

Climate Threats and Corresponding Adaptation/Resilience Solutions

From the "[Adaptation and Resilience](#)" Topic Overview Page
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Climate Impact	Causes of Increased Frequency and Severity of Impact	Future of the Threat and Its Impacts to Communities and the Economy	Where in the United States	Examples of Adaptation and Resilience Solutions
Extreme Cold	Climate change-induced arctic warming causes atmospheric pressure differences as air heats up and expands. This phenomenon weakens the pressurized restraints on cold wind bands surrounding the North Pole, allowing cold winds to stretch farther south.	- The frequency, intensity, and duration of extreme cold weather will decrease over the long term, but unexpected extreme cold events will become more frequent in the short term, especially in historically mild areas. - Extreme cold disproportionately impacts already-vulnerable populations, such as people who have preexisting health issues. - Intensely destructive winter storms (those with damages above \$1 billion) cost the United States an average of \$4.1 billion per event, and intensely destructive crop freezes cost \$3.7 billion per event. Winter Storm Fern's property losses are estimated to be more than \$4 billion.	Southern and southeastern states are more susceptible to cold-weather damage due to the fact that their infrastructure is not designed to withstand winter storms.	- Insulation and building envelope measures separate the inside of a building from the outside, which helps maintain home temperatures in a power loss. - Redesigning stormwater systems to minimize water pooling and incorporate insulation can minimize freezing damage. - Utilities can practice vegetation management, double-up on electrical circuits, and upgrade their grid to ensure constant power during storms.
Extreme, Prolonged, and Unexpected Heat	Climate change increases the frequency, intensity, and spread of heat waves. A warmer atmosphere also holds more water vapor, making sweating less	- The world is expected to heat by 1.5°C (2.7°F) by 2050, with urban centers feeling twice the level of heat stress as rural surroundings. - Extreme heat is the deadliest form of extreme weather in the United States, taking an average of 211 lives annually. Low-income or vulnerable communities, as well as communities of color, are disproportionately	Those living in the Southwest (including parts of California and Texas), New England, and the Midwest are most at risk of energy emergencies during heat waves. Urban areas are particularly affected as infrastructure absorbs heat, leading to " heat islands " that	Covering roofs with reflective material can deflect heat better than traditional highly-absorbent materials, with 65% heat deflection compared to 10% for traditional dark materials.

	effective and exacerbating heat effects.	affected, as well as those who live in dense urban areas. Heat waves cost the nation over \$162 billion in 2024. Energy costs may rise up to 22% as temperatures increase, impacting consumers and straining grid infrastructure. Agricultural productivity can be cut in half during heat waves.	are up to 7°F hotter than surrounding areas.	- Replacing concrete and asphalt with reflective pavements can help keep structures up to 10°F cooler. - Planting more vegetation can reduce temperatures by an additional few degrees.
Floods	Warmer air holds more water, causing more intense rainfall events. These events are taking place in changing landscapes with expanded development in coastal areas and floodplains, which increases flood risk.	- Floods caused 145 deaths in 2024. Studies estimate 230 additional flood-related deaths per year in 2020 than 2005, with almost 10,000 additional deaths projected by 2100. - The global population living in flood-prone areas has grown between 20 and 24% since 2000. In the United States, Black populations are expected to bear a disproportionate increase in flooding risk. - Floods cost Americans between \$180 billion and \$496 billion per year, a figure expected to significantly rise in the future. By 2051, flood risk could increase by 10% for residential properties and roads, 7% for commercial properties, and 6% for critical infrastructure compared to 2021. Damage is expected to cost \$32 billion for at-risk U.S. homes by 2051, compared to \$20 billion in 2021.	Coastal communities across the country, especially in states like Louisiana and Florida, will be at greater risk from coastal flooding. Northwestern states are also at risk. Kentucky and West Virginia are vulnerable to riverine flooding.	- Nature-based solutions like restoring wetlands and oyster reefs can absorb coastal flooding and reduce storm surge. Every \$1 spent on wetlands and reef restoration saves \$7 in avoided flood costs. - Building barriers can help protect critical infrastructure. Managed retreat or relocation of infrastructure to higher elevation may be the best solutions in certain cases.
Hurricanes	Rising ocean temperatures and water levels coupled with atmospheric changes create ideal conditions for hurricane formation—quite literally the perfect storm.	Maximum rainfall totals are expected to rise 17.7% by 2050, with an 11% increase in inundated land. The frequency of intense hurricanes is expected to double in this timeframe. - Hurricanes and tropical storms take an average of up to 11,000 lives annually in the United States, with that number expected to rise by another 10,000 by 2100. Stronger wind gusts	Coastal, southern, and Appalachian states will be impacted, as well as island territories in the Atlantic and Caribbean. Rural areas and small towns with aging infrastructure will be hit hard.	Rebuilding infrastructure to withstand strong winds and implementing better drainage systems to prevent flooding. Shoring up shorelines, as well as preserving natural topology like wetlands and dunes, can keep flooding to

