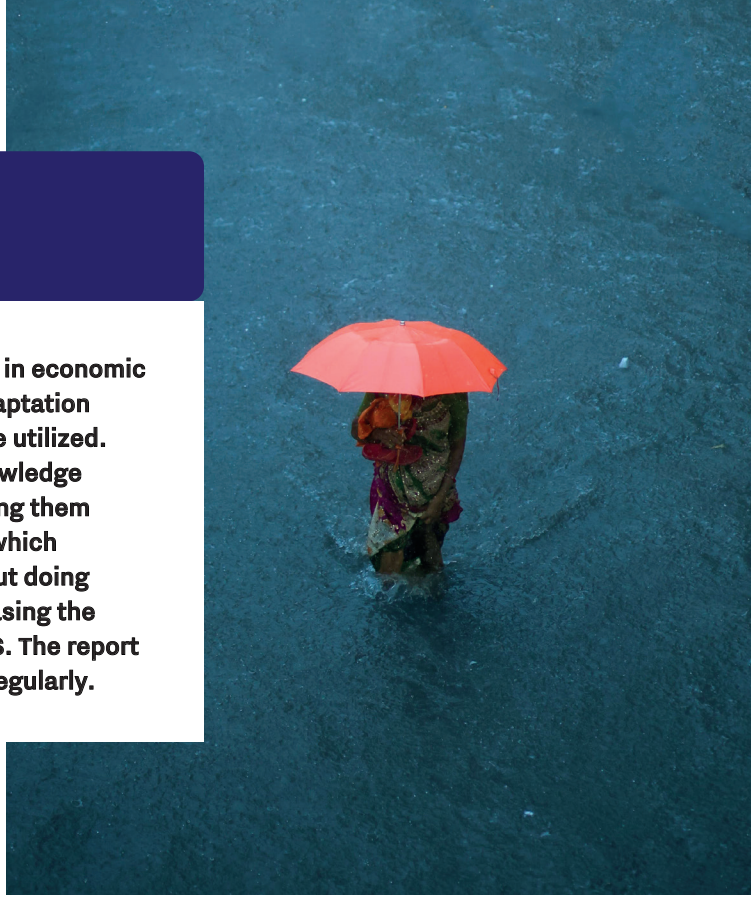
Opportunity Report Resilience United States

Embassy of the Kingdom of the Netherlands in the USA Department of Infrastructure and Water Management

March, 2025

Content

Reading guide



The purpose of the report is to provide insight in economic opportunities regarding water and climate adaptation and to explore how these opportunities can be utilized. The report will help Dutch companies and knowledge institutions to enter the U.S. market by showing them where possible opportunities lie for them (in which counties or cities) and by informing them about doing business in the U.S. This contributes to increasing the revenue model for Dutch companies in the U.S. The report is an ongoing document and will be updated regularly.

Target group of the report

The report targets Dutch companies and knowledge institutions seeking to enter the U.S. market.

The structure of the report

This report begins with the problem analysis. Hereafter, opportunities for coastal, river, and urban resilience are introduced. Here, we briefly describe the context and identify the regions most affected by these disasters. Opportunities for Dutch companies and knowledge institutions follow this. For each opportunity, information is provided on the challenges facing this city or county, the projects, funding, and the network the embassy has. After the opportunities, information is provided on doing business in the U.S. Here, the focus will be on federal and private financing, financing in the Netherlands, procurement, and agents and distributors. Next is a chapter with background information on the changing weather cycle. Finally, there is a brief description of relevant federal laws and events. The sources used are Climate Central, the Environmental Protection Agency (EPA), the NOAA National Centers for Environmental Information, the United States Global Change Research Program (USGCRP), and other U.S. governmental websites on finance.

Providing opportunities for Dutch businesses and knowledge institutions

This report offers several opportunities for Dutch companies and knowledge institutions to potentially enter the U.S. market. The selection of these opportunities was made by researching the following criteria:

- Prognoses of floodings, droughts, and heat stress;
- The locations of the disasters;
- The projects;
- The places where financing is available;
- The available Dutch network.

The identified opportunities will be in counties and cities. We chose this because there is less continuity at the federal level than at the state and local levels. This is due to the administration that changes every four years. On state and local levels, we see more continuity and thus more potential to increase the revenue model for Dutch companies in the U.S. Furthermore, counties and cities provide more concrete and practical opportunities for Dutch companies and knowledge institutions. Cities (especially smaller cities) are more approachable for Dutch businesses and knowledge institutions. To illustrate, big cities like Houston or New York have a high concentration of active companies in coastal management, and there is already long cooperation with the Netherlands. In contrast, smaller cities like Galveston might offer more opportunities for the Dutch business sector.

Problem analysis

Climate change is profoundly impacting water-related problems in the U.S (See Figure 1). Rising global temperatures are one of the leading causes of this problem.

Climate change affects the water cycle by influencing when, where, and how much precipitation falls. It also leads to more severe weather conditions over time. Rising temperatures cause water to evaporate in more significant quantities, leading to higher atmospheric water vapor levels and more frequent, heavy, and intense rains in the coming years. Changes in the water cycle will increase the risk of flooding and drought and reduce water resources for people and ecosystems.

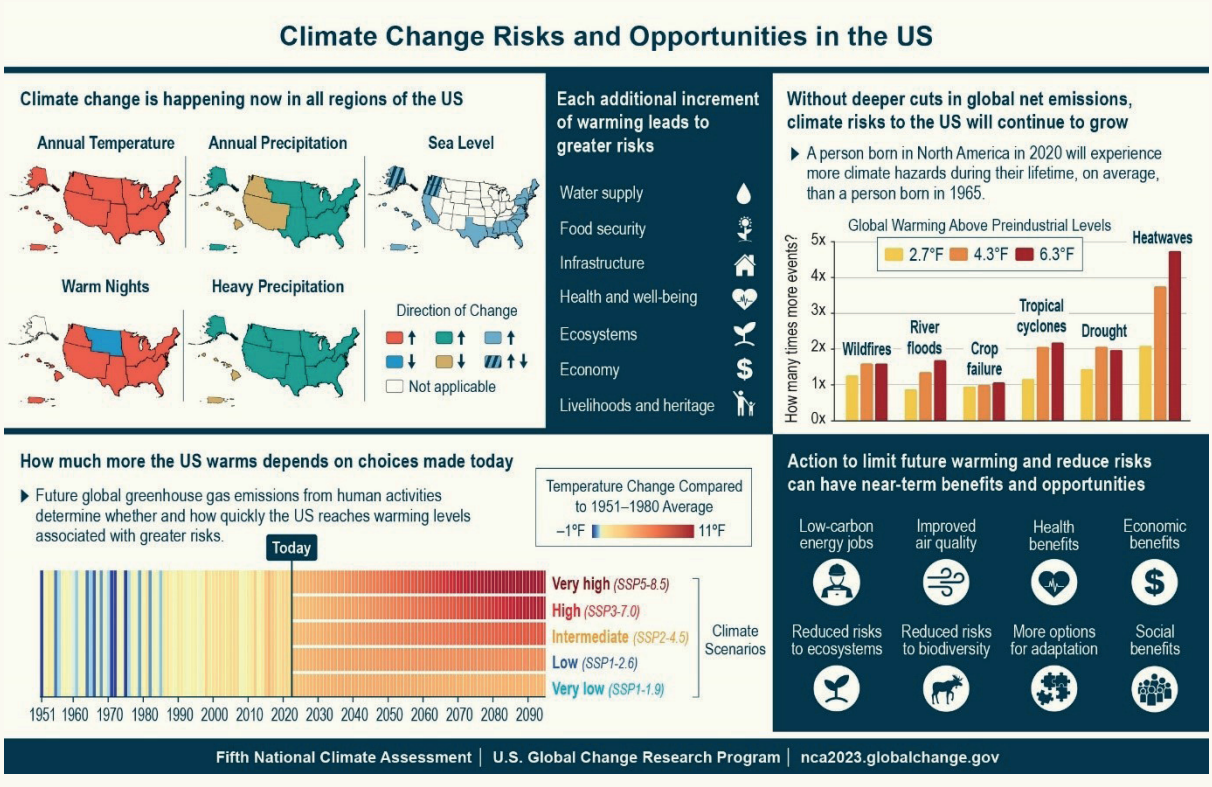


Figure 1: Climate change risks and opportunities in the US (USGCRP, 2023)

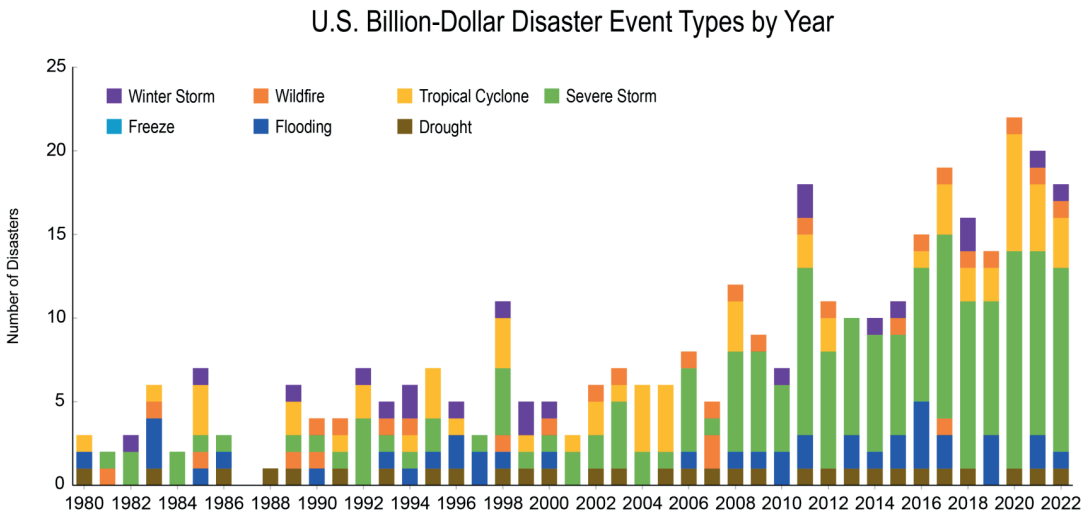


Figure 2: Billion-Dollar Disasters (USGCRP, 2023)

An increase in severe storms, excess floods, and extreme periods of drought is expected in the U.S. (See Figure 2). According to various research institutes, these are the following predictions;

- $106 billion worth of coastal property will likely be below sea level by 2050 if the U.S. continues on its current path.
- The sea level is expected to rise 25-30 cm (10 to 12 inches) over the next 30 years (2020-2050).
- Regarding hurricanes, the likely increase in average annual losses is expected to grow by $7.3 billion.
- Days with extreme heat will increase. NOAA predicts that the average American will likely see 27 to 50 days over 32 degrees Celsius (90 Fahrenheit).
- The most extreme precipitation days have intensified, and will intensify, in every major U.S. region, led by the Northeast (+60%) and Midwest (+45%).
- Global warming is expected to enhance drought extremes in the United States throughout the twenty-first century.

The impacts of climate change are far-reaching, and projections for rising sea levels and increasing severe weather events seem to worsen. Therefore, it is essential to take action to prepare for and adapt to current and projected impacts of climate change. Efforts to adapt to climate change and reduce net greenhouse gas emissions are underway in every US region, and most have expanded since 2018 (See Figure 3). This data shows the increasing opportunities for water management projects that benefit climate adaptation.

