhaps unquantifiable, benefits beyond enhanced climate resilience for the community? All things being equal, those strategies and actions that provide additional benefits would be preferred over those that do not.

- **Cost-effectiveness:** In many cases, the cost to implement a strategy or action can be estimated, along with the outcome (or benefit) expected from the investment. Cost-effectiveness criteria estimate the expense that is required to produce a given outcome or output. Examples include the average dollar amount needed, per home, to harden against tropical storms; the cost to reduce a community population's vulnerability to a specific potential hazard by *X* percent; and the investment necessary to reduce the incidence of a serious health hazard to *X* percent.

- **Equity:** Assessing the equity impacts of climate adaptation strategies begins with evaluating how different demographic groups benefit or are harmed from a given action. Key questions include: what individuals or community groups are reaping benefits and who is negatively affected? Special consideration should be given to historically underserved groups, such as low-income, minority, elderly, chronically sick, and mobility impaired people and households. The intent of the equity criterion is to allocate the benefits and costs of climate adaptation investment equitably across a community in a manner that reduces, rather than perpetuates, existing inequities.

- **Flexibility:** Given the uncertainty in the timing and scale of climate hazards and risks, many climate adaptation plans emphasize strategies and actions that can be phased in over time, or whose adaptive capabilities can be easily expanded.

- **Implementation feasibility**. This criterion reflects the legal, financial, organizational, political, and social challenges associated with implementing a strategy or action. Some strategies may offer significant risk reduction potential yet face major political or social barriers. Alternatively, some strategies may be "low-hanging fruit" and able to be quickly and easily implemented.

- **Robustness:** Given the uncertainty of future climate conditions, strategies that provide resilience benefits under different scenarios are preferable over those whose benefits only occur with one possible future. This is particularly applicable to strategies or actions that mitigate current

threats, hazards, or risks and provide long-term benefits at the same time. This analysis should also consider timing and the consequences of taking no action. A particular action may be significantly more costly or ineffective (e.g., conservation of key habitat) if the action is delayed.

Identify Resource and Information Needs

After selecting strategies and actions undertaken, planners identify the resources and information needed to carry out actions of the adaptation plan. Resource requirements will vary widely depending on the strategies/actions selected and can encompass a wide range of items, such as engineering or construction equipment; site-specific analytics, including measurement or analytical tools (e.g., drones, computers); external funding; new hires or volunteers; land needs, natural resources (e.g., seeds, saplings), and/or habitat-specific interventions (e.g., endangered species). Resources should be listed without regard to current availability. Then, the planning team can identify what resources are currently available and what will need to be obtained moving forward.

Partnerships, such as through mutual aid agreements, are an important method for obtaining resources not readily available to a community, particularly for smaller or under-resourced communities. Identifying regional partners that either (a) have the needed resource, or (b) have a similar need for the same resource, can help cut costs and establish mutually beneficial working relationships. These partners may be governmental or non-governmental. Local businesses, for example, may be willing to provide certain resources or be willing to help fund their acquisition. External funding sources, such as federal or state grants, are another good mechanism for obtaining needed resources (see Appendix C for a list of emergency management funding resources).

Key Takeaways for Emergency Managers: Step 4

- Lead or participate in the multi-agency and multidisciplinary process of identifying and prioritizing strategies and actions to enhance community resilience.
- Draw upon experience and local knowledge of past hazard events in the formation of adaptation strategies and actions.
- Encourage innovation in developing new strategies and actions.
- Contribute to the preparation of the climate adaptation plan by linking information relating to the local hazard mitigation plan, recent experience with climate-related hazards and community preparedness.
- Identify the physical, financial, or institutional resources and information needed to implement strategies/actions.

4.5. Step 5: Prepare and Review the Plan

Step 4 resulted in a set of prioritized strategies and actions for enhancing community resilience to climate change-related threats, hazards and risks. The next step is to prepare and review the plan. This includes writing the actual plan, leveraging the information from Steps 2, 3, and 4 of the planning process.

Climate Adaptation Plans Components:

- A summary of the expected climate impacts to the community and region; background on the methods and approach used to evaluate risk; the results of the local and regional risk analysis; and key threats to underserved populations and important community assets.
- Specific goals and objectives that outline the long-term desired outcomes for the community and break these goals into targeted and actionable steps.
- Strategies, actions, and responsibilities to achieve one or more objectives through targeted policy, investment, engagement, operational changes, and/or institutional reform.

Review of a climate adaptation plan follows a similar pattern to that for traditional planning. First, the planning team should review the plan and then make it available to other pertinent stakeholders. Given that the adaptation plan may be the first within a jurisdiction, it may be useful to review peer community plans and use these as a source of comparison. This can help identify areas that are underdeveloped in the current draft plan, such as the rigor of the performance metrics. Similar to the process in *CPG 101*, three criteria can be used when evaluating the plan:

- **Adequacy**: Does the scope of the plan include the primary (and ideally secondary) climate threats to the community? Do the plan's goals, objectives, strategies and actions propose a course for mitigating climate-related risk? Are the plan's assumptions (e.g., climate science) valid?
- **Feasibility**: Are the organizations/agencies capable of accomplishing assigned tasks, either with available resources or with reasonable expectation of securing necessary resources? Are the timeline and project size sufficient to meet the stated need and practical? Can coordination with necessary stakeholders or government agencies be secured?
- **Acceptability**: Do the adaptation strategies meet the threats posed by climate change? Are the strategies and objectives designed to be equitable and achieve social as well as physical resilience? Is the plan consistent with the law and with relevant guidance?

These criteria can be used to evaluate the plan's goals, objectives, and strategies, along with how they are coordinated and allocated across agencies or stakeholders. Moreover, they can be useful in assessing whether the resources needed to implement a strategy or action are immediately available or whether outside funding sources will need to be pursued. The Tompkins County, NY case study below provides an example of a final climate adaptation chapter in a comprehensive plan.

Case Study: Tompkins County, New York Climate Adaptation Strategy

The Tompkins County (NY) Comprehensive Plan includes a chapter on adaptation. This chapter indicates that "it is the policy of Tompkins County to:

- Maintain floodways and limit floodplain development to reduce damages from flooding;
- Improve connectivity of open space to prevent fragmentation of ecosystems and isolation of plant and wildlife populations;
- Promote adaptation measures that lessen climate impacts on the local economy;
- Encourage actions that protect underserved populations from climate change impacts;
- Prepare for community recovery in the event of disaster."

The Tompkins County Department of Planning and Sustainability also developed a Resiliency and Recovery Plan to help reduce the risks associated with hazards and the changing climate. The plan lays a foundation for collaborative action with each of the municipalities in Tompkins County and a broad group of stakeholders. It addresses four critical areas from the County's Hazard Mitigation Plan: Flooding, Drought, Debris Management, and Economic Recovery.