		will inflict more physical damage. Black, Indigenous, and People of Color (BIPOC) communities, people with disabilities, and the financially disadvantaged are expected to bear disproportionate impacts. Hurricanes have already cost the United States \$1.5 trillion from 1980 to 2024. The average cost of a big hurricane hitting the United States is \$23 billion. By 2050, hurricanes and other coastal storms are expected to cost Americans \$35 billion per year.		a minimum.
Storm Surge	Over the past 100 years, the 6- to 8-inch rise in sea levels has amplified the impact and reach of coastal storms. The rate of sea level rise is 2.5 times what it was a century ago.	- Studies estimate a 20% increase in surge levels through 2050. Sea levels could rise an additional 4 feet by 2100, leading to more intense, frequent, and wide-reaching surges. - Storm surges account for around half of all lives lost due to hurricane damage. Working class and BIPOC communities are often the hardest hit, along with those who live in public housing or near coastline. - Surge- and wind-related hurricane damage costs the United States approximately \$30 billion annually, with that number expected to grow 40% by 2075.	The East and Gulf coasts are the most impacted by storm surge flooding, with the Atlantic Ocean's sea level rising faster than other oceans' sea levels.	- Building new homes on elevated surfaces can mitigate storm surge effects. - Homeowners must fortify all entry points of their homes to withstand water loading and remove potential flying objects from the surrounding area. Communities can invest in sand dunes, floodwalls, and warning systems.

Wildfires	Higher temperatures coupled with decreased summer rainfall promote wildfires. Years of natural fire suppression have left fuel build-up behind, furthering the problem.	- Wildfire incidents are expected to rise 30% globally by 2050. Wildfire smoke contains black carbon (soot), nitrogen oxides, and hydrocarbons, which further contribute to global warming. - Wildfire smoke kills 40,000 Americans annually, with that number expected to rise to 70,000 by 2050. - Wildfires can cause immense property damage, a loss of carbon sinks, and air pollution that can worsen cardiovascular and respiratory problems. - Wildfires have cost the United States an average of \$10.9 billion annually in the past decade, a remarkable increase from the previous decade's \$1.5 billion.	The Federal Emergency Management Agency's Wildfire Risk Index shows that the Northwest, Southwest, and West are more prone to wildfires due to their drier climates, as well as Florida due to its heat.	Communities can remove invasive species and flammable plants, use noncombustible materials for landscaping, and add fire-resistant vents to homes. - To stop fire spread, dead flammable vegetation can be removed from forests and vegetation gaps can be placed strategically to cut off wildfire paths.
Sea Level Rise	Global warming has caused land-based ice sheets, ice caps, and glaciers to melt and contribute water to the sea. Plus, warm water thermally expands , which also increases sea levels.	- By 2050, destructive high tide flooding will occur 3-10 times annually; currently, it happens less than once a year. 132 million people are at risk of property and infrastructure damage and displacement. - Floods cost Americans between \$180 billion and \$496 billion per year.	Coastal communities , which represent 30% of the U.S. population, will be the most impacted, including local businesses. The East and Gulf coasts are particularly susceptible .	Communities can invest in early-warning systems, conserve coastal ecosystems, and invest in flood-friendly infrastructure, such as elevated buildings and floodwalls.