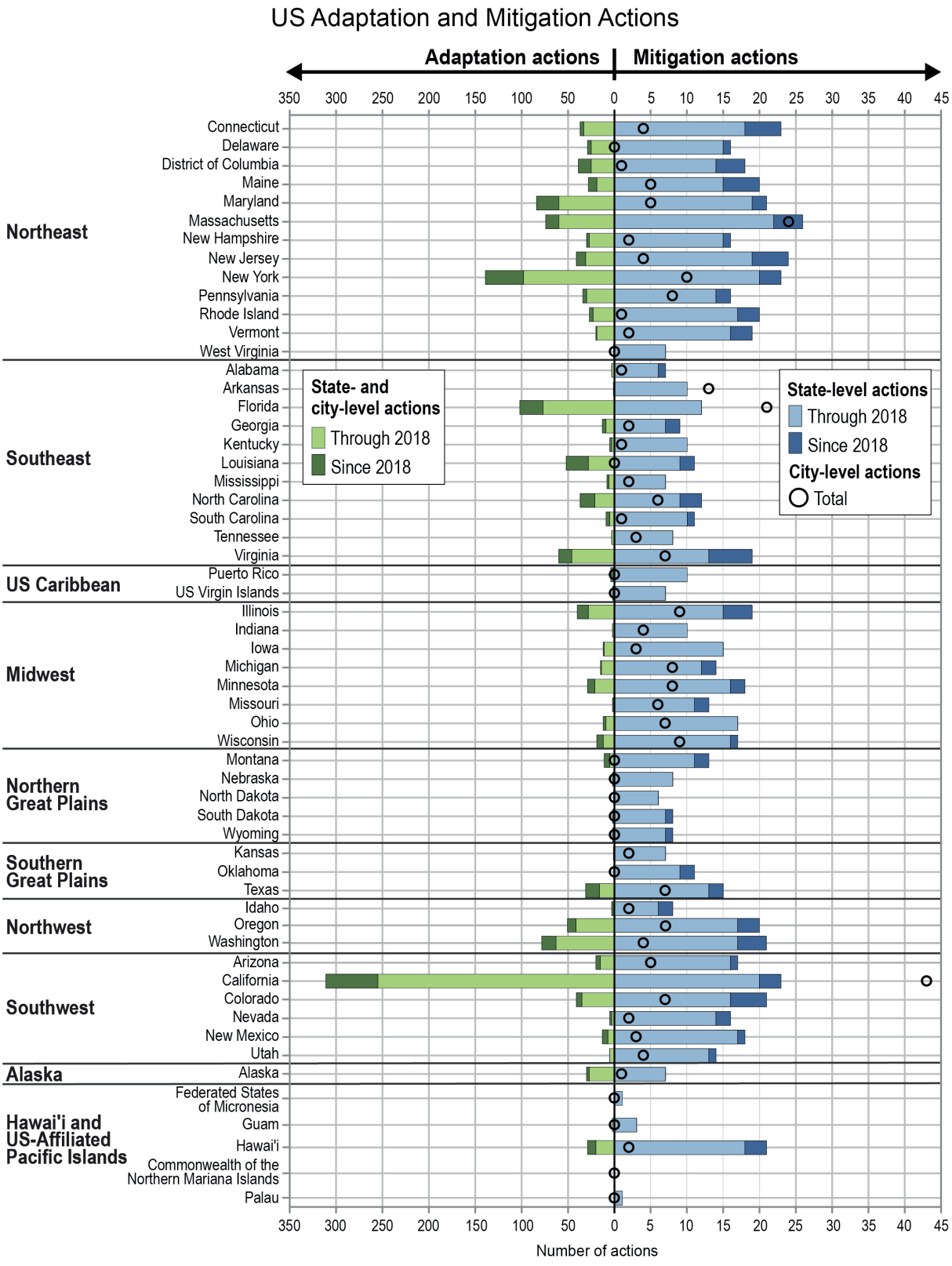
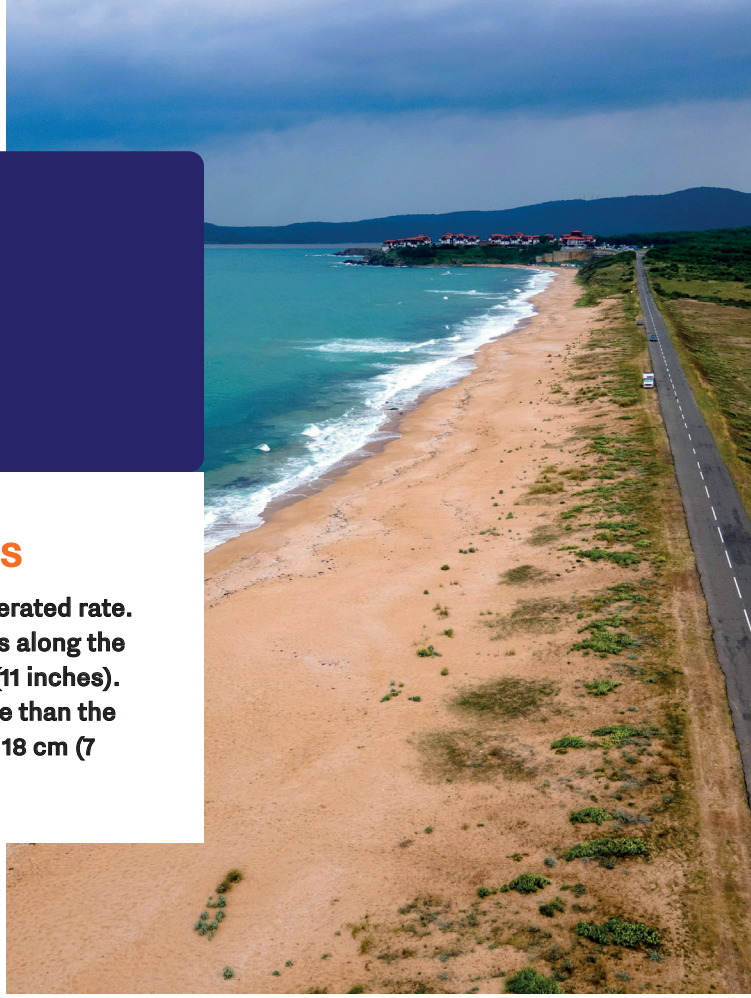


Figure 3: US adaptation and mitigation actions (USGCRP, 2023)

Opportunities coastal resilience



Coastal flooding predictions

The global mean sea level is rising at an accelerated rate. Over the next 30 years (2020-2050), sea levels along the U.S. coasts are expected to rise about 28 cm (11 inches). This increase is 10 centimeters (4 inches) more than the global average sea level rise of approximately 18 cm (7 inches).

Because of the rising sea levels, the severity and risks of coastal hazards are increasing. Coastal flooding will occur 5-10 times more often by 2050 than in 2020 in most locations. It is even expected that in 2100, major flooding will occur almost daily along the U.S. coastlines.

Flood events have different causes. On the one hand, rising sea levels result in permanent inundation by daily high tides, also called high tide flooding (HTF). An average HTF occurrence spans multiple high tides and around two days. Whereas several cities are experiencing 10 to 20 days of high tide flooding yearly, projections say it will likely occur 25 to 75 days annually by 2050.

On the other hand, flooding can be temporary and driven by storm events. Hurricanes, for instance, are becoming stronger and fading more slowly. This means that storms are moving deeper inland and bringing higher storm surges. Likewise, warmer sea temperatures also cause wetter hurricanes, with 10-15 percent more precipitation from storms projected. Storms such as Hurricane Harvey in 2017 (which dropped more than 1.5 meters (60 inches) in some locations), Florence in 2018 (with over 0.9 meters (35 inches)) and Imelda in 2019 (1.1 meters (44 inches)) demonstrate the devastating floods that can be triggered by these high-rain hurricanes.

Regions

The US coast spans 153.646 kilometers (95.439 miles), and more than 40% of Americans live near it. The coast underpins substantial sectors of the economy, serving as the entry and exit for goods and services, generating revenue through recreation and tourism, and supporting fisheries and other water-based industries. The impacts of flood events are huge, as more than $1 trillion of property and structures are at risk.

As of 2020, the highest annual frequencies of coastal flooding are along the northeast Atlantic and western Gulf coastlines (see Figure 4). This is partly due to greater exposure to solid storms and broad, shallow continental shelves allowing for higher storm surges. Since 2014, Hilo (Hawai'i) has often exceeded the flood threshold—an average of 18 days per year—followed by Galveston, Texas, and Sewells Point, Virginia.

Cities on the East Coast where sinking land is exacerbating sea level rise and coastal floodings include New York City and Atlantic City; Virginia Beach; Charleston, South Carolina; and Savannah, Georgia. The Gulf Coast experiences many of the most severe cases of subsidence — parts of Galveston, Texas, and Grand Isle, La., are slumping into the ocean faster than global average sea levels are rising.

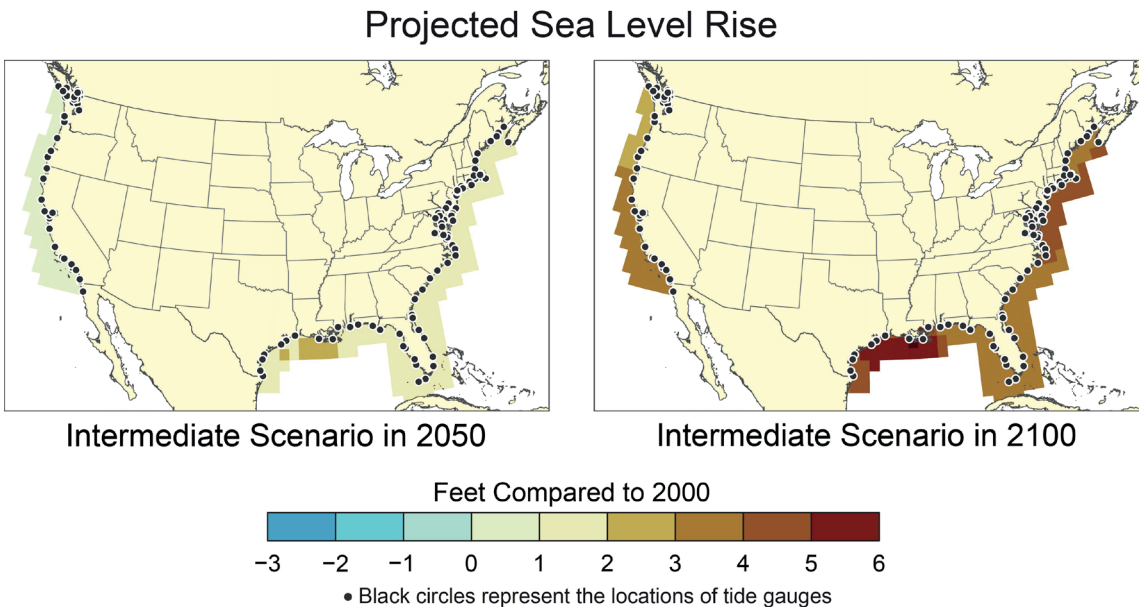
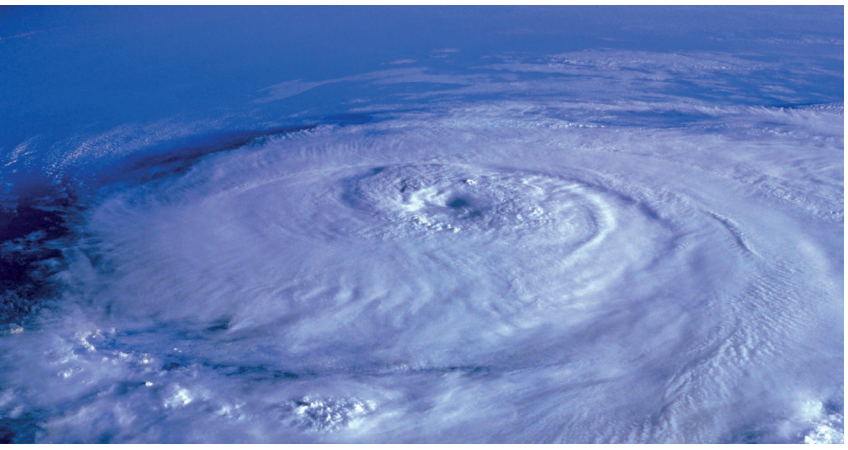


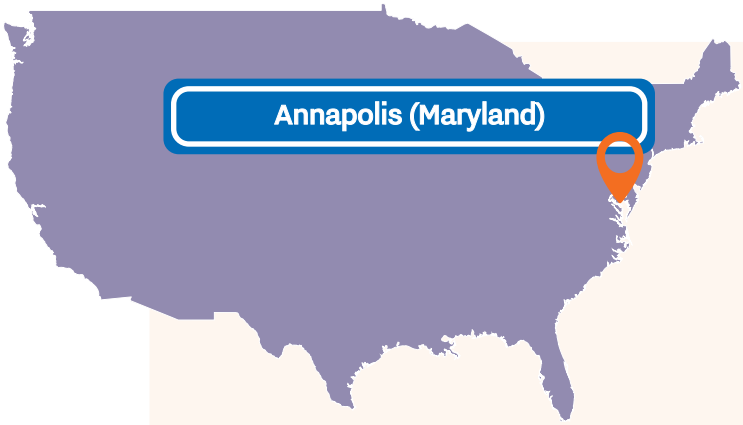
Figure 4: Frequency of flooding along US coast, 2014-2023 versus 1950-1959 (USGCRP, 2023)



In specific, the following states experience coastal flooding: Maine, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Delaware, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Texas, California, Oregon, Washington.

Hurricanes often make landfall along the Atlantic and Gulf of Mexico coastal areas, Puerto Rico, the U.S. Virgin Islands, Hawaii, parts of the Southwest, the Pacific Coast, and the U.S. territories in the Pacific.

Opportunities



General information

Annapolis is the capital of the U.S. state of Maryland. It is the county seat of Anne Arundel County and its only incorporated city. Situated on the Chesapeake Bay at the mouth of the Severn River, 25 miles (40 km) south of Baltimore and about 30 miles (50 km) east of Washington, D.C., Annapolis forms part of the Baltimore–Washington metropolitan area. The 2020 census recorded its population as 40,812, an increase of 6.3% since 2010.

Challenges

The City of Annapolis is susceptible to floods anytime during the year but especially from March to September. Flooding is primarily due to the City's location as a coastal community. The lowest lying land is in the downtown Annapolis/City Dock area and Eastport, located at the mouth of the Severn River, Annapolis Harbor, and Spa Creek. The city of Annapolis is on track for 120 flooding events per year.

To illustrate: because of tropical storm Debby in August 2024, the floodwaters in downtown Annapolis surged to over 4 feet above normal levels at City Dock. The city estimated that the storm costed 19 businesses and nonprofits over $162,000 in lost revenue and equipment damage.