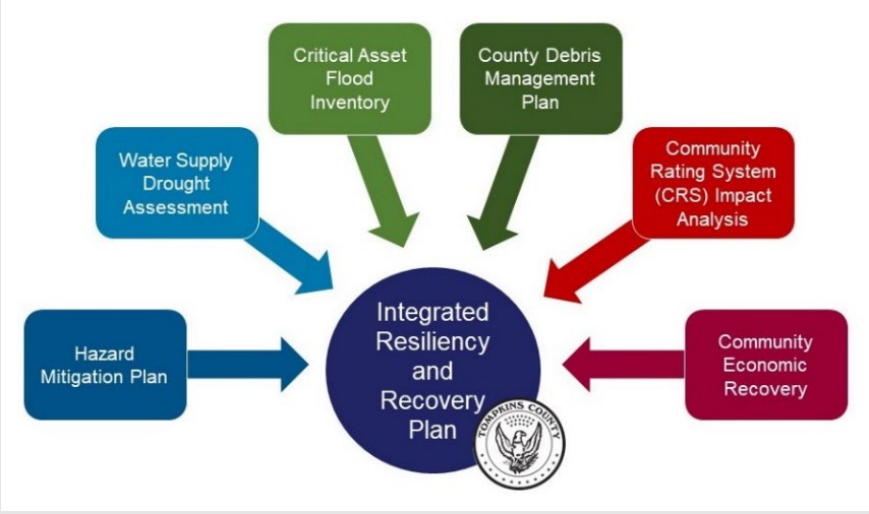

Figure 12: Plan Integration in Tompkins County's (NY) Climate Adaptation Plan[90]

[90] Tompkins County NY, Tompkins County Resiliency and Recovery Plan (2022). https://tompkinscountyny.gov/planning/climate-adaptation.

Key Takeaways for Emergency Managers: Step 5

- Lead or participate in multi-agency efforts to write and review the climate adaptation plan.
- Help identify the roles and responsibilities of stakeholders to carry out the plan.
- Provide information on possible funding sources for implementing planned strategies/actions.

4.6. Step 6: Implement and Maintain the Plan

Once reviewed, approved, and released, implementation and maintenance of the plan begins. This step focuses on monitoring and evaluating the performance of the plan, updating the plan as needed, and mainstreaming adaptation planning in the community.

Implementation is a long-term process. Some tasks will occur soon while other strategies are implemented and updated over a course of years. The callout box below outlines key considerations for implementation.

Considerations When Implementing and Maintaining the Plan

- Assigning sub-tasks to individuals, groups, or organizations;
- Obtaining the financial resources to pay for implementation;
- Developing interorganizational partnerships and agreements when implementation includes multiple players;
- Developing a constituency for the different actions among key stakeholders and the public; and
- Linking assigned actions to the decision-making processes of that organization(s).

As with most planning efforts, climate adaptation planning is an iterative process that entails regular reviews and adjustments. Updates are particularly important for climate adaptation planning where advances in climate science occur constantly, new data sources become available, intervening extreme weather events provide new information on the severity and extent of the resulting damage, and the communities themselves change in various ways.

Monitor and Evaluate Performance

Monitoring and evaluating the performance of the plan and regularly reviewing the underlying assumptions is an important part of assessing whether a community's climate adaptation plan is still relevant and appropriate and meeting the desired outcomes. Monitoring should address the criteria in the performance metrics designed in Step 3 but should also ensure the underlying assumptions that led to the selection of adaptation strategies are still valid. For example, monitoring should collect information on changing climate and community characteristics, advancements in climate science or technology, and performance of risk reduction and other adaptive strategies. This information provides an important feedback loop to determine whether adjustments to the plan are needed. Analyzing individual strategy effectiveness could lead to minor adjustments or they might suggest a rethinking of the entire strategy.

Exercise the Plan

FEMA's Long-Term Community Resilience Exercise Resource Guide is a "one-stop–shop" for any jurisdiction or organization looking to conduct a climate-focused exercise.

Source: https://www.fema.gov/node/long-term-community-resilience-exercise-resource-guide.

Ideally, an agency or multi-agency structure would be designated to lead the implementation, monitoring, evaluation, and revision of the plan. For some communities, this may be the emergency management agency, who is already monitoring for hazard mitigation plans and THIRAs as well as evaluating exercises and real-world events through after-action reports.

Update the Goals, Objectives, and Metrics of the Plan

Revising or updating a climate adaptation plan can occur periodically, such as every five years or when circumstances dictate, such as in the aftermath of a particularly severe extreme weather event. The plan should establish this process and the update should be undertaken by the same (emergency management) agency or multi-agency structure that coordinates monitoring and evaluation. Updating the plan might include altering how a goal or objective is being implemented, or it may involve altering the strategy itself. In the latter instance, strategy changes should be vetted with leadership to ensure that their implementation is feasible. Even evaluating what strategies and implementation practices have been ineffective is a useful learning exercise for future planning efforts.

Factors for Updating Climate Plans

- New information on climate science
- New tools and data for vulnerability and risk analysis
- Experience with recent extreme weather events
- Community development patterns
- Population characteristics
- Community values
- Updates to other community plans and strategies
- Addition of new staff and expertise
- New technology innovations that change demand and service patterns
- Laws and regulations

Key Takeaways for Emergency Managers: Step 6

- Participate in multi-agency efforts to raise community awareness of the need to implement adaptation plan recommendations.
- Collect data and information on climate-related hazards to inform future plan updates and monitor the performance of implemented strategies.
- Lead or participate in evaluating whether implemented and recommended adaptation strategies are still appropriate given changing environmental conditions.
- Coordinate changes in the local hazard mitigation plan with the strategies of the adaptation plan and its monitoring and evaluation.

5. Conclusion

The purpose of this guide is to help SLTT emergency managers incorporate climate adaptation into emergency management planning efforts. The six-step planning process presented here is broadly applicable to many different climate adaptation planning contexts, yet the individual actions and planning roles are designed to help SLTT emergency managers both lead and support adaptation planning. Emergency managers' experience identifying and mitigating hazardous threats and vulnerabilities can be of great use in planning for long-term community resilience and adaptation even as climate change continues to be a "risk multiplier."

Many of the initial steps in the climate adaptation planning process presented here are similar to those used in *CPG 101*; however, as described earlier, there are several key differences:

1) While planning and preparing for emergencies always involves uncertainties and a need to assess risks, climate-related threats magnify this uncertainty due to an inability to predict future emissions and climate mitigation policies. Therefore, adaptation planning should address multiple climate scenarios (e.g., intermediate emissions, high emissions) and investigate which projections are most applicable to the community.