Droughts	Warmer atmospheric temperatures cause water to evaporate out of soils and plants, drying them out . In mountainous areas, there is a smaller snowpack , which means less meltwater during summer months.	• Since the previous half century, drought area has increased by 17% in the western United States. Drought frequency and duration has increased by 29% globally since 1998. • Drought-related costs are expected to rise anywhere from 35% to 110% by 2035. The agricultural sector will be especially impacted. More crops are expected to wither, and the spread of pests and disease will accelerate, potentially causing food insecurity.	Due to their predicted inability to fully adapt to drought and their sensitivity to it, the states of Iowa, Montana, and Oklahoma are most at risk. The Southwest, already susceptible to recurring droughts, is similarly at risk.	• Communities can invest in water-efficient infrastructure, as well as repair leaks and cracks, to conserve water. • Governments can implement aquifer recharge processes, lead desalination and water reuse efforts, and invest in research and preparedness efforts.
Ocean Acidification	After carbon dioxide is released into the atmosphere, some of it dissolves into the upper layers of the ocean. Its reaction with seawater makes carbonic acid , which lowers ocean pH.	• Researchers predict a pH drop of 0.4 units by 2100, which is a more than 200% increase in acidity from pre-industrial levels. • By 2100, ocean acidification is expected to cause an estimated \$1 trillion in global economic losses, or \$46.20 for every ton of carbon dioxide emitted.	Alaska, the Florida Keys, Puerto Rico, and the U.S. Virgin Islands are all at risk , especially seafood industry workers in these areas. Continental coastal states—in New England, the Mid-Atlantic, and the entire Pacific Coast—are similarly at risk.	• Investing in ocean research and modeling efforts can inform policy decisions, thereby protecting, managing, and restoring oceanic ecosystems.
Saltwater Intrusion	As groundwater is pumped to the surface near coasts, a vacuum is created that draws in saltwater to fill the gaps. Freshwater reserves can be slow to replenish due to warmer and drier climates. Rising sea levels and increased coastal flooding also contribute to	• Saltwater intrusion is a problem for the 9% of U.S. farmland that is coastal. Salt patches, a sign of saltwater intrusion, have doubled. • Salt water could intrude into 77% of coastal freshwater sheds throughout the world by 2100. • In some communities, saltwater intrusion has threatened food security and local economies as crops struggle to grow. • In the agricultural sector, salt-degraded land could yield annual economic losses of up to \$27.3 billion globally.	Coastal areas around the United States are being impacted, especially the East and Gulf Coasts, and California.	• Farmers can add gypsum to neutralize affected soil, plant salt-tolerant crops, or build diversionary infrastructure, like floodgates, water pumps, and dams. • States can convert farmland to wetlands, grasslands, or woodlands for conservation purposes.

	intrusion.			
Shifting Precipitation Patterns	Evaporation increases with warmer temperatures, and hotter air can hold more water vapor. As a result, wetter areas will get even more precipitation, and drier areas even less.	- Heavy storm precipitation is expected to increase by at least 40% in the United States by 2099. Shifts in rainfall affect water availability, impacting plant growth and ecosystem development while creating more droughts or floods. - Flooding exacerbated by increased precipitation may cost the United States \$40 billion annually by 2050.	Generally, the West Coast is receiving less precipitation while the East Coast is receiving more. The number of days with extreme precipitation is expected to increase across the country, with the largest increases along the East Coast, South, and Pacific Northwest.	Communities can build in higher-elevation areas, invest in flood-control infrastructure, limit non-permeable and non-absorbent surfaces, and rework water treatment pathways to prevent overflow.
Erosion	Coastal flooding events carry away soil and sand, eroding shores. As sea levels rise and hurricanes and storm surges intensify, the rate and severity of coastal erosion grows .	- The United States lost more than 80,000 acres of coastal wetlands every year between 2004 and 2009. Some areas could lose more than 6.5 feet of land per year in the coming decade. - Coastal erosion causes around \$500 million per year in property loss and structural damage in the United States. - Sand replacement efforts cost the federal government \$150 million annually.	States along the Gulf and East Coasts are the most vulnerable, especially coastal Louisiana and the Chesapeake Bay watershed.	Coastal restoration efforts, which involve moving structures inland and returning shoreland to its natural state, can be cost-effective strategies. Structural solutions like sand replacement and shoreline "hardening" should be used with caution.