Projects

- The City Dock project aims to protect the City Dock against sea-level rise and flooding which is essential for advancing the City's economy and safeguarding the City's cultural and historical heritage. The project's resiliency solutions will help transform the City Dock area into a vibrant community space with shaded gathering spaces, a splash pad, a raised promenade, and eating areas. The project is being developed as a Progressive Public-Private Partnership.
- The City of Annapolis contracted with AECOM (infrastructure consulting firm) to develop final engineering design plans for the mitigation of flooding at Compromise and Newman streets through construction of a new pump station including a wet well, control building and back-up generator; realignment of the existing storm drain systems; and construction of a new bulkhead at the end of Newman Street.

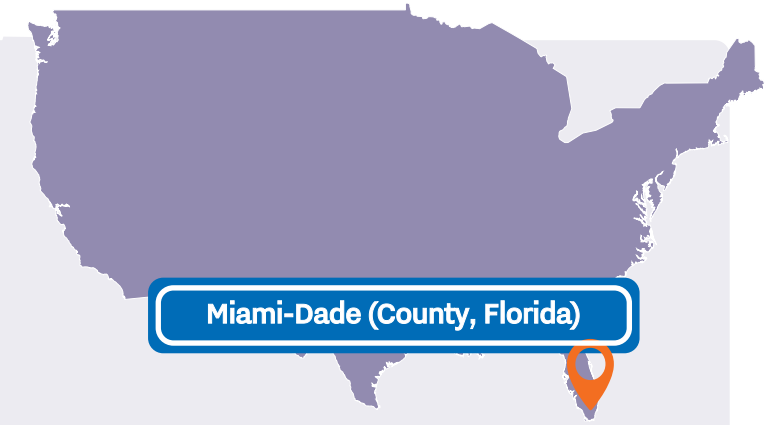
Available funding

- Anne Arundel County Executive Steuart Pittman and City of Annapolis Mayor Gavin Buckley announced the Resilience Authority secured nearly $20 million in federal, state and local funding to protect Anne Arundel County's shorelines, communities, and residents from climate threats like increased flooding, heat waves, sea level rise, and extreme weather events. This was announced in September, 2023.
- The City of Annapolis was awarded $3.7 million in federal and state grant funding for four projects involving flood mitigation and storm water control in June, 2024. The Annapolis Office of Emergency Management and the Department of Public Works collaborated on the grant applications.
- In December 2023, U.S. Senators Chris Van Hollen and Ben Cardin and Congressmen Steny H. Hoyer, John Sarbanes and Kweisi Mfume (all D-Md.) announced $12,901,800 in National Fish and Wildlife Foundation (NFWF) and National Oceanic and Atmospheric Administration (NOAA) funding for restoration and resiliency projects to improve coastal communities and their fish and wildlife habitats. Annapolis received two federal grants:
  - > The Resilience Authority of Annapolis and Anne Arundel County, $819,300, for Establishing a Nature-Based Resilience Pilot with the Annapolis Maritime Resilience Initiative.
  - > The Resilience Authority of Annapolis and Anne Arundel County Restoration, $1,340,400, for the Restoration of an Urban Stream to Create a Holistic Stream, Wetland, and Shoreline Complex.

Available network

- The Mayor of Annapolis
- The City Council of Annapolis
- The State of Maryland Emergency Management

General information



Miami-Dade County is located in South Florida, the southeastern part of the U.S. state of Florida. The County had a population of 2,701,767 as of the 2020 census, making it the most populous County in Florida and the seventh-most populous County in the United States. Miami-Dade County consists of a low-lying mainland, an island chain, and a complex metropolitan area of over 2.5 million residents and 12 million annual tourists who heavily use the urban park system, especially coastal parks and waterways. Furthermore, Miami-Dade County is the only County in the nation to possess within its boundaries two national parks, Biscayne National Park and Everglades National Park, as well as the heavily used Biscayne Bay Aquatic Preserve, which is urban Miami-Dade's signature amenity.

Challenges

- Miami-Dade County has significant challenges as to flooding as it is located in a hurricane-prone area, is built on porous limestone, and has low elevation. Because Miami-Dade County is located in a unique geographical location, it is particularly susceptible to flooding from major rain events and storm surges (due to tropical weather), but also more frequently king tide/sunny day flooding events (temporary inundation of low-lying areas during high tide causing high groundwater levels). Sea level rise and compound flooding have also increased the sense of urgency.
- The County is surrounded by the waters of the Atlantic Ocean, Biscayne Bay, and the Everglades (nicknamed the River of Grass), and it has many creeks, rivers, lakes, and canals within its borders. South Florida has its rainy season from May to October, during which the region receives 60-70% of its yearly rainfall of which a large quantity of the precipitation occurs during hurricane season (June 1 thru November 30).
- Miami-Dade County lies near sea level (only 4-5 feet above sea level mostly) and has high groundwater levels. Therefore, major rain events more frequently leave rainwater without draining, causing occasional flooding.

Projects

Most significantly, the so-called Miami-Dade County Back Bay (MDBB) Coastal Storm Risk Management (CSRM) Feasibility Study is an umbrella report for coordinating, formulating plans, and evaluating alternatives for addressing coastal storm risk for the highly vulnerable communities in Miami-Dade County.

> The Report reflects the extensive collaboration between the US Army Corps of Engineers (USACE), Miami-Dade County, municipalities, stakeholders, and environmental resource agencies. It is an interim response containing actionable recommendations for managing storm surge flooding risks in the short term while additional study efforts continue.

> The Report includes a mix of initial recommended measures to reduce coastal storm damage, prioritizing communities at the highest risk for storm surge flooding. These include non-structural strategies such as floodproofing critical infrastructure (fire stations, wastewater pump stations, etc.), elevating residential structures, and floodproofing nonresidential buildings like businesses.

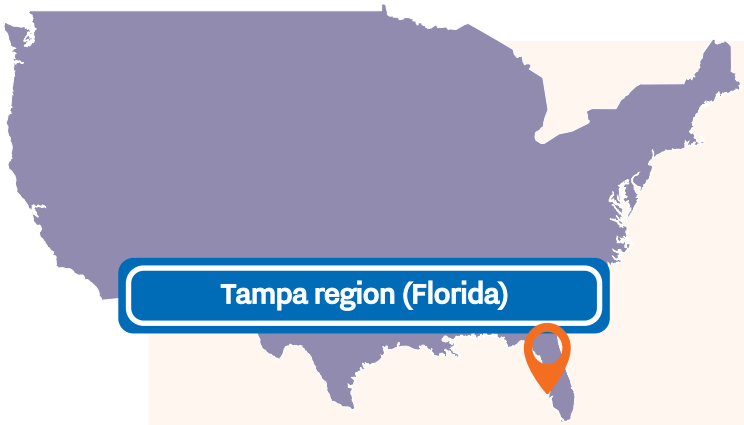
> The Report also includes a request for Congress to authorize two new programs, a Nature-Based Solutions (NBS) Pilot Program, and a Nonstructural Program. The NBS Pilot Program proposes working with partners to design, implement, and monitor a mix of NBS projects to learn about storm surge damage reduction and ecosystem health benefits and improve the USACE's ability to apply these solutions in other current and future coastal storm-risk-management-feasibility studies. The Nonstructural Program proposes to develop and implement nonstructural measures for unique buildings, for which USACE policy guidance and implementation practices are still being developed.

Available funding

Split over various steps and phases, a budget of $2.7 billion is aimed to be worked out between the U.S. Army Corps of Engineers and Miami-Dade County to create multiple lines of defense. It also includes several million dollars to study the effectiveness of reefs, mangroves, and other nature-based solutions on shredding storm surges, which will help determine future features. Most of the work focuses on elevating 2,100 mostly residential structures, single and multifamily, in areas that planners identified as prone to storm surge flooding and financially vulnerable. About 400 structures, mostly government buildings, would be floodproofed with barriers. Those include police and fire stations, schools used as hurricane shelters, emergency operations centers, and other critical infrastructure facilities. The costly elevation work is expected to cost nearly $700 million, with floodproofing costs estimated at $223 million.

Available network

- Miami-Dade County (including knowledge institutions, non-profits, and a few companies)
- Commander at the Jacksonville District of the U.S. Army Corps of Engineers (USACE)
- Chief Resilience Officer of Miami Dade



General information

Tampa is a city on the Gulf Coast of the U.S. state of Florida. With an estimated population of 403,364 in 2023, it is the 49th-most populous city in the country and the third-most populous city in Florida after Jacksonville and Miami. Tampa is part of the Tampa-St. Petersburg-Clearwater, Florida Metropolitan Statistical Area, a four-county area composed of roughly 3.1 million residents. This makes it the second-largest metropolitan statistical area (MSA) in the state and the sixth-largest in the Southeastern United States, behind Dallas-Fort Worth, Houston, Washington D.C., Atlanta, and Miami. The Greater Tampa Bay area has over 4 million residents, generally including the Tampa and Sarasota metro areas.

Challenges

- Tampa is vulnerable to hurricanes and was hit by two major hurricanes in 2024, Milton and Helene. The heightened risk is partially a result of topography. Florida's Gulf of Mexico coastline is shallow with a gentle, sloping shelf. The higher ocean floor is a barrier that retains the storm's water outflow, forcing the ocean to surge onto shore. That's the opposite of Florida's east coast, where the ocean floor drops suddenly a few miles from the coast. A 2015 report from the Boston-based catastrophe modeling firm Karen Clark and Co. concluded that Tampa Bay is the most vulnerable place in the U.S. to storm surge flooding from a hurricane and stands to lose $175 billion in damage. More than 41 percent of hurricanes that hit the United States also make landfall in Florida. The state has been hit by more than double the number of hurricanes than Texas, the next closest hurricane-prone state. However, the Tampa Bay region was mainly spared in 2024 due to a natural phenomenon that dried the bay up instead of flooding it, a reversed storm surge. Still, both hurricanes were a strong wakeup call for Tampa Bay, as a 5-11 feet (1.5-3.4 meter) storm surge was initially predicted.
- Climate change also significantly impacts the coasts of the Tampa area. Rising temperatures from greenhouse gas emissions have warmed the oceans, led to sea level rise, and added moisture to the air, all key factors determining a hurricane's strength and the potential flooding it can cause. Due to global warming, global climate models predict hurricanes will likely cause more intense rainfall and have an increased coastal flood risk due to higher storm surges caused by rising seas.

Projects

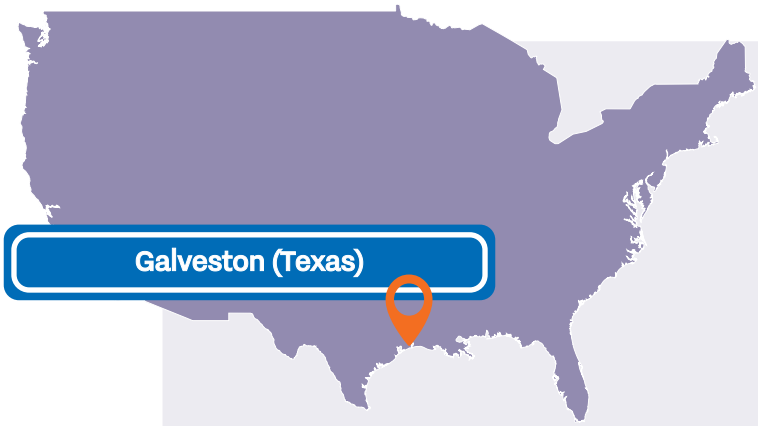
Further research needed in 2025, as region is still in recovery mode and the upcoming changes at federal government might have an impact on focus and federal funding.

Available funding

- The West Coast of Florida is still in recovery mode, with significant disaster funds coming from FEMA and the State of Florida. Additional funds with a longer-term focus are expected from the federal government and the State of Florida.
- The Florida Department of Environmental Protection offers Resilient Florida Grants to counties, municipalities, and special districts to adapt critical assets to risks associated with flooding and sea level rise. This grant has benefitted multiple communities in the Tampa Bay area, and the application period for 2024 ended in September 2024. Potential funds for 2025 (and beyond) have yet to be announced.
- The State of Florida also has the My Safe Florida Home grant program (max. $10,000 per grant) for homeowners to protect their homes from hurricanes. This might interest Dutch companies providing temporary flood protection—resilient Florida. Significant state and federal (including FEMA) resources are to be expected.

Available network

- Local government in the Tampa Bay region (Hillsborough County, Tampa, St. Petersburg, Tampa Bay Regional Planning Council)
- University of South Florida



General information

Galveston is a coastal resort city and port off the Southeast Texas coast on Galveston Island and Pelican Island in the U.S. state of Texas. The community of 211.31 square miles (547.3 km2), with a population of 53,695 at the 2020 census, is the county seat of surrounding Galveston County and second-largest municipality in the county. It is at the quickly expanding southern end of the Greater Houston-metropolitan area, encompassed by water. Its location at the Galveston Bay on the north side and the Gulf of Mexico on the south side, makes it extreme vulnerable for multiple causes of flooding.

Challenges

Galveston faces significant challenges due to inadequate drainage systems, subsidence, and rising sea levels threatening its coastal infrastructure and creating back-bay flooding in the historic center. Extreme rainfall events, subsidence, and storm surge flooding caused by hurricanes further complicate long-term mitigation efforts. Addressing these vulnerabilities requires robust investment in resilient infrastructure and adaptive strategies to protect the city, its port (among others, very important cruise ship port and activities related to the offshore industry), tourism (historic district and sea-wall beach area), and the local residential areas.