2) Actions to address climate change, as well as knowledge of climate science and vulnerabilities, are constantly evolving. Planning for climate-resilient communities should become an iterative process to ensure that strategies and plan priorities reflect the best information available. Furthermore, exercising, monitoring and adjustment of plan implementations ought to occur regularly to optimize the effectiveness of adaptive actions. Changing economic and demographic considerations may also necessitate adjustments to the plan or its implementation.

3) Creating and sustaining a climate-resilient community is most feasible when adaptive responses are incorporated into all aspects of community planning and decision-making. For example, decisions about future land use or capital improvement projects ought to include climate considerations, such as shifting flood hazard areas or infrastructure design standards. Moreover, the equity implications of both climate impacts and responses should be an important part of the discussion both in creating the adaptation plan and in developing other community plans and policies. In this and many other cases, a broad, community-wide approach to climate resilience is important. A thorough and iterative planning process, along with strong community partnerships that draw on a range of social and technical expertise, will create a strong foundation for building and sustaining a climate-resilient community.

Appendix A: Climate Impacts on Emergency Response and Recovery Planning

Climate change is a risk multiplier. The hazards that regions and communities are occasionally exposed to will become more frequent, more severe, and afflict new areas. Some of the most damaging events have been the result of combined weather phenomena, producing multiple hazards simultaneously. Hurricane Sandy, for example, was the combined result of a nor'easter and a hurricane, producing devastating results. Natural hazards can also co-occur with other phenomena amplifying the overall risk. In 2021, Louisiana was hit by the second-most damaging hurricane in the state's history, Hurricane Ida, in the midst of the COVID-19 pandemic, putting greater stress on the area's hospitals, among other social and economic impacts of the pandemic.

Figure A-1 highlights some hazards that will become more widespread or more severe due to climate change. The figure also lists potential direct (or primary) and cascading (or secondary) impacts.

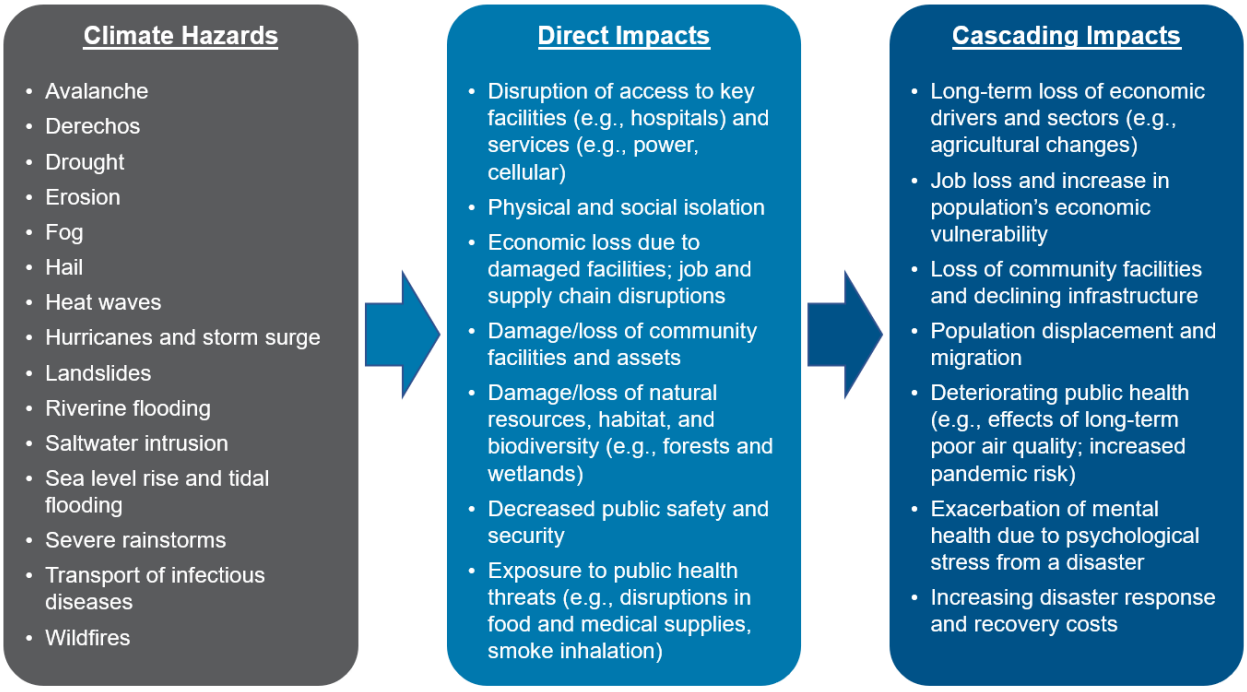

Figure A-1: Climate Hazards and Their Direct and Cascading Impacts

Weather extremes associated with climate change will also likely directly impact or cause cascading impacts to response planning and into recovery. Using the eight Community Lifelines and Recovery Support Functions (RSFs), below is a bulleted list of direct or cascading impacts from an emergency response and recovery perspective.[91]

[91] For more information on FEMA's Response and Recovery Climate Change Planning Guidance, see https://www.fema.gov/sites/default/files/documents/fema_response-recovery_climate-change-planning-guidance_20230630.pdf.

Safety and Security Lifeline

- An anticipated increase in climate-related events may strain SLTT response resources and capacities, resulting in increased requests for federal support.
- Decreased water volumes in remote streams and ponds may hamper firefighting capabilities.
- Persons with disabilities and those who live in rural areas have restricted (or lack) access to government services.
- Under-resourced populations and communities may lack access to capital that could help support resilience investments.

Food, Hydration, Shelter Lifeline

- Temperature and precipitation extremes may affect water quality and availability, agricultural productivity, and ecosystems and species.
- Thawing permafrost may lead to unsafe food storage and preservation.
- People with disabilities have high rates of illness, injuries, or death during extreme events, as cognitive, hearing, physical, and mobility impairments may impede their safe evacuation.
- Sheltering needs may overwhelm SLTT capacities due to increases in climate-related events. Federal support may be required for the provision of additional sheltering and/or the relocation of impacted populations to unaffected areas.
    - Wrap-around services may need to be provided for survivors waiting to access aid sites to ensure their health and well-being (e.g., moving water distribution to shaded areas in extreme heat scenarios). Pre-identified aid sites may need to be reevaluated to ensure protection for those awaiting access.

Health and Medical Lifeline [92]

- More frequent and severe heat waves will lead to more heat-related illnesses and deaths.
- Changes in the timing and lengths of the seasons may cause shifts in the geographic areas where disease-carrying insects such as mosquitoes, ticks, and fleas typically transmit West Nile Virus, dengue fever, Lyme disease, malaria, and other diseases.
- Increasing temperatures may cause degradation of air quality, exacerbating health conditions such as heart disease.
- Increased plant growing seasons may increase pollen exposure and allergies, a greater number of severe storms will increase mold exposures, and increased temperatures and wildfire risk will lead to more air pollution, all of which can worsen lung diseases and other health problems.
- Extreme weather events are associated with an increased risk of food- and water-borne illnesses, as sanitation services, hygiene measures, and safe food and water supplies are often compromised after such events.
- An increase in the loss of patient medications is expected due to a larger number of power outages and subsequent lack of refrigeration capabilities.