Projects

- Texas General Land Office (GLO) Grants: In May 2021, the GLO approved $179 million for flood mitigation projects in Galveston County. The City of Galveston received the first $54.3 million for the South Shore Drainage Project, aiming to manage water from a 25-year storm event and retain stormwater from a 100-year event within city rights-of-way. The project includes constructing an outfall pump station on English Bayou with an estimated 1,200 cubic feet per second capacity. The first work is being done, and there will be calls to upgrade the pumping system further. Yet, this will only partially solve the chronic flooding problem (far from it), and more solutions are being sought.
- Community Development Block Grant Mitigation (CDBG-MIT) Funds: The Texas General Land Office also manages CDBG-MIT funds allocated by the U.S. Department of Housing and Urban Development (HUD) to support long-term resilience efforts. These funds are designated for areas that have experienced significant disasters, aiming to mitigate future risks. Eligible activities include:
  - > Flood control and drainage improvements
  - > Infrastructure enhancements
  - > Green infrastructure projects
  - > Public facilities upgrades

Galveston can apply for these funds to support comprehensive flood mitigation projects. For instance, the GLO has previously awarded substantial grants to other Texas communities for similar initiatives.

- Texas State Flood Plan: The Texas Water Development Board's 2024 State Flood Plan includes significant flood mitigation projects, with the Coastal Texas Project (see below) ranked as the top priority. This plan addresses statewide flood risks, including those in Galveston County. The exact funding amount available for specific locations/cities/districts has yet to be established, but this is expected to become clearer by 2025.
- FEMA Flood Mitigation Assistance (FMA) Grant Program: This program provides federal funds to assist states and communities in implementing measures to reduce or eliminate long-term flood risks to structures insured under the National Flood Insurance Program (NFIP). The Texas Water Development Board also administers this program within the state.
- Coastal Texas Protection Plan/Ike Dike / Texas Coastal Spine: This comprehensive USACE and the Texas General Land Office plan recommends a combination of structural and nonstructural measures to reduce risks from coastal storms and restore ecosystems. The proposed ring barrier system for Galveston includes floodwalls, gates, pump stations, and levees to protect approximately 15.8 square miles of the city. It is part of the total USD 32-53 billion plan.

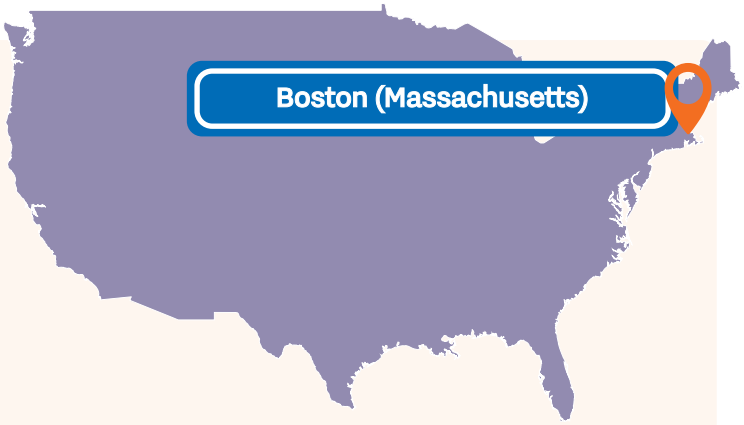
Available funding

See above-mentioned projects.

Available network

- City of Galveston (Office of Public works, Office of Emergency Management)
- Texas A&M University in Galveston
- Institute for a Disaster Resilient Texas (also connected to TU Delft)
- US Army Corps of Engineers Galveston Branch
- Texas Water Development Board
- Local advocacy groups

General information



Boston is the capital of Massachusetts and has a population of 675.647, according to the 2020 Census. The larger Greater Boston metropolitan statistical area has a population of 4.9 million as of 2023. Boston is known for its leadership in higher education and research. The city's climate is characterized by hot and humid summers and cold and stormy winters, with occasional periods of heavy snow.

Challenges

- Boston's relative sea level (location-specific sea level rise, considering both oceanic and land changes) is rising at an accelerating pace. The average relative sea level rise rate between 2001 and 2019 was 0.21 inches per year, about twice the average rate over the last century. The relative sea level in Greater Boston is rising faster than the global average due to a combination of regional ocean warming and geodynamical processes (including local vertical land motion) associated with past and current changes in the distribution of land ice around the world.
- Most of Greater Boston's extreme flooding events are caused by winter storms that coincide with anomalous high tides. The height of the tide largely controls the severity of flooding during a storm in Greater Boston. Boston Harbor will see an increasing number of high tide nuisance flooding days, defined as days when at least one hourly water level measurement exceeds local flooding thresholds defined by NOAA (7.1 feet above 2000 mean sea level for minor flooding or 7.9 feet for moderate flooding). Based on recent projections, Boston's minor flood threshold will be exceeded on roughly half the days of each year by the early-2050s.

- Boston's historic coastline is different from the coastline nowadays. As early as 1722, colonists started to change the natural outline of Boston by using landfill to create new space for shipping facilities, rail infrastructure, development, and more. By the turn of the 19th century, Boston's landfilling project had almost completely changed the coastline's shape. Today, about one-sixth of Boston sits on landfill. This new land is usually constructed right above the historic high tide line. Consequently, much of that created land is vulnerable to coastal flooding.

Projects

- In 2016, the City of Boston released the Climate Ready Boston report in 2016. The report included a citywide climate vulnerability assessment and strategies to address the impacts of climate change. The report laid the foundation for subsequent actions across the City, including additional planning efforts, policy and regulatory changes, and the formation of the Office of Climate Resilience.
  > The Climate Ready Boston team transitioned to the Office of Climate Resilience (OCR) in August 2024. Building on the work of the Climate Ready Boston initiative, the new office provides a centralized leadership structure for the City to spearhead the delivery of climate resilience in Boston in coordination with partners in other City departments, state and federal agencies, and the private sector. The Office of Climate Resilience is a part of the Environment, Energy and Open Space (EEOS) Cabinet.
  > Between 2017-2022, - as part of the Climate Ready Boston initiative - the City of Boston completed Coastal Resilience Solutions Plans for each of Boston's five coastal neighborhoods, including Charlestown, Dorchester, Downtown/North End, East Boston, and South Boston. As of now, the City is implementing its plans. Some projects are finished, but many are still in progress or have not started. Check the Coastal Resilience Project Tracker for the projects' most up-to-date status.

- Mayor Wu launched the policy agenda "Green New Deal" in 2020. The Green New Deal is a vision for tackling the climate crisis in Boston. Priority areas are building decarbonization, transportation, clean energy, resilience and nature, and workforce.
- In fall 2025, the City of Boston will release its 2030 Climate Action Plan. The plan will include a detailed roadmap for 2026-2030, outlining the actions needed to advance Boston's 2030 and 2050 climate resilience goals. The OCR will accelerate Boston's citywide response to pressing climate challenges, such as coastal flooding, extreme heat, and stormwater flooding, and as one part of the City's comprehensive leadership on climate action, coordinate departments across the City to deliver critical projects that protect Boston's residents and make neighborhoods more livable.

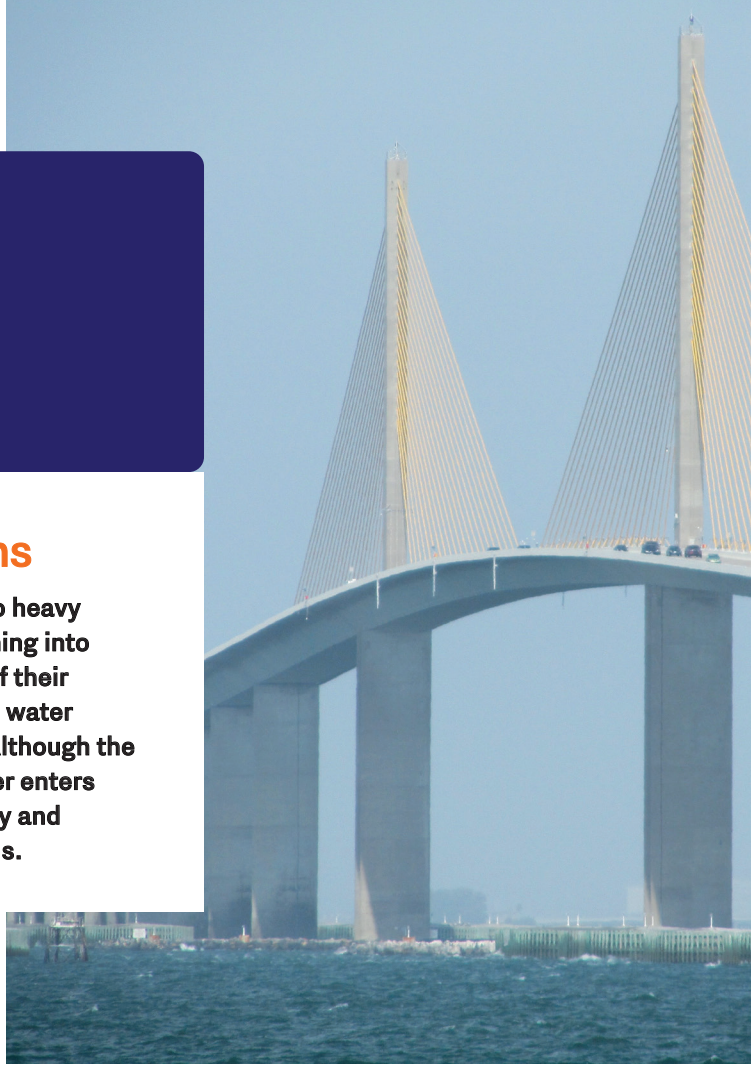
Available funding

- The American Rescue Plan (ARPA) secured funding for the Green New Deal. This fund is used to jumpstart transformative citywide and community projects to combat the climate crisis and revitalize local economies disrupted by the COVID pandemic. By the end of 2024, all ARPA funds must be allocated. Other funding comes from the Bipartisan Infrastructure Law and Inflation Reduction Act.
- For the planning and implementation phase of the Coastal Resilience Solutions Plans, different funds are being used by the City of Boston. For instance, the City of Boston has been awarded a Municipal Vulnerability Preparedness (MVP) grant in 2023 of $330,500 to advance the design of coastal resilience strategies extending along Bennington Street in East Boston and Frederick's Park in Revere. An MVP program supports cities and towns in Massachusetts in beginning planning for climate change resiliency and implementing priority projects. The project is part of the Coastal Resilience Solutions for East Boston and Charlestown, also known as the Phase II plan.

Available network

- Massachusetts Executive Office of Energy and Environmental Affairs
- City of Boston
- Stone Living Lab

Opportunities riverine resilience



Riverine flooding predictions

Rivers and streams experience flooding due to heavy precipitation or spring snowmelt quickly draining into streams and rivers. As a result, the capacity of their natural or constructed channels exceeds, and water overflows the banks into surrounding areas. Although the size or magnitude depends on how much water enters the waterway upstream, most places, even dry and mountainous regions, are susceptible to floods.

The amount and frequency of river flooding may vary in response to variations in the size and frequency of heavy precipitation events brought on by rising temperatures, which cause more water to evaporate from the land and oceans. In extreme precipitation, annual rainfall in the Central and Eastern U.S. has increased over the last decade, leading to a bigger river streamflow.

Variations in streamflow when the snow melts and how much snowfall accumulates over the winter can also impact flood patterns. Warming conditions are expected to cause earlier snowmelt, altered rates of snowmelt, evaporation directly from the snow, and longer snow-free periods. Trends also show earlier peak snowpacks, smaller volumes, and decreasing snow-season duration.

Regions

The largest drainage basin in the U.S. is the Mississippi River. From its traditional source of Lake Itasca in northern Minnesota, it flows generally south for 2,340 miles (3,766 km) to the Mississippi River Delta in the Gulf of Mexico. The river either borders or passes through the states of Minnesota, Wisconsin, Iowa, Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. Major tributaries are the Illinois, Missouri, Ohio, and Red Rivers. Along with its connecting tributaries, it is primarily used for transporting agricultural and manufactured goods across the country.

The Ohio River, upper Mississippi River, and lower Missouri River are susceptible to floods based on projected changes in precipitation, evapotranspiration, and soil moisture. Projections indicate future increases in annual precipitation of 0.3% to 1.5% per decade in the eastern Midwest and 0.2% to 0.5% in the western Midwest. Winter and spring precipitation is expected to increase, while summer and autumn precipitation is projected to be more variable.

Opportunities

General information

St. Louis is an independent city in the U.S. state of Missouri. It is located near the confluence of the Mississippi and the Missouri rivers. In 2020, the city proper had a population of 301,578, while its metropolitan area, which extends into Illinois, had an estimated population of over 2.8 million. It is the largest metropolitan area in Missouri and the second-largest in Illinois. The city's combined statistical area is the 20th-largest in the United States.

Challenges

- St. Louis is situated along the Mississippi River, just south of its confluence with the Missouri River. This location makes the city particularly vulnerable to flooding, especially during periods of heavy rainfall and rising river levels. With no surrounding mountains to run interference, the city is wide open to cold weather sweeping in from the north and hot, humid weather rising up from the south, and is prone to tornadoes.
  > With over 9,600 miles of pipeline serving an area of over 520 square miles, the St. Louis Metropolitan Sewer District (MSD) is the fourth-largest sewer system in the United States. Our seven wastewater treatment facilities process an average of 350 million gallons of sewage daily. St. Louis City and its older inner suburbs are served by combined sewers or pipes carrying wastewater and stormwater. The City's combined sewers are some of the oldest in the country—giant, subterranean brick tunnels running beneath our historic neighborhoods and downtown. During wet weather, especially heavy rains, the volume of the combined sewage and rainwater can overwhelm the capacity of our sewers, causing a mixture of sewage and rainwater to bypass the treatment facility and discharge directly into local rivers. Furthermore, storm drains are often blocked with debris.
- The city's geography includes bluffs and terraces that rise 30 to 61 meters above the river's western banks, which offer some protection but do not eliminate the risks posed by its proximity to the river and the impacts of climate change.

Project

Metropolitan St. Louis Sewer District (MSD) Project Clear is a long-term effort by the MSD, undertaken as part of an agreement with the U.S. Environmental Protection Agency and the Missouri Coalition for the Environment. The project was launched in 2012, accounts for $6 billion, and is a 28-year initiative. This massive and multi-faceted program will

tackle the region's issues on three fronts: Get the Rain Out, Repair and Maintain, and Build System Improvements. By disconnecting residential downspouts, rain-scaping, and various other efforts, our Get the Rain Out program will prevent excess stormwater from entering the sewer system. Repair and Maintain will accelerate the work MSD is already doing to renew our existing sewer system. Build System Improvements involve the construction of new wastewater management structures, such as deep underground tunnels and above-ground storage tanks.

Available funding

See above-mentioned project.

Available network

- Port Director of St. Louis
- Mississippi River Cities & Towns Initiative (MRCTI)
- Mayor's office

Riverine drought predictions

Whereas rivers and streams experience flooding on the one hand, they experience periods of extreme drought on the other hand. Drought patterns are impacted by the amount of precipitation and snowmelt, which affect the streamflow of rivers and streams.

Due to warming conditions, the characteristics of rainfall and snowmelt are expected to change. For instance, parts of the Southwest are getting drier – the average annual precipitation decreased between 10% and 15%. Furthermore, the Southeast experiences drier conditions during spring and summer.

Riverine droughts also develop in response to extremely high temperatures. Across the U.S., annual average surface temperatures have risen. Moreover, unusually high temperatures have increased in the western U.S. and several Gulf and Atlantic Coast areas. Consequently, these high temperatures dry out rivers and streams.

When rivers experience low water levels, such as the Mississippi River flowing into the Gulf of Mexico, it allows salty water from the sea to push its way upstream. Under normal conditions, the downstream flow of the river prevents significant upriver progression of the salt water. However, when water levels are low, salt water can travel upstream and threaten municipal drinking water and industrial water supplies. This process is called saltwater intrusion. Not only does this threaten fresh water supplies, salinization also impacts agriculture and the natural environment.

Regions

The Mississippi River not only experiences floods, it also experiences periods of drought. For example, The 2012 Great Plains drought led to nearly $35 billion in direct losses for the U.S., including closing the Mississippi River at least three times. These drought conditions impacted numerous Southern and Midwestern states (TX, LA, OK, KS, IL, MO, NE) and surrounding states. The droughts developed in response to precipitation deficits, extremely high temperatures, and evapotranspiration.

Opportunities

General information

New Orleans is located along the Mississippi River in Louisiana. In 2020, the city had an estimated population of 383,997. New Orleans has a major port and is considered an economic and commercial hub for the broader Gulf Coast region of the U.S. In August 2005, New Orleans was severely affected by Hurricane Katrina, which flooded more than 80% of the city, killed more than 1800 people, and displaced thousands of residents. The population declined by 50%.

Challenges

During the summer and fall of 2023, Louisiana experienced one of its driest and hottest summers on record. While drought developed across the state, rain shortfalls further north led to low water levels in the Mississippi River. Consequently, the below-normal discharge into the Gulf of Mexico threatened to contaminate the water supply of the Mississippi River with salt (salinization). Thus, by late October 2023, Louisiana was gripped by two water crises: a severe local drought and saltwater contamination in the Mississippi River channel.

- The severe local drought: New Orleans had 39.85 inches (ca 102 cm) of rain in 2023. This is nearly 2 feet (60 cm) below normal rainfall. Simultaneously, Louisiana had its hottest summer on record. Several cities, including New Orleans, broke their daily heat records.
- Saltwater contamination: the intrusion of salt water into the Mississippi River is a naturally occurring process since the Gulf of Mexico is below sea level. Hence, denser salt water moves upriver along the bottom of the river beneath the less dense freshwater flowing downstream. In 2022, flows had declined so severely that the US Army Corps of Engineers (USACE) constructed an emergency sill to prevent saltwater intrusion upriver from the Gulf of Mexico; such a barrier had only been required on three other occasions (1988, 1999, 2012). In 2023, USACE began construction again on an emergency sill. The sill will naturally erode when the Mississippi River returns to the flow levels required to push the saltwater wedge back down the river to the Gulf of Mexico.

Projects

These will be updated in the near future.

Available funding

These will be updated in the near future.

Available network

- Honorary Consul of the Kingdom of the Netherlands
- Mississippi River Cities & Towns Initiative (MRCTI)

Opportunities urban resilience

Urban flooding predictions

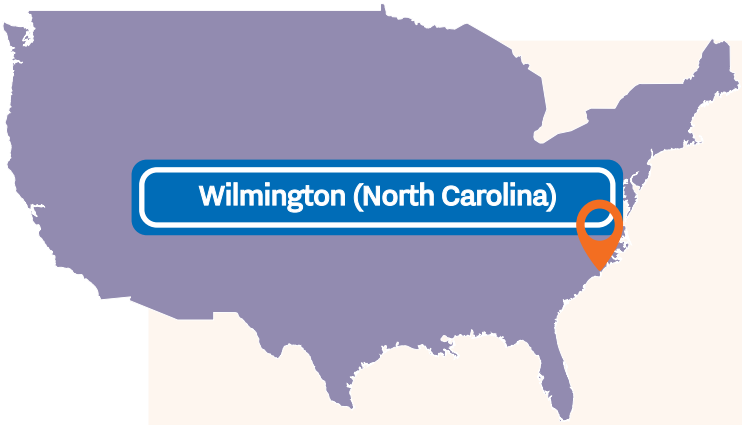
Over the past decade, major hurricanes and extreme storm events have caused great damage on many urban areas throughout the United States. While the major storms of the past years (such as Harvey, Maria, Irma, Helene) will be remembered as hurricanes, in many cases it was the intense rainfall that brought urban areas to a standstill, overwhelming homes and transportation arteries with flood water. These events are called urban flooding.

Urban flooding is often caused by aging and inadequate infrastructure, coupled with rapid land development which increase the amount of storm runoff to already stressed drainage systems, creating pockets of flooding in ill-equipped and vulnerable neighborhoods. Many of the urban wastewater and stormwater systems that provide the backbone of urban flood mitigation are in poor condition and—in some locations—are inadequate and in need of strong support. As temperatures rise and weather patterns become more unpredictable, cities are experiencing heavier rainfall and more frequent storms, leading to increased runoff and a higher risk of flooding.

Regions

In much of the U.S., the growing number of extreme rainfall events that produce intense precipitation are resulting in—and will continue to result in—increased urban flooding.

Opportunities



General information

Wilmington is a port city in New Hanover County, in southeastern North Carolina, United States; it is also the county seat. With a population of 115,451 (as of the 2020 census), it is also the eighth-most populous city in the state and the principal city of the Wilmington, NC, Metropolitan Statistical Area, which includes New Hanover, Brunswick, and Pender counties. As of 2023, its metropolitan statistical area had an estimated population of 467,337. Wilmington is no stranger to the impacts of severe weather, having endured numerous notable storms throughout its history.

Challenges

- Wilmington experiences its highest rainfall during the late summer months, particularly in August and September, with each month averaging over 8 inches of rain. This period accounts for nearly 40% of the annual rainfall. Wilmington's proximity to the Atlantic Ocean and its relatively flat topography contribute to its flooding issues. The city's drainage system often becomes overwhelmed during heavy downpours.
- In Wilmington, stormwater runoff is channeled through a complex system of storm drains, pipes, ditches, ponds, culverts, creeks, and wetlands, flowing straight into our waterways. Multiple watersheds in Wilmington drain into the Cape Fear River or Intracoastal Waterway, which ultimately drains into the Atlantic Ocean. However, the existing drainage infrastructure is aged in several watersheds, and some of them are undersized.

Projects

- Stormwater capital projects are constructed when the existing stormwater drainage system is inadequate, resulting in flooded streets and property. These projects also strive to improve water quality whenever possible. Stormwater utility fees provide the funding and staff resources for planning, design, and construction of capital improvement projects.
  - > An example of a major project in Wilmington is the Fifth Avenue Street Water Utility Improvement Project. From mid-2023 into 2025, Fifth Avenue will undergo major upgrades, including street resurfacing, sidewalk repairs, stormwater drain improvements, and a full replacement of water and sewer utilities. Once completed, Fifth Avenue will be restriped to include one lane for vehicular traffic, ample on-street parking, and a dedicated bike lane in both directions.

- The North Carolina Department of Environmental Quality is developing the North Carolina Flood Resiliency Blueprint, which will form the backbone of a state flood planning process to increase community resilience to flooding throughout North Carolina's River basins. The Flood Resiliency Blueprint (started in 2022) will be a resource for riverine and stream management and support the establishment and furtherance of local government stormwater maintenance programs to reduce flooding in North Carolina. The project will explore and learn from examples of similar work in other states and identify major watersheds affected by flooding through the incorporation of existing and future flood risk projections to ultimately direct funds toward activities that best support the creation of an actionable blueprint. The main objective of the blueprint is to form a set of prioritized projects and funding strategies that the State can implement in each of North Carolina's 17 River Basins. The goals of the project:
  > Develop an online decision support tool which seamlessly guides state, county, municipal, and other jurisdictions to identify and select flood mitigation strategies responsibly, systematically, equitably, and transparently.
  > Develop community and basin-specific risk management processes to identify and address flooding for NC communities.
  > Establish a repeatable, statewide methodology for prioritizing, and selecting flood mitigation strategies for future implementation.

Available funding

- Stormwater utility fees provide funding for stormwater capital projects. These fees are based on the amount of impervious (hard) surface area on a property and the cost of providing comprehensive stormwater management. For other projects, the City of Wilmington used grants from the Environmental Protection Agency, National Fish & Wildlife Foundation, NC Clean Water Management Trust Fund (CWMTF), NC Coastal Nonpoint Source Program, or other funding sources.
- The Flood Resiliency Blueprint is funded through a $20 million allocation to the Department of Environmental Quality Division of Mitigation Services from the North Carolina General Assembly. An additional $96 million is allocated to the Division of Mitigation Services to fund priority projects identified in the development of the Flood Resiliency Blueprint for the following river basins: Neuse, Cape Fear, Tar-Pamlico, White Oak, and Lumber.

Available network

- City Manager's office
- Wilmington Business Development
- North Carolina Southeast
- North Carolina Department of State
- NC Chamber of Commerce
- North Carolina Ports

General information

Philadelphia, also known as Philly, is the most populous city in the U.S. state of Pennsylvania and the sixth-most populous city in the United States, with a population of 1,603,797 in the 2020 census. The city is the urban core of the larger Delaware Valley, also known as the Philadelphia metropolitan area, the nation's eighth-largest metropolitan area and seventh-largest combined statistical area with 6.245 million residents and 7.366 million residents, respectively.

Challenges

- Philadelphia experiences tidal flooding due to its proximity to two tidal rivers. Both the Delaware River bordering Philadelphia's east and the Schuylkill bordering the west are tidal rivers; their water levels rise and fall with those of the Atlantic Ocean, channeled through the Delaware Bay. Over the past century, sea levels around Philadelphia have risen approximately 12 inches (ca. 30 cm), increasing the frequency and severity of tidal flooding.
- Philadelphia has several low-lying areas, primarily near its rivers and streams. In addition, Philadelphia's landscape is characterized by extensive impervious surfaces like roads and buildings, which contribute to rapid runoff during heavy rainfalls. This runoff can overwhelm the city's stormwater management systems, leading to flooding in low-lying areas and streets.
  > Much of Philadelphia operates on combined sewer systems (approximately 60% of the City), where stormwater and wastewater share the same pipes. This system can become overwhelmed during heavy rainfall, leading to combined sewer overflows that discharge untreated sewage and stormwater into local waterways.

Projects

- The Philadelphia Water Department and the U.S. Army Corps of Engineers have been working on a feasibility study (since May 2019) to build a levee to mitigate flooding along Cobbs Creek. This study is part of a long-term flood resilience strategy for Eastwick, located in Southwest Philadelphia. The Eastwick study area is along the confluence of Darby and Cobbs Creeks, west of the Schuylkill River, and north of the Delaware River and Philadelphia International Airport. Eastwick primarily comprises residential and commercial establishments, while the adjacent area to the south and east is explicitly comprised of industrial and commercial establishments. Eastwick has experienced increased frequency, duration, and intensity of riverine and marsh flooding during storm events, including hurricanes and major cyclones.
  > On October 8, 2024, The City of Philadelphia's Office of Sustainability received $1,383,069 in congressional funding to construct the Eastwick Near-term Flood Barrier Project as an interim measure to protect vulnerable residents from flooding and increase flood resilience in the Eastwick neighborhood. The project's design process is tentatively scheduled to begin in spring 2025.