[92] U.S. Department of Health and Human Services, *Climate Change and Health Equity* (2022). https://www.hhs.gov/climate-change-health-equity-environmental-justice/climate-change-health-equity/index.html.

- Increasing frequency and severity of wildland fires will reduce ambient air quality causing increases in respiratory distress, especially among those with respiratory ailments, children, and the elderly.

Energy (Power Grid and Fuel) Lifeline

- Transmission line capacity will decline at higher temperatures, reducing power availability; extreme heat may also cause powerlines to droop.[93]
- Extreme temperatures increase demand for cooling and heating capabilities, which may result in electricity shortfalls.
- Climate-related incidents, such as increases in extreme heat and wildfires, will increase the likelihood of public safety power shutoffs, limiting access to power.
- Extreme flooding or severe weather will threaten energy infrastructure.
- Frontline communities are historically the last communities to have their utilities restored.

Communications Lifeline

- Extreme flooding or severe weather may impact communications infrastructure due to damage or loss of power.
- Buried fiber optic cables and nodes, which provide communications and internet services, are at risk of failure due to sea level rise and flooding. Similar fiber optic cable issues may occur above ground due to high winds associated with hurricanes, derechos, and other extreme weather events. Communications nodes are often clustered at low elevations around dense populations. Fiber buried on land is water- and weather-resistant but is not designed to be submerged.[94]
- Persons with access and functional needs will require the need of assistive technology or other communication support to receive information and how to respond during a disaster.

Transportation Lifeline

- Extreme heat can warp railways and impact rail operations, cause paved surfaces to buckle and disrupt transit, and also make it difficult for airplanes to take off.[95]
- Higher winds and wildland fires may disrupt air traffic.
- An increase in flooding or weather events that result in the accumulation of debris will impact transportation routes.
- More than 60,000 miles of roads and bridges in coastal areas are at risk of flooding from climate-change-related sea level rise.[96]

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[93] National Public Radio. *During the heat wave in the Pacific Northwest in 2021, the intense heat melted some power cables in Portland*. (2021). https://www.npr.org/2021/06/29/1011269025/photos-the-pacific-northwest-heatwave-is-melting-power-cables-and-buckling-roads.

[94] National Public Radio. *Rising Seas Could Cause Problems For Internet Infrastructure* (July 16, 2018). https://www.npr.org/2018/07/16/627254166/rising-seas-could-cause-problems-for-internet-infrastructure.

[95] Jacobs, J.M., et al., *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment. Volume II* (2018). https://nca2018.globalchange.gov/downloads/NCA4_Ch12_Transportation_Full.pdf.

[96] Ibid.

- Permafrost thaw may reduce the viability of roads made of ice and snow and damage transportation infrastructure due to ground sinking.[97]
- Compounding climate-related weather events that impact the transportation system could severely impact supply chains due to worker attrition, flooded routes, etc. Disruptions to supply chains will impact operations, logistics, and management activities for response and recovery.
- The development of community-specific distribution management plans that highlight vulnerable transportation infrastructure and alternate commodity points of distribution should be supported.
- Disruptions to transportation infrastructure can affect communities and their access to food, healthcare systems, and social services.

Hazardous Materials Lifeline

- Increased climate-related weather events may result in larger quantities of waste materials requiring processing. This may lead to increased GHG emissions from waste management activities as well as insufficient capacities for handling surges in the necessary recycling, treatment, and disposal processes for the waste generated.[98]
  - Extreme weather events may impact industrial facilities resulting in contamination of surrounding communities (often low-income communities) requiring permanent evacuation and exposure to hazardous materials.
- Severe storms and heavy flooding are likely to result in industrial process disruptions which could result in autocatalytic reactions, explosions, and discharges when a facility is not able to store chemicals at the proper temperature on alternate power sources or properly shut down continuous flow process.
- Low-income communities may be disproportionately impacted by hazardous materials events due to their proximity to hazardous facilities or transportation routes. These communities may also have limited resources to respond to and recover from such events.
- Indigenous communities that practice subsistence farming and fishing are particularly vulnerable to the impacts of hazardous materials.

Water Systems Lifeline

- Thawing permafrost may lead to the deterioration of reservoirs and impoundments that rely on the existence of permafrost for wastewater containment.
- The intersection of flooding and warmer weather may cause bacterial growth in local water sources, leading to health concerns (e.g., toxic algae blooms).

[97] USGCRP, *Fourth National Climate Assessment: Chapter 26: Alaska* (2018). https://nca2018.globalchange.gov/chapter/26/.

[98] EPA. *Waste Management Planning to Mitigate the Impact of Climate Change.* https://www.epa.gov/homeland-security-waste/waste-management-planning-mitigate-impact-climate-change.

Economic Recovery Support Function

- Labor hours lost by weather-exposed workers due to high temperature days. [99] There is also an equity consideration on the demographics of weather-exposed workers, who will be more impacted by climate change.
- Increase in property damage and business income losses due to increasing frequency and intensity of climate-related hazards.
- The displacement of socially vulnerable and underserved people may often coincide with the displacement of essential, front-line workers who are the foundation of a community's economy.

Health and Social Services Recovery Support Function

- Individuals are at higher risk of developing chronic illnesses such as asthma, or fatalities from cancer, residing in areas with higher counts of particulate air pollution.[100]

Community Assistance Recovery Support Function

- Equity issues regarding illiteracy should be taken into consideration when conducting community engagement and training.
- Community assistance efforts and climate considerations should be incorporated into long-term recovery planning support strategies.
- FEMA should partner with the federal interagency, when possible, to leverage other agency authorities that support mitigation activities and build climate resilience.

Infrastructure Systems Recovery Support Function

- Projects should leverage resilience funding support[101] for projects that adhere to consensus-based building codes and standards for low-carbon materials.
- Recovery-funded grant projects should emphasize mitigation measures (e.g., through the Hazard Mitigation Grant Program [HMGP] and 406 Mitigation funding) that support risk reduction actions, climate adaptation actions, and nature-based or green infrastructure solutions.
- Benefit-cost calculations should be streamlined for hazard mitigation solutions that are local, sustainable, and nature based, when possible, to enable better alignment with grant obligations and planning timelines.

Housing Recovery Support Function

- Temporary housing and sheltering will continue to be a prominent and challenging aspect of disaster recovery. FEMA will undertake state-led pre-disaster planning initiatives on housing to

[99] EPA. *Social Vulnerability Report.* https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf.