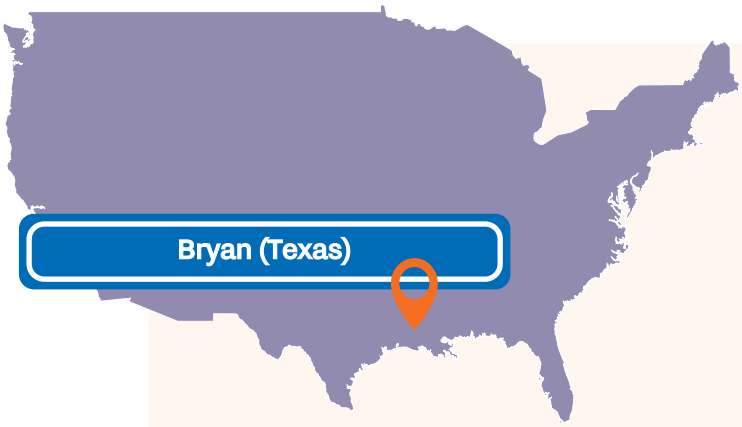
- **Green infrastructure:** One way the city deals with the limitations of the combined sewer system is the "Green City, Clean Waters" initiative. This 25-year plan, started in 2011, focuses on implementing green stormwater infrastructure to manage stormwater runoff by mimicking natural processes. Green stormwater infrastructure includes rain gardens, green roofs, permeable pavements, and stormwater tree trenches, which help reduce runoff volume by entering the sewer system, thereby decreasing combined sewer overflows.
- **Resilience strategy:** The city of Philadelphia is currently looking to create a resilience strategy for the southern part of the city. The area is at a very low elevation, and home to the airport (PHL), the Naval Shipyard, as well as a wide swathe of community fabric in the form of residential homes, sports stadia, and transportation infrastructure. There is also a growing need for resiliency strategies to help ensure adequate drinking water, given recent droughts as well as the movement of the "salt wedge" from the ocean shifting further upstream and closer to the city's water intakes.

Available funding

See above-mentioned projects.

Available network

- City of Philadelphia, Department of Sustainability
- University of Pennsylvania Water Center
- World Trade Center Philadelphia
- Philadelphia Museum of Art
- Drexel University
- Philly Water Utility
- NYC Dept. of Environmental Protection (NYC Water Utility; shares water resources via "boundary conditions" with City of Philadelphia)



General information

- Bryan is a city in and the county seat of Brazos County, Texas, United States. It is located in the heart of the Brazos Valley (East and Central Texas). As of the 2020 census, the city had a population of 83,980. Bryan borders the city of College Station, which lies to its south. Together they make up the Bryan-College Station metropolitan area, the 15th-largest metropolitan area in Texas with 268,248 people as of 2020.
- Bryan is similar to other cities located in the eastern part of Texas with mostly flat terrain and some rolling hills, significant amounts of urban impervious cover (concrete, asphalt, and homes), slow-absorbing soil, and potential for heavy rainfall from thunderstorms, tropical storms, and hurricanes all combine to form ideal conditions for flooding. Due to its humid-subtropical climate and general proximity to the Texas coast, many cities in this region are susceptible to large amounts of rainfall that are often too great for its infrastructure and creeks to handle.

Challenges

- Bryan faces several flooding challenges due to its geographic and climatic conditions. The city's flat terrain, slow-absorbing soils, and significant urban development make it susceptible to flooding during heavy rainfall events. The humid subtropical climate and proximity to the Texas coast further increase the risk, as Bryan often experiences substantial rainfall from thunderstorms, tropical storms, and hurricanes.
- The city's drainage infrastructure channels stormwater into eight creek systems: Carters, Burton, Briar, Hudson, Thompson, Still, Cottonwood Branch, and Turkey. These creeks then flow into the Brazos or Navasota Rivers. These waterways can overflow during intense rainfall, leading to localized flooding, especially in areas with inadequate drainage systems.
- Bryan has implemented several measures to address these challenges, yet despite these efforts, challenges persist. Rapid urbanization increases impervious surfaces, reducing natural water absorption and exacerbating runoff. Maintaining and upgrading aging drainage infrastructure requires significant investment. Additionally, unpredictable weather patterns due to climate change can lead to more frequent and severe flooding, necessitating ongoing adaptation and preparedness.

Projects

- Floodplain Management Plan: In October 2023, the Bryan City Council approved an updated Floodplain Management Plan. This plan, developed with input from residents, aims to identify flood risks, understand vulnerabilities, and implement mitigation strategies to protect the community from flood impacts.

- Flood Early Warning System (B-FEWS): In early 2024, Bryan installed a flood early warning system across 20 flood-prone roadways. Funded partly by a $180,000 grant from the Texas Flood Infrastructure Fund, this system uses high-water alert sensors to notify emergency response teams and city staff about rising water levels. Automated flashing beacons warn drivers to "Turn Around, Don't Drown," enhancing safety during heavy rains.
- Public Education and Resources: The city provides residents with information on flood risks, flood insurance, and property protection measures. Resources include floodplain maps, guidelines for obtaining flood insurance, and advice on safeguarding properties against future floods.

Available funding

- Flood Infrastructure Fund (FIF): Administered by the TWDB, the FIF offers financial assistance through loans and grants for flood control, mitigation, and drainage projects. Bryan has already utilized this fund to install a flood early warning system, receiving a $180,000 grant to support the $450,000 project.
- Texas State Flood Plan: The Texas Water Development Board's 2024 State Flood Plan includes significant flood mitigation projects, with the Coastal Texas Project (see below) ranked as the top priority. This plan addresses statewide flood risks, including those in Bryan. At this time, the exact funding amount available for specific locations/cities/districts is not established, but this is expected to become clearer by 2025.
- FEMA Flood Mitigation Assistance (FMA) Grant Program: This program provides federal funds to assist states and communities in implementing measures to reduce or eliminate long-term flood risks to structures insured under the National Flood Insurance Program (NFIP). The Texas Water Development Board also administers this program within the state.
- Resilient Communities Program: The RCP provides grants to develop, adopt, and implement modern building codes, flood damage prevention ordinances, and forward-looking land use plans that incorporate resiliency measures. The program aims to ensure that structures within communities can withstand future natural disasters. Eligible applicants include cities, counties, federally recognized tribes, and councils of government located within CDBG-MIT-eligible areas. The maximum award amount is $300,000 per applicant.
- Community Development Block Grant Mitigation (CDBG-MIT) Funds: The Texas General Land Office manages CDBG-MIT funds allocated by the U.S. Department of Housing and Urban Development (HUD) to support long-term resilience efforts. These funds are designated for areas that have experienced significant disasters, aiming to mitigate future risks. Eligible activities include:
  > Flood control and drainage improvements
  > Infrastructure enhancements
  > Green infrastructure projects
  > Public facilities upgrades

  Bryan can apply for these funds to support comprehensive flood mitigation projects. For instance, the GLO has previously awarded substantial grants to other Texas communities for similar initiatives.

Available network

- City of Bryan, City-manager and Office of Public Works
- Torres & Associates, Engineering firm that works with City of Bryan on flood resilience
- Texas A&M University in College Station
- Institute for a Disaster Resilient Texas (also connected to TU Delft)
- Texas Water Development Board
- Local advocacy groups

Heat stress and drought predictions

Annual average surface temperatures have risen since 1901 in the U.S. Temperatures have increased the most in the North, West, and Alaska. Nationwide, unusually hot summer nights and hot summer days have become more common.

Along with rising temperatures, climate change is expected to lead to more frequent, more intense, and longer heat waves during the summer months. In recent years, the average heat wave in major U.S. urban areas has been about four days long. This is about a day longer than the average heat wave in the 1960s.

Similarly, drought in many parts of the U.S. is expected to become more frequent, longer, and more severe. Average drought conditions across the U.S. have varied over time (see Figure 5). From 2000 through 2023, roughly 10 to 70 percent of the U.S. land area experienced conditions that were at least abnormally dry at any given time.

Urban areas are especially vulnerable to high temperatures. Vegetation is often lacking in urban areas, and surfaces are paved or covered with infrastructure, which absorbs and re-radiates heat. Moreover, human activities such as warming buildings and driving cars also add heat to urban areas. This effect is called an "urban heat island," which makes cities significantly warmer than their rural surroundings.

Drought conditions are challenging for urban areas, too. Because of the rising Earth's average temperature, evaporation rates have increased, drying out soil. Consequently, when rain events get more episodic, with heavier deluges, it is difficult for soil to soak it up. This could create pressure on water storage to contain excessive amounts of water. Moreover, dry soil conditions may lead cities to ban open flames and fireworks. When cities suffer from severe drought, a drought watch may be issued to encourage voluntary water conservation and ensure city agencies are ready with water conservation plans.

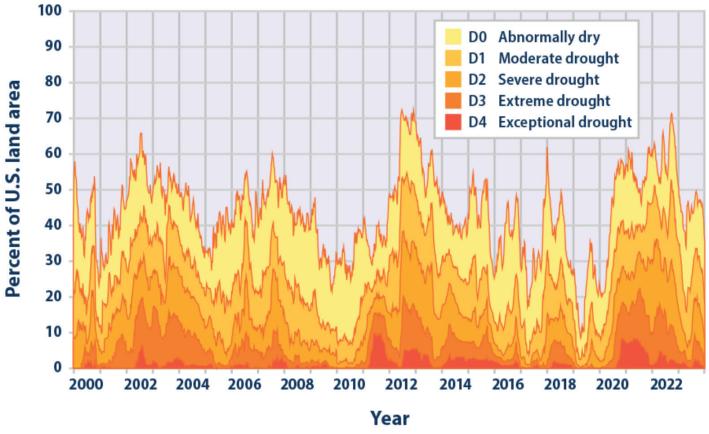


Figure 5: U.S. lands under drought conditions, 2000-2023 (EPA)

Regions

Decreased precipitation has been prominent in southwestern states such as California, Arizona, and New Mexico. In the Southwest of the U.S., climate forecasts suggest that there may be persistent precipitation deficits in the region, especially in the spring, which would raise the possibility of a meteorological drought (precipitation deficit).

Higher temperatures may increase the frequency and extent of soil moisture deficit across the country due to increased evapotranspiration. Consequently, most regions of the U.S. will experience drought at least occasionally. To illustrate, in November 2024, almost the entire United States (87.16%) experienced drought during the last week of October. In New York, October 2024 was the driest since records began in 1869. The urban heat island effect is also expected to become prevalent in more cities (where 80% of the U.S. population lives).

Opportunities

General information

Phoenix is the capital and most populous city of the U.S. state of Arizona, with 1,662,607 residents as of 2024. It is the fifth-most populous city in the United States and the most populous state capital in the country.

Challenges

Phoenix is for a large portion, about 60%, of its water supply dependent on the Colorado River. Due to climate change the supply through the Colorado river dwindles and at the same time the temperatures in Arizona and Phoenix are increasing. The temperatures consistently peak above 110 degrees Fahrenheit (43 degrees Celsius). Focus of the city is to minimize water usage/ conserve water use over a span of decades. However the city also realizes that one can not only conserve the way out of this challenge. Aspects as alternative supplies as well as growth of the city and type of growth need to be taken into account as well.

Projects

Given that water supply might be an issue in the future, the city of Phoenix and Arizona have identified three strategies to address this impending water shortage.

- Augmentation generally means that water agencies are looking for alternative water supplies. One augmentation project is to increase the capacity of nearby reservoirs, such as the Bartlett Reservoir. The Bartlett Reservoir is fed through the Verde River, part of the broader Salt River watershed. One of the projects is to make the Bartlett Dam 100 feet taller. The cost is projected to be $1 billion.
- Advanced water purification or wastewater recycling is another project that falls under the augmentation category. Phoenix has approved a $300 million construction project to revive the Cave Creek Water Reclamation Plant. Other cities out of state that are dependent on the Colorado River for their water supply are looking into similar strategies as Los Angeles.

- Groundwater is another city source of water, and the sustainable management of this specific source is a hot political issue currently in Phoenix and Arizona. In addition to the above initiatives, communities along the Salt River / Rio Salado are aiming to revitalize the river and its adjacent ecosystems. Urban rivers can be a source of civic pride that connects diverse communities and enhances the region's future economic and environmental vitality.

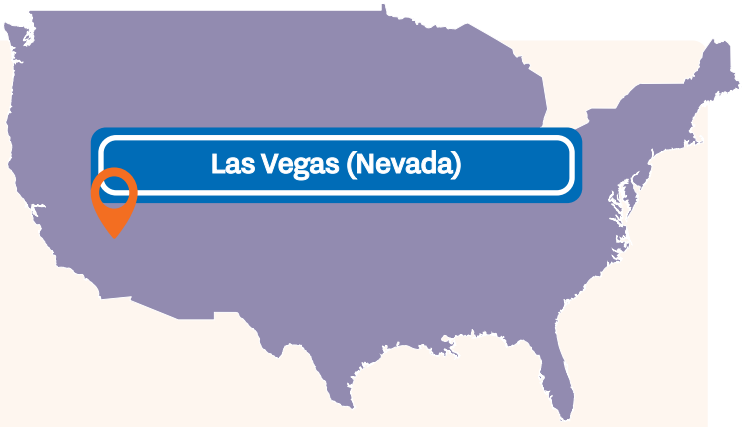
Available funding

Phoenix's future water supply depends on the right amount of funding, especially from federal resources. Under the Biden Administration, large sums of money have been allocated to the water infrastructure and water supply infrastructure in Arizona. It is uncertain whether the next administration will be as generous as the Biden administration. The Arizona Department of Water Resources gives great insights about water funding opportunities on the state and federal levels.

Available network

- Greater Phoenix Economic Council
- City of Phoenix and Office of the Mayor
- Arizona State Government / Arizona Department of Water Resources
- NBSO Phoenix
- Honorary Consul of the Kingdom of the Netherlands

General information



Las Vegas is the most populus city in Nevada (Carson City is the capital). According to the U.S. Census Bureau, the city had 641,903 residents in 2020, while the metropolitan population consisted of 2,227,053 residents. Las Vegas is the county seat of Clark County, in a basin on the floor of the Mojave Desert. Much of the landscape is rocky and arid, with desert vegetation and wildlife. The city's climate is described as a subtropical hot desert climate.

Challenges

- Almost all of Southern Nevada finds itself in extreme drought conditions, according to the U.S. Drought Monitor. In February 2025, Las Vegas broke its streak of 214 dry days with 0.01 inches of rain. It is the second time in 88 years that the city experienced 200 days or more without rain. In 2020, the city's record for the longest stretch with no measurable rain stood at 240 days. Consequently, the Colorado River Basin is experiencing the worst drought in recorded history (providing water to seven states in the Western U.S.). Due to below-normal snowfall and runoff into the basin, these conditions resulted in significantly lower water levels at major system reservoirs. The water level of Lake Mead, which serves as one of the river's primary water storage reservoirs, has dropped more than 150 feet (ca. 45 meters) since January 2000.
- The Southern Nevada has among the hottest climates in the U.S. and has been identified as one of the fastest-warming regions in the country. Temperatures regularly exceed 100 F (ca. 38 Celsius) during summer months. The Las Vegas region's average annual temperature rose nearly 6 F between 1970 and 2018. Furthermore, according to a 2017 Climate Central study, the urban heat island effect makes the urban area 7.3 F hotter than surrounding regions.

Projects

- The Southern Nevada Water Authority (SNWA) has developed and implemented one of the nation's most comprehensive water conservation programs. These conservation efforts have helped the community reduce its per capita water use by 58 percent between 2002 and 2023, even as the population increased by more than 786,000 residents during that time. Programs that have helped achieve this accomplishment include:
  - > Water Smart Landscape Rebate Program - 232 million square feet of grass have been removed, saving 189 billion gallons of water since 1999.
  - > Water Efficient Technologies Program - Since 2001, participating businesses have saved more than 24 billion gallons of water through the program.
  - > Water Smart Homes - Nearly 17,000 homes were built via the program from 2005-2020, saving 14 billion gallons of water.
  - > Pool Cover Instant Rebate Coupon Program - More than 45,000 coupons were distributed before the program was retired in June 2020, saving an estimated 5.6 billion gallons of water.
- To address the urban heat island effect, the SNWA is taking different steps. For example:
  - > The SNWA is collaborating with Clark County and other stakeholders to quantify water and energy benefits associated with cool roof retrofits. This research will guide potential incentive programs to reduce UHI and water use associated with evaporative cooling.
  - > Through involvement in the Clark County-led All-In Regional Climate Collaborative, the SNWA and community partners are pursuing competitive grant funding to implement programs, policies and projects that reduce greenhouse gas emissions, mitigate UHI impacts and save water.
  - > In collaboration with Southern Nevada Strong and the Regional Transportation Commission, the SNWA provided downscaled climate data used to develop the recently published Extreme Heat Vulnerability Study. The study highlights the region's vulnerability

to extreme heat and informs future work efforts.
    - The SNWA offers in-kind support to the newly developed Southern Nevada Heat Resilience Lab (SNHRL), led by the Desert Research Institute. The lab brings together public service providers, researchers and experts to explore innovative solutions for extreme heat adaptation and response.
- Cities in Nevada are required to develop a Master Plan to guide future decisions about their physical development. Master plans identify current issues and needs in the community and set forth goals, policies and actions to address issues. The goals for the 2050 Master Plan of Las Vegas include:
    - Land Use: As the city grows, we plan for where people will live, work, and play, while ensuring preservation.
    - Open Space: Parks, recreation and open spaces are essential parts of our city.
    - Transportation & Infrastructure: Moving people and goods is essential, and future infrastructure must be accounted for.
    - Economy & Education: Ensuring our region boasts a competitive economy that is diverse and makes use of new technologies.
    - Services & Facilities: The provision of city services is the foundation for a world-class community.

  Within the Master Plan, several efforts to mitigate the urban heat island effect are taken into account.

Available funding

On January 10th 2025, the Bureau of Reclamation announced investments in various long-term conservation projects. Regarding the Southern Nevada, U.S. Senators Jacky Rosen (D-NV) and Catherine Cortez Masto (D-NV) announced that they helped deliver $60 million for the Southern Nevada Water Authority's (SNWA) landscape rebate program. The investment will fund the conversion of 23 million square feet of non-native, water-intensive grasses to water-efficient desert landscaping.

Available network

Consulate General in San Francisco

Doing business in the U.S.

Federal funding

In the U.S., grants are financial awards provided by federal, state, and local governments, as well as private organizations, to individuals, organizations, or entities to support specific projects, initiatives, or purposes. Accordingly, both states and businesses can receive grants.

Disclaimer: please note that parts of the text may be subject to change given the new administration in the U.S.

Federal grants

Federal grants are the most extensive and standardized federal grants in the U.S., administered by various departments and their federal agencies to achieve national objectives and stimulate the economy. The grant process follows a linear lifecycle that includes creating the funding opportunity, applying, making award decisions, and successfully implementing the Award. Federal grants are listed on Grants.gov, the central online resource for finding and applying for federal funding opportunities.

Example: FEMA (Federal Emergency Management Agency)
FEMA offers grants for pre and post emergency or disaster related projects. These funds support critical recovery initiatives, innovative research and many other programs. FEMA uses grants as their principal funding mechanism to commit and award federal funding to eligible state, local, tribal, territorial, certain private non-profits, individuals and institutions of higher learning.

There a different types of FEMA grants, but one that will be highlighted is the Building Resilient Infrastructure and Communities (BRIC) program. The program aims to support communities as they build capability and capacity. BRIC also encourages and aids innovation. It helps partnerships grow; supports infrastructure projects; and fosters flexibility and consistency. All 50 states, U.S territories, the District of Columbia, and federally recognized Indian tribal governments are eligible to apply for BRIC grants.

Key steps in the application process for a federal funding opportunity

1. Make sure you have registered an account on Grants.gov.
2. Determine your eligibility and identify a funding opportunity using Grants.gov search.
3. Apply to the funding opportunity by creating a workspace.
4. Complete your application.
5. Check your application for errors and submit your completed application.

Are you eligible?

States are often the primary recipients of federal grants, especially for large-scale programs. States may also act as intermediaries, redistributing federal funds to local governments, businesses, or nonprofits. In addition to government organizations, many types of organizations (and individual applicants) are generally eligible to apply for funding opportunities on Grants.gov.

Small businesses may be awarded grants when the meet the size standards established by the U.S. Small Business Administration (SBA) for most industries in the economy. Besides specific numerical standards for small businesses, the following general requirements must be met:

- Be a for-profit business of any legal structure
- Be independently owned and operated
- Not be nationally dominant in its field
- Be physically located and operate in the U.S. or its territories

Businesses outside the U.S. may still be counted as small if they have an operation in the U.S. that makes a significant contribution to the U.S. economy through payment of taxes or use of American products, materials, or labor.

The authorizing legislation and agency policies will determine whether a foreign individual or organization may apply for the grant. Foreign applicants need to complete the same registration process as domestic applicants, but there are additional steps to this registration process. Depending on the intended usage of the grant you are applying for, you may need to file a U.S. tax return which requires a Taxpayer Identification Number (TIN), also referred to as an employer Identification Number (EIN).

State grants

State governments often administer grants funded by state revenues or federal pass-through funds (federal grants managed and distributed by state governments). These grants support state-specific priorities. Each state has its website or portal for grant opportunities, such as the Texas eGrants. States often follow various application requirements, and funding cycles may have different timelines. In addition, states impose their own legal requirements for how funds must be managed, reported, and audited.

Local grants

Local governments (counties, cities, and towns) offer grants through local revenues, state funds, or federal pass-through funds. Local grants are often advertised through city or county websites, local economic development offices, or community foundations.

Did you know that several websites present an overview of climate resiliency funding opportunities? To learn more, visit U.S. Climate Resiliency Toolkit.

Private funding

Private grants differ from federal grants in that they are funded by private entities—such as foundations, corporations, or individuals—rather than governments. These foundations or corporations publish grant opportunities on their websites, in directories, or through industry networks.

Alongside these foundations, several banks support climate resiliency projects by funding initiatives. For instance, Bank of America is involved in funding climate resilience projects through its Resilient Community Impacts Funds, which support cities in the U.S. Moreover, there are green banks involved in climate resilience funding. Generally, government entities, as well as businesses, are eligible for foundation and bank grants.

Two examples of foundations:

- The Rockefeller Foundation
  The Rockefeller Foundation is a philanthropic foundation that promotes humanity's well-being by finding and scaling solutions that advance opportunity and reverse the climate crisis.
- The Kresge Foundation
  The Kresge Foundation is a private, national foundation that works to expand equity and opportunities in America's cities through grantmaking and social investing in the environment, for instance. Concerning the environment, the Kresge Foundation helps cities combat and adapt to climate change while advancing racial and economic justice.

Funding from the Netherlands

RVO

The Rijksdienst voor Ondernemend Nederland (RVO), or the Netherlands Enterprise Agency, is a government organization that supports entrepreneurs, businesses, and organizations in the Netherlands with various services. Its primary goal is to promote sustainable, innovative, and international business practices. For entrepreneurs looking to expand their business to the U.S., the RVO provides specialized support and resources to facilitate the process.

Examples are:

- Market Information and Insights:
  RVO offers detailed information about the U.S. market, including industry trends, business opportunities, and local regulations. This helps entrepreneurs understand their target market and create a compelling entry strategy.
- Subsidies and Financial Support:
  Entrepreneurs may qualify for subsidies or grants to conduct feasibility studies, develop their export strategy, or cover some of the costs of international expansion.
- Trade Missions and Events:
  Entrepreneurs can participate in trade missions, exhibitions, and matchmaking events organized by RVO. These events are designed to help Dutch businesses showcase their products and services to the U.S. market.
- Regulatory and Legal Guidance:
  RVO assists with understanding U.S. laws and regulations, such as permits, intellectual property protection, and tax requirements, helping businesses navigate the legal aspects of operating in the U.S.

Dutch investment organizations

The Netherlands has a strong tradition in water management and climate adaptation, and several Dutch investment organizations and initiatives focus on supporting companies in these sectors, including those aiming to expand to international markets like the U.S. One example:

- Invest International is a Dutch government-backed organization that supports companies and projects contributing to sustainable development and international business growth. It receives funding from the Dutch Ministry of Foreign Affairs, alongside the Dutch Ministry of Finance and other public and private sources. The organization focuses on financing and facilitating projects that align with the United Nations' Sustainable Development Goals (SDGs), particularly in areas like water management, renewable energy, infrastructure, and climate adaptation.

  Invest International provides tailored financial solutions to Dutch businesses and international partners engaged in impactful projects, including loans, equity investments, and guarantees. For businesses in sectors such as water management or climate adaptation, Invest International can help by bridging funding gaps, de-risking investments, and fostering partnerships to facilitate market entry and project implementation abroad.

Procurement

Procurement in the U.S. involves the process by which federal, state, and local governments acquire goods, services, and construction projects from external suppliers. The procurement process varies significantly depending on the level of government.

Federal procurement

At the federal level, procurement is highly standardized and regulated across agencies. SAM.gov, which stands for Systems for Award Management, is the primary portal for federal contract opportunities. SAM.gov serves as a centralized platform, ensuring transparency, accessibility, and competition in the federal procurement process. The most essential step to secure a federal contract in the U.S. is to register your business on SAM.gov. This registration is mandatory for any business bidding on federal contracts.

The federal contracting process consists of the following steps:

1. **Planning:** Agencies identify their needs and set procurement goals.
2. **Solicitation:** Agencies issue requests for proposals (RFPs), requests for quotes (RFQs), or invitations for bids (IFBs).
3. **Bidding:** Vendors submit bids or proposals, which are evaluated based on specific criteria.
4. **Awarding:** Contracts are awarded to the vendor to offer the best value, often after negotiations.
5. **Administration:** The government oversees contract execution to ensure compliance.

Federal contracting for small businesses

The U.S. government is the largest customer in the world. It buys all types of products and services — in both large and small quantities — and it's required by law to consider buying from small businesses.