[100] National Institutes of Health. The Impact of Disasters on Populations with Health and Health Care Disparities. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2875675/.

[101] FEMA. *Recovery and Resilience Resource Library*. https://www.fema.gov/emergency-managers/practitioners/recovery-resilience-resource-library.

build greater resilience to climate-related disasters and encourage better planning and preparedness practices.

Natural & Cultural Resources Recovery Support Function

- FEMA Recovery programs support the widespread adoption of the Federal Flood Risk Management Strategy and policy updates to ensure its implementation.
- Anticipated increase in the frequency and intensity of weather events will pose a heightened risk to the protection of cultural heritage resources, which in recovery are a shared responsibility of FEMA's Office of Environmental and Historic Preservation, the Heritage Emergency National Task Force, and the Natural and Cultural Resources RSF.

Appendix B: Climate Data and Mapping Applications

- Climate Risk and Resilience Portal (ClimRR) (Center for Climate Resilience and Decision Science):[102] A public-private partnership that represents the newest developing climate science modeling. ClimRR empowers individuals, governments, and organizations to examine simulated future conditions at mid- and end-of-century for a range of climate perils. Additional hazards will be added over time. The ClimRR National Map Explorer allows users to view over 100 different climate visualizations in an interactive map and the ClimRR Local Climate Summary provides users with a snapshot of climate projections for a chosen location.

- Climate Mapping for Resilience and Adaptation (CMRA) (USGCRP/NOAA):[103] CMRA aggregates currently available federal datasets to create a climate risk information tool that also includes grant finance opportunities and policy information. This tool is a community-focused, user-friendly model that provides high level trend information for state, local, tribal, and territorial communities. View real-time maps showing where climate-related hazards are occurring today.

- Climate Explorer:[104] The Climate Explorer offers graphs, maps, and data downloads of observed and projected climate variables for every county in the U.S. For the contiguous U.S., the tool shows projected conditions for two possible futures: one in which humans make a moderate attempt to reduce global emissions of heat-trapping gases, and one in which human emissions of heat-trapping gases continue increasing through 2100.

- FEMA National Risk Index (NRI) for Natural Hazards:[105] The National Risk Index is an online mapping application from FEMA that identifies communities most at risk to 18 natural hazards. This application visualizes natural hazards risk metrics and includes data about expected annual losses from natural hazards, social vulnerability, and community resilience.

- FEMA Resilience Analysis and Planning Tool (RAPT):[106] A Geographic Information System planning tool to inform strategies for emergency management. RAPT includes over 100 preloaded layers including FEMA's Community Resilience Index, Census demographic data, infrastructure, live weather, hazards, NOAA sea level rise projections, and ClimRR future conditions data.

- Drought.gov:[107] The National Integrated Drought Information System is a multi-agency partnership that coordinates drought monitoring, forecasting, planning, and information at national, tribal, state, and local levels.

[102] For more information on ClimRR, see https://climrr.anl.gov.

[103] For more information on CMRA, see https://resilience.climate.gov/.

[104] For more information on the Climate Explorer, see https://toolkit.climate.gov/tool/climate-explorer-0.

[105] For more information on the NRI, see https://www.fema.gov/flood-maps/products-tools/national-risk-index.

[106] For more information on RAPT, see http://fema.gov/rapt.

[107] For more information on Drought.gov, see https://www.drought.gov/.

Appendix C: Financing Climate Adaptation and Mitigation

Policies, plans and strategies to mitigate climate change risks are of limited use if they are not adequately funded and resourced. The Federal government, SLTT governments, regional planning bodies, the private sector, and philanthropic organizations regularly provide funding for climate-related risk mitigation projects. Savvy planners can make use of many existing programs to support climate-related risk mitigation activities even if the programs do not exist to specifically combat climate-related risks. For instance, many federal grant dollars to upgrade infrastructure or mitigate natural hazards (most of which are influenced by climate change) can be used to achieve a variety of objectives including climate-related risk mitigation. The Funding Strategies for Flood Mitigation handout depicts funding sources for climate-related risk mitigation and resilience-building activities. Perhaps most important, thinking with a climate-resilient mindset can help planners find creative funding sources for climate-related risk mitigation activities.

The remainder of this section reviews programs that provide funding that may often be used to mitigate climate-related risks. This list is not comprehensive. Many other programs and funding sources exist and the following call out box provides some useful overview guides.

Funding and Financial Management Resources

- Disaster Financial Management Guide: Helps SLTT jurisdictions establish and implement sound disaster financial management practices.
- U.S. Climate Resilience Toolkit: Provides a range of government entities and private foundations offering financial and technical resources to advance local adaptation and mitigation efforts in the U.S.
- The Institute for Local Government, Budgeting and Financial Management: Provides access to numerous resources and case stories for engaging the public in the budgeting process, as well as a repository of budgeting/finance forms.
- The Grants Learning Center: Allows users to explore available federal grants and financial assistance, learn about the laws and regulations for awards, examine grant eligibility, explore grant registration and management tools, and more.
- The Ready-to-Fund Resilience Toolkit: Helps increase climate resilience and create thriving, just, and equitable communities by securing funding and finance for the physical and social infrastructure necessary for climate resilient communities.

Annual Program Funding Provided by Federal Agencies

This section details annual program funding from primarily federal sources. Several federal programs provide annual mitigation or mitigation-related funding to SLTT governments. The requirements for participation, eligibility, cost share, performance periods, acceptable uses of funds and other details vary from program to program. This section highlights some key programs that may support climate

adaptation and mitigation activities. Planners should consult program-specific guidance to determine if each program can support a community's needs.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) PROGRAMS

The federal government has numerous grant programs available that can support community resilience improvements. FEMA grant funds are available for pre- and post- emergency or disaster related projects.[108] Some climate related FEMA resources are highlighted below:

Building Resilient Infrastructure and Communities

FEMA's Building Resilient Infrastructure and Communities (BRIC) funds capability- and capacity-building activities such as mitigation planning, project scoping and building code adoption; and mitigation projects that directly impact the natural and built environment. BRIC is funded from a six-percent set-aside of estimated disaster expenses for each major disaster (declared under the Stafford Act); the amount of available funding is described in the annual Notice of Funding Opportunity (NOFO). The NOFO also describes the current year's funding priorities. Local communities apply through the appropriate state, tribe, or territory. The Bipartisan Infrastructure Law (BIL) has provided an additional $1 billion in program funding over five years (Fiscal Years 2022-2026). Under the Justice40 Initiative, BRIC aims to deliver 40% of its overall benefits to disadvantaged communities that are marginalized, overburdened by pollution and underserved.

For communities and Tribal Nations with limited resources, the BRIC non-financial Direct Technical Assistance is available. This assistance, provided for up to 36 months, helps local and tribal jurisdictions to reduce disaster damage, build community resilience and sustain successful mitigation programs. The wide-ranging Direct Technical Assistance includes climate risk assessments, community engagement, partnership building, hazard mitigation and climate adaptation planning.

Flood Mitigation Assistance

FEMA's Flood Mitigation Assistance (FMA) Grant is focused on reducing or eliminating repetitive flood damage to buildings insured by the National Flood Insurance Program through mitigation planning and projects. FMA's annual NOFO describes the amount of funding available in a given year, which fluctuates as it is based on Congressional appropriations. The NOFO also describes the priority scoring criteria, which usually includes consideration of climate change and future conditions. Local communities apply through the appropriate state, tribe, or territory. The BIL provided an additional $3.5 billion in program funding over five years (Fiscal Years 2022-2026). Under the Justice40 Initiative, FMA aims to deliver 40% of its overall benefits to disadvantaged communities that are marginalized, overburdened by pollution and underserved.

[108] For more information on FEMA grants, see https://www.fema.gov/grants.

Safeguarding Tomorrow Through Ongoing Risk Mitigation Program

The Safeguarding Tomorrow Through Ongoing Risk Mitigation Program is a capital loan program, similar to the Clean Water Act revolving loan fund, that allows grant recipients to provide loans for zoning and land-use planning. Communities must contribute funds to be eligible; they will receive a reduced interest rate to undertake projects. Interested communities should consult their State Hazard Mitigation Officer about upcoming training and webinars. For more information, see Safeguarding Tomorrow Revolving Loan Fund Program.

Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program

FEMA's Rehabilitation of High Hazard Potential Dam (HHPD) grant program provides technical, planning, design, and construction assistance in the form of grants for rehabilitating eligible high hazard potential dams. High hazard potential is classification standard for any dam whose failure or mis-operation will cause loss of human life and significant property destruction. A state or territory with an enacted dam safety program, the State Administrative Agency, or an equivalent state agency, is eligible for the grant.

DEPARTMENT OF TRANSPORTATION (DOT) PROGRAMS

Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation Program

The BIL provided $7.3 billion in formula funding to states and $1.4 billion in competitive grants to eligible entities "to increase the resilience of the transportation system." Eligible projects include evacuation routes, coastal resilience, making existing infrastructure more resilient or efforts to move infrastructure to nearby locations not continuously impacted by extreme weather and natural disasters.

DOT Thriving Communities Program

The Thriving Communities Program aims to ensure that disadvantaged communities adversely or disproportionately affected by environmental, climate, and human health policy outcomes have the technical tools and organizational capacity to compete for federal aid and deliver quality infrastructure projects that enable their communities and neighborhoods to thrive.

Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant Program

The RAISE Grant program provides an opportunity to obtain funding to build and repair road, rail, transit, and port projects. RAISE grants are eligible to a wide range of applicants, including special purpose districts and transit agencies, along with traditional state, local, tribal, and territorial governments. Funding is split between urban and rural areas.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD) PROGRAMS

Community Development Block Grant

HUD's Community Development Block Grant (CDBG) program supports the development of stronger and more resilient communities. Investment support may include infrastructure, economic development projects, public facilities installation, community centers, housing rehabilitation, public services, clearance/acquisition, etc. The CDBG program also includes targeted funding for post-disaster recovery and hazard mitigation.[109]

ENVIRONMENTAL PROTECTION AGENCY (EPA) PROGRAMS

Environmental Justice Thriving Communities Grantmaking

The Environmental Justice Thriving Communities Grantmaking Program is a competition to select multiple Grantmakers around the nation to reduce barriers to the federal grants application process communities face and increase the efficiency of the awards process for environmental justice grants.

Wildfire Smoke Preparedness in Community Buildings

The EPA's Wildfire Smoke Preparedness in Community Buildings Grant Program supports enhancing wildfire smoke preparedness in community buildings. The program provides grants and cooperative agreements to States, federally recognized Tribes, public pre-schools, local educational agencies, and non-profit organizations for the assessment, prevention, control, or abatement of wildfire smoke hazards in community buildings and related activities.

DEPARTMENT OF HEALTH AND HUMAN SERVICES (HHS) PROGRAMS

Low Income Home Energy Assistance Program

Health and Human Services' Low Income Home Energy Assistance Program seeks to mitigate extreme heat impacts by providing funding to grant recipients for cooling assistance, summer crisis assistance, year-round crisis assistance, and weatherization. In addition, help for maintaining air conditioning use during a heat event can be obtained through the program, which provides federally funded assistance to reduce the costs associated with home energy bills.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) PROGRAMS

The National Oceanic and Atmospheric Administration maintains a list of Climate Resilience Funding Opportunities. While not comprehensive, this website is regularly updated with funding opportunities that may support climate risk mitigation and resilience-building activities for SLTT governments.

[109] HUD also provides eligible grantees with direct grants for use in developing Indian and Alaska Native communities through the Indian Community Development Block Grant. For more information on this grant and other tribal specific federal funding opportunities, see https://www.hud.gov/program_offices/public_indian_housing/ih/tribal_climate_resilience_and_adaptation_funding.

The Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA)

The Bipartisan Infrastructure Law (BIL) of 2021 and Inflation Reduction Act (IRA) of 2022 marked two pieces of landmark legislation that provide unique funding opportunities for clean energy, climate adaptation, infrastructure resilience, environmental justice, and much more. Funding opportunities for several federal agencies are listed below, though many more can be found using the BIL Guidebook and IRA Guidebook.

- FEMA programs received $6.8 billion in funding from the BIL, with funding allocated to BRIC, FMA, Dam Safety, and other grant programs. In addition, the IRA provides financial assistance for investments in low-carbon materials, which is available through FEMA's Public Assistance, Hazard Mitigation Grant Program, and BRIC programs.
- The BIL and IRA allocated over $6 billion to NOAA programs. Some highlights include: $1.47 billion in funding for coastal resilience (Climate-Ready Coasts); $592 million for the protection of fisheries; and $575 million for the Climate Resilience Regional Challenge.
- Nearly $10 billion in combined funding from the BIL and IRA is available via EPA programs (summarized here). Funding is available for projects to mitigate greenhouse gas emissions, reduce climate pollution impacts, and advance environmental justice initiatives.
- Nearly $35 billion in combined BIL and IRA funding was allocated to the Department of Interior. Funding is available for ecosystem restoration, drought mitigation, landscape conservation, and includes targeted funding ($13 billion) for Tribal communities.
- Health and Human Services created the *Quickfinder for Leveraging the IRA for the Health Sector* to help the health sector identify grants, loans, and tax credits that can be used to fund resilience and renewable infrastructure.

Post-Disaster Funding Provided by Federal Agencies

This section details post-disaster program funding from federal sources. FEMA operates several post-disaster recovery and mitigation programs that provide an opportunity for communities to address climate risk mitigation and resilience building.

FEMA POST-DISASTER FUNDING

Public Assistance Program

FEMA's Public Assistance (PA) program provides supplemental grants to SLTT governments and certain types of private non-profits so communities can quickly respond to and recover from major disasters or emergencies. Through the PA program, FEMA provides supplemental federal grant assistance for debris removal, emergency protective measures, and the restoration of disaster-damaged, publicly owned facilities and specific facilities of certain private non-profit organizations. The PA program also encourages protection of these damaged facilities from future incidents by

providing assistance for hazard mitigation measures. Potential applicants can apply within 30 days following a Presidential disaster declaration. FEMA's PA funding will cover no less than 75 percent of the project's cost.

Hazard Mitigation Grant Program (HMGP)

FEMA's Hazard Mitigation Grant Program (HMGP) provides funding to SLTT governments to rebuild in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a Presidentially declared disaster. In 2021, FEMA made $3.46 billion of HMGP funding available to SLTT governments specifically to address the impacts of climate change. HMGP funding can be used for mitigation planning, post-disaster code adoption and enforcement, and mitigation projects that address any natural hazard. The amount of HMGP funding available to a state, tribe or territory is based on the estimated total federal assistance provided under a presidential disaster declaration. States, tribes and territories determine mitigation priorities, which differentiates HMGP from BRIC and FMA, where the priorities are set by FEMA. Local communities and private non-profits apply through the appropriate state, tribe or territory.

HMGP Post-Fire Program

The HMGP Post-Fire program is structured largely the same way as HMGP, with the main exception being the source of funding. HMGP Post-Fire is available to states, tribes and territories affected by fires that result in a Fire Management Assistance Grant (FMAG). FEMA determines annually how much funding will be available based on a rolling 10-year national average of assistance provided under FMAG declarations and determines an allocation to affected states, tribes and territories. FEMA also sets the funding priorities, with the highest priority being wildfire and post-wildfire mitigation activities such as defensible space, erosion control and slope failure prevention in affected counties or tribal lands.

DOT POST-DISASTER FUNDING

Federal Highway Administration (FHWA) Emergency Relief (ER) Program

FHWA administers the Emergency Relief (ER) Program for emergency repair or reconstruction projects on the Federal-aid highway system needed "as a result of 1) natural disasters or 2) catastrophic failures from an external cause. The applicability of ER funds is based on the extent and intensity of the disaster and the severity of the highway damage. The damage must be severe, occur over a wide area, and result in unusually high expenses to the highway agency. ER funds may be used on repairs that "improve the long-term resilience of the Federal-aid highways, if 1) the design is consistent with current standards, or 2) the State DOT demonstrates that the resilience feature is economically justified to prevent future recurring damage.[110]

[110] FHWA, "Integration of Resilient Infrastructure in the Emergency Relief Program," Memorandum from Hari Kalla, Associate Administrator for Infrastructure and Gloria Shepard, Associate Administrator for Planning, Environment, and Realty to Associate Administrators, Division Administrators, and Directors of Field Services. October 11, 2019. https://www.fhwa.dot.gov/specialfunding/er/191011.cfm.

Funding Provided by State and Local Governments

Adapting to climate change is often a local or regional pursuit. State and local governments play an important, and growing, role in the financing and funding of adaptation projects. While many states have authorized grant programs or financing authorities, the funding of resilience and adaptation projects through local financing remains important. The *Local Elected and Appointed Official Guide*[111] is a great resource for developing bond issues, special assessments, and/or taxes for application to resilience programs.

Case Study: Climate Protection Fund

On November 3, 2020, the people of the City and County of Denver voted in favor of raising the local sales and use tax by 0.25 percent to create the Climate Protection Fund. This fund, which is expected to raise up to $40 million per year, is dedicated to eliminating greenhouse gas emissions and air pollution, supporting climate adaptation, and creating new jobs to improve the lives of community members. Its efforts focus on the communities most harmed by climate change: low-income households, communities of color and Indigenous people, babies, children, pregnant women, the elderly, people with disabilities, people with access and functional needs, and people with chronic health conditions.

Source: https://www.denvergov.org/files/assets/public/climate-action/documents/cpf/climate-protection-fund-qa.pdf.

STATE GRANT PROGRAMS

States have implemented a wide variety of grant programs with funding for climate resilience and adaptation, including traditional infrastructure (e.g., transportation, stormwater, wastewater), green infrastructure, wildlife and biodiversity conservation, flood management, drought, heat waves, and many other outputs. Some programmatic examples include: the Virginia Community Flood Preparedness Fund Grant, which was established to help Virginia's communities mitigate the impacts of flooding; the California Environmental Protection Agency's Environmental Justice Grants, which offer funding opportunities to non-profit community organizations and Tribal governments to address environmental hazard impacts; and New York's Climate Smart Communities Program, which provides broad funding to communities for both climate mitigation and climate adaptation.

As there are an ever-increasing number of grant programs, FEMA's Recovery and Resilience Resource Library is a useful resource for finding new funding opportunities, along with other information and tools to help craft a strong grant proposal.

[111] FEMA, *Local Elected and Appointed Official Guide: Roles and Resources in Emergency Management*, 2022, https://www.fema.gov/sites/default/files/documents/fema_local-elected-officials-guide_2022.pdf

STATE-AUTHORIZED FINANCING

Beyond direct grants to local governments, some states have passed legislation empowering local governments to establish districts or authorities whose purpose is to fund resilience projects. For example, in May of 2020 the Maryland General Assembly passed SB 457, which allowed local governments to create Resilience Authorities that can establish a diverse arrange of financing for a range of resilience-oriented projects. The authorities can issue bonds, levy fees for services, or rely on government or nonprofit contributions, among other funding streams. In turn, they have a wide array of powers (other than eminent domain) to build, acquire, manage, or operate infrastructure and resilience projects.

California AB 733, enacted in 2017, similarly authorized local governments in the state to create enhanced infrastructure financing districts specifically for climate adaptation projects. Given the broad hazards and impacts associated with climate change, this law provides flexibility for local governments to invest in projects adapting to flooding, drought, and heat waves, as well as the spread of infectious diseases and other public health impacts.

Private and Philanthropic Funding

A variety of private and philanthropic funding is available to SLTT communities in climate risk mitigation, resilience and adaptation program design and planning. For instance, many large corporations maintain philanthropic programs which may provide monetary support for climate risk mitigation and resilience building programs. Elected and appointed officials can be helpful in making introductions to business leaders and helping to broker funding for these projects. Planners should consider the value a business may receive from their funding: safer and more resilient communities for their employees, less risk to their operations, or public relations benefits.

Many nonprofits with explicit climate-related risk mitigation and resilience building missions exist across the country. Some focus on specific issues such as wetlands or ocean conservation, sustainable commerce, climate change action, education or renewable energy demonstration and deployments. For example, the Wildlife Conservation Society operates a Climate Adaptation Fund that focuses on investment and innovation in adapting wildlife and ecosystems to climate change.

Case Study: Groundwork Jacksonville

In 2021, Groundwork Jacksonville was awarded $294,000 from National Fish and Wildlife Foundation, with support from NOAA and AT&T, earmarked for the preliminary (30 percent) design of the Hogans Creek restoration. The goal of the resilience project is to reduce flooding, improve water quality, restore habitat, and provide access to recreation in and around the creek.

The number of nonprofit philanthropic organizations offering funds related to climate-related risk mitigation is rapidly growing. Many of these organizations are members of the National Voluntary Organizations Active in Disaster, making this a good starting point for exploring nonprofits offering

climate resilience project funding. The Georgetown Climate Center's Adaptation Clearinghouse is another great resource, where users can search for funding or financing opportunities and filter by region or locality, focal sector, or jurisdictional focus.

Appendix D: Glossary

- **Adaptation:** Adjustment in natural or human systems to a new or changing environment that takes advantage of beneficial opportunities or moderates negative effects.
- **Cascading Impacts:** Cascading impacts from extreme weather/climate events occur when an extreme hazard generates a sequence of secondary events in natural and human systems that result in physical, natural, social, or economic disruption, whereby the resulting impact is significantly larger than the initial impact.
- **Climate:** Climate is determined by the long-term pattern of temperature and precipitation averages and extremes at a location.
- **Climate Change:** A change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent human-driven changes in the composition of the atmosphere or in land use.
- **Climate Mitigation ("Mitigation" also "Greenhouse Gas [GHG] Mitigation"):** Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere.
- **Climate Projection:** The simulated response of the climate system to a scenario of future emission or concentration of GHGs and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.
- **Climate Resilience:** The capacity to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.
- **Community Risk Analysis:** Understanding potential risks and the actions needed to address those risks by answering the following: 1) Which threats and hazards may affect our community? 2) If they occur, what impacts would those threats and hazards have on our community? 3) Based on impacts, what capabilities should our community have in place?
- **Compound Weather/Climate Events:** The terms 'compound events', 'compound extremes' and 'compound extreme events' refer to the combination of multiple drivers and/or hazards that contributes to societal and/or environmental risk.
- **Emissions Scenarios:** Quantitative illustrations of how the release of different amounts of climate altering gases and particles into the atmosphere from human and natural sources will produce different future climate conditions. Scenarios are developed using a wide range of assumptions about population growth, economic and technological development, and other factors.
- **Environmental Justice:** The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.
- **Equity:** Equity is the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied

such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.

- **Frontline Community:** Communities or populations that have experienced systemic socioeconomic disparities, environmental injustice, or another form of injustice and are highly vulnerable to and will experience disproportionately high adverse impacts from environmental and climate injustice and inequitable climate actions.
- **Future Conditions:** Future Conditions refers to the changing risk of natural disasters due to climate change, population patterns, land use, and community development.
- **Global Warming:** Refers to the long-term increase in global average temperature as a result of human activity. Climate change encompasses global warming but refers to the broader range of changes that are happening to our planet.
- **Greenhouse Gases (GHGs):** Gases that absorb heat in the atmosphere near the Earth's surface, preventing it from escaping into space. If the atmospheric concentrations of these gases rise, the average temperature of the lower atmosphere will gradually increase, a phenomenon known as the greenhouse effect. GHGs include, for example, carbon dioxide, water vapor, and methane.
- **Hazard Mitigation:** any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.
- **Natural Hazards:** Source of harm or difficulty created by a meteorological, environmental, or geological phenomenon or combination of phenomena.
- **Nature-Based Solutions:** Sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience.
- **Resilience:** The ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from adverse conditions and disruptions.
- **Risk:** Threats to life, health and safety, the environment, economic well-being, and other things of value. Risks are often evaluated in terms of how likely they are to occur (probability) and the damages that would result if they did happen (consequences).
- **Underserved Communities:** Underserved communities are defined in Executive Order 13985 as populations sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified by the list in the preceding definition of ‘‘equity.’’
- **Vulnerability:** The degree to which physical, biological, and socioeconomic systems are susceptible to and unable to cope with adverse impacts of climate change.
- **Weather:** The state of the atmosphere with respect to wind, temperature, cloudiness, moisture, pressure, etc. Weather refers to these conditions at a given point in time.

Appendix E: Acronyms

BIL	Bipartisan Infrastructure Law
BIPOC	Black, Indigenous, and People of Color
BRIC	Building Resilient Infrastructure and Communities
CPG	Comprehensive Preparedness Guide
CDBG	Community Development Block Grant
CDC	Centers for Disease Control and Prevention
CEJEST	Climate and Economic Justice Screening Tool
ClimRR	Climate Risk and Resilience Portal
CMRA	Climate Mapping for Resilience and Adaptation
DOT	Department of Transportation
EJ	Environmental Justice
EJScreen	Environmental Justice Screening and Map Tool
EOP	Emergency Operations Plans
EPA	Environmental Protection Agency
ER	Emergency Relief
FHWA	Federal Highway Administration
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Assistance
FMAG	Fire Management Assistance Grant Program
GHG	Greenhouse Gas
HHPD	High Hazard Potential Dam
HIRA	Hazard Identification and Risk Assessment
HMGP	Hazard Mitigation Grant Program

1945	HUD	Housing and Urban Development
1946	IPCC	Intergovernmental Panel on Climate Change
1947	IRA	Inflation Reduction Act
1948	LGBTQ+	Lesbian, Gay, Bisexual, Transgender, and Queer
1949	NASA	National Aeronautics and Space Administration
1950	NRI	National Risk Index
1951	NBS	Nature-Based Solutions
1952	NIST	National Institute of Standards and Technology
1953	NOAA	National Oceanic and Atmospheric Administration
1954	NOFO	Notice of Funding Opportunity
1955	PA	Public Assistance
1956	RAISE	Rebuilding American Infrastructure with Sustainability and Equity
1957	RAPT	Resilience Analysis and Planning Tool
1958	RCP	Representative Concentration Pathways
1959	RSF	Recovery Support Function
1960	SLTT	State, Local, Tribe, Territory
1961	SPR	Stakeholder Preparedness Review
1962	SSP	Shared Socioeconomic Pathway
1963	SVI	Social Vulnerability Index
1964	THIRA	Threat and Hazard Identification and Risk Assessment
1965	U.S.	United States
1966	USGCRP	United States Global Change Research Program