Basic requirements before small businesses can compete for government contracts

- Register with SAM
  - > To participate in government contracting, you must register your business in the federal government's System for Award Management (SAM). SAM is a database that government agencies search to find contractors. Using SAM, you'll be able to certify that your business is eligible for contracts that are reserved for small businesses.
- Get proper registrations and ID Number
  - > Before you can bid on government proposals, you need to get a Unique Entity Identifier (UEI). You will receive a UEI when you register with System for Award Management (SAM). Entities doing business with the federal government must use the UEI created by the system. You'll also need to match your products and services to a North American Industry Classification System (NAICS) code. NAICS codes classify businesses based on the particular product or service they supply. To find your NAICS code, view the NAICS code list at the U.S. Census Bureau.
- Meet size standards
  - > To be eligible for government contracts reserved for small businesses, your business must meet size requirements set by SBA.
- Maintain compliance
  - > In order to participate in government contracting, you must comply with all laws and regulations. The federal government's purchasing process is governed by the Federal Acquisition Regulation.

How to find contracts?

There are a number of databases you can use to find federal contracts to bid on. Similarly, there are multiple databases that government agencies use to find contractors.

- The Dynamic Small Business Search (DSBS) is a database that government agencies use to find small business contractors for upcoming contracts. Small businesses can also use DSBS to find other small businesses to work with. SBA maintains the DSBS database. The information you provide when you register your business in the System for Award Management (SAM) is used to populate DSBS, so you should create a comprehensive business profile.
- Federal business opportunities for contractors are listed at SAM.gov. Government agencies are required to use SAM to advertise all contracts over $25,000.
- If you want to sell to the government, securing a contract with the U.S. General Services Administration (GSA) — the government agency that connects government buyers with contractors. Securing a contract with the GSA is also called "getting onto the GSA Schedule," which means you've been approved to do business with the government.
- SubNet is a database of subcontracting opportunities posted by large contractors looking for small businesses to serve as subcontractors. SBA maintains a directory of federal government prime contractors with subcontracting plans.
- You can find (almost) all United States government procurements on the Deltek website. This website requires a subscription, but business owners can request a "Free Demo".

You may want to market your business directly to a government agency or prime contractor. You can do that by learning what agencies or prime contractors need, and then showing them how your business can fulfill that need.

- Federal Procurement Data System – Next Generation is the repository of all federal contracting data for contracts over $25,000. With this system, you can see which agencies have contracts and with whom they have contracts, what agencies buy, and which contractors have contracts.
- USASpending.gov tracks government spending through contracts awarded. This searchable database contains information for each federal contract. You can use this information to help identify procurement trends within the government and potential opportunities.
- Many federal agencies have what's called an Office of Small and Disadvantaged Business Utilization (OSDBU) or an Office of Small Business Programs (OSBP). These offices work to identify opportunities to contract with small businesses.

State and local procurement

State and local governments operate independently of the federal system, and their procurement opportunities are published on separate portals. For example, in Florida, the portal MyFloridaMarketPLace (MFMP) is used, whereas, in Philadelphia, the portal eContract Philly is used. In other words, every state and local government has its own portal for managing contracts. It is advisable to look for their specific portal for procurement opportunities.

Agents and distributors

When starting a U.S. business, founders and owners must designate an individual or entity to receive legal correspondence on behalf of the company. Entrepreneurs sometimes overlook this requirement. The role of a registered agent is critical because it ensures that a business remains compliant with state laws and receives essential correspondence quickly, such as service of process, tax returns, and compliance documents. Furthermore, agents are often knowledgeable about the market and the competition and often already have an extensive network of (potential) customers. Their main goal is to acquire customers for the products of the manufacturers. Due to the vastness of the United States, you will often need to work with multiple trading partners with good local contacts. Industry associations can also mediate in the search for a suitable trading partner.

In most states, requirements for registered agents include:

- Having a physical address in the state (no post office boxes).
- Being available during regular business hours.
- Being a state resident or business entity authorized to operate in the state.

Would you like more information, or are you looking for an agent or distributor in the U.S.? Then, contact the trade association for commercial agents, the Manufacturers' Agents National Association (MANA).

Background information

The changing weather cycle

The weather cycle is changing in the United States. Accordingly, the characteristics and timing of extreme precipitation and storm surges are changing.

Extreme precipitation

Climate change causes higher variance in precipitation frequency and intensity. Warming conditions mean more evaporation. When rain-triggering conditions are favorable, more saturated air leads to extreme precipitation. Also, higher emissions (warming conditions) lead to more extreme precipitation across the U.S. compared to lower emissions (cooler conditions). In other words, if no action is taken and temperatures continue to rise, extreme precipitation will increase.

Extreme precipitation refers to instances during which the amount of rain or snow experienced in allocation substantially exceeds what is normal. Between 1895 and 2023, the proportion of land area with significantly higher than average annual precipitation totals grew. Additionally, a more significant percentage of precipitation has come from intense single-day events. The prevalence of extreme single-day precipitation events has risen substantially since the 1980s.

For every 1°F of warming, the air can hold an extra 4% moisture (Clausius-Clapeyron equation). Most of the U.S. is projected to see increases in precipitation extremes with 2°C (3.6°F) of global warming. With 2°C (3.6°F) of warming, 85% of the 3,111 total U.S. counties are likely to experience a 10% or higher increase in precipitation falling on the heaviest 1% of days.

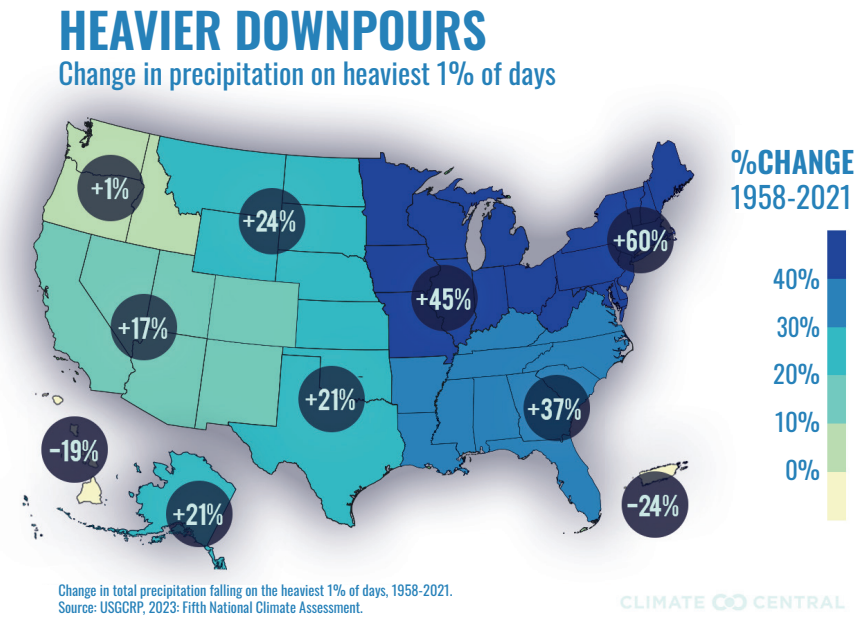


Figure 6: Extreme precipitation change 1958 - 2021 (Climate Central)

With that, the characteristics of precipitation are changing. Whereas the annual rainfall in the central and Eastern U.S. has risen over the last decade, parts of the Southwest are getting drier. The average yearly precipitation in the east and central U.S. from 2002–2021 was 5%–15% higher than the 1901–1960 average. At the same time, the average annual precipitation decreased between 10% and 15% in the Southwest. The most extreme precipitation days have intensified in every significant U.S. region (see Figure 6) , led by the Northeast (+60%) and Midwest (+45%).

The timing of the precipitation also varies: the Northeast and Midwest have seen wetter conditions in all seasons, and the Southeast has received more precipitation in the fall but drier conditions in spring and summer. Across most of the Southwest, precipitation was more than 15% below average during summer, fall, and spring and 10%–15% above average in the winter.

Storm surge

Rising global temperatures are not only making the outside air warmer, oceans are also experiencing record-breaking temperatures. For instance, the heat in the Gulf of Mexico, where many of these storms develop, has been abnormally high and this extra heat acts as a sort of jet fuel for hurricanes, quickly turning them into major storms. Consequently, water from the ocean is pushed toward the shore by the force of the winds swirling around the hurricane. This advancing surge combines with the normal tides and can increase the water level by 30 feet or more.

The maximum potential storm surge for a particular location depends on a number of different factors. For example, a storm surge is sensitive to changes in storm intensity, forward speed, size, angle of approach to the coast, central pressure, the shape and characteristics of coastal features such as bays, and the width and slope of the continental shelf. A Category 4 storm hitting the Louisiana coastline, which has a very wide and shallow continental shelf, may produce a 20-foot storm surge, while the same hurricane in a place like Miami Beach, Florida, where the continental shelf drops off very quickly, might see an 8 or 9-foot surge.

Rising sea levels will cause storm surges from tropical storms to travel further inland than in the past, impacting more coastal properties. In addition, storm surges that occur today are 8 inches higher than they would have been in 1900. By 2100, storm surges will happen on top of an additional 1 to 8 feet of global sea level rise as compared to the year 2000.

Consequences of severe water events

Coastal and riverine floodings, extreme drought, and severe weather events in the U.S. are causing significant environmental, economic, health, and social damage. In this report, we define these consequences as follows:

Environmental consequences are consequences to the conditions in which people, animals, and plants live. This includes infrastructure.

Economic consequences relate to producing, distributing, and consuming goods and services.

Health consequences are about physical and emotional well-being.

Social consequences relate to impacts on society.

Environmental consequences

Floodings bring challenges that are harmful in the short and long term. In the short term, hurricanes can significantly damage or wash away infrastructure (roads, bridges, and power lines) and property. In the long term, high tide flooding (HTF) can cause frequent road closures, reduced stormwater drainage capacity, deterioration of infrastructure not designed to withstand frequent exposure to salt water, and movement of saline water into freshwater aquifers.

Due to rising sea levels, the probability of more destructive coastal flooding increases. These impacts may be exacerbated by coastal subsidence, which means sinking coastal land areas. Sinking land occurs for different reasons: groundwater extraction, oil and gas extraction, seismic activity, and soil compaction, either naturally from the weight of sediments or heavy buildings pressing down on the ground. Hence, communities on the U.S. coast are sinking at different rates.

While regular flooding helps to maintain the nutrient balance of floodplain soils, larger or more frequent floods could disrupt ecosystems by displacing aquatic life, affecting water quality, and increasing soil erosion. In agricultural areas, rising groundwater and saltwater intrusion into irrigation systems reduce crop productivity, leading to infertile farmland due to a lack of salt-tolerant crops. In rivers, salinity can also cause

damage. In drought years, with less fresh water to push it out, salt water can travel many miles upstream, contaminating drinking water supplies and requiring desalination.

Drought and extreme heat also affect the environment. Drought extremes are expected to increase throughout the twenty-first century, ultimately affecting water resources, wildfire activities, and crop loss. Under extreme drought conditions, water resources, including groundwater, surface water, and soil moisture, are severely diminished and can create a water emergency. Drought can exacerbate complicated water allocations in many environments where urban, suburban, and agricultural land is interconnected (such as in the western USA). Next to drought, high temperatures can affect communities by increasing summertime peak energy demand, air pollution, and greenhouse gas emissions.

Hurricane Sandy

Hurricane Sandy formed in the central Caribbean on October 22, 2012, and made landfall near Atlantic City, NJ, on the evening of October 29, 2012. It created widespread coastal flooding and over $88.5 billion in reported economic damage. The storm damaged or destroyed at least 650.000 homes and caused power outages for approximately 8.5 residents from Maryland to Massachusetts.

Infrastructural damages

Several cities and towns along the Atlantic coast of New Jersey and New York were devastated, and the storm surge was made worse by high tides amplified by the full moon that occurred on October 29. Air, rail, and road transportation ground to a halt, with more than 20,000 flights canceled. In New York City, a storm surge measuring nearly 14 feet (about 4.3 meters) combined with heavy rains caused the Hudson River, New York Harbor, and the East River to flood the streets and tunnels of Lower Manhattan. Parts of subway lines were inundated causing 5.4 million normal weekday riders to be stranded. In addition to subway tunnels, flooding closed three vehicular tunnels into and out of Manhattan, interrupting the commutes of 217,000 vehicles. Regarding housing, more than 400 New York City Housing Authority buildings containing approximately 35,000 housing units lost power, heat, or hot water. Along the coastline of New Jersey, the damage was extensive, too. Part of Atlantic City's world-famous Boardwalk was destroyed, and many of the city's homes and businesses not protected by seawalls were also heavily damaged or destroyed by the storm surge.

Hurricane Harvey

On August 25, 2017, Hurricane Harvey (category 4) made its initial impact near Rockport, Texas. Over the following days, the storm stalled over southeast Texas, dumping more than 50 inches of rain. This historic U.S. rainfall caused massive flooding that displaced over 30,000 people and damaged or destroyed over 200,000 homes and businesses. Harvey was the most significant tropical cyclone rainfall event ever recorded in U.S. history, both in scope and peak rainfall amounts and caused $160 billion in damage.

Biodiversity

It was estimated that Harvey delivered 14 × 109 m3 of freshwater (3.7 times the bay's volume) and deposited 9.9 × 107 metric tons of sediment (equivalent to 18 years of average annual sediment load) to Galveston Bay. The bay became virtually fresh for a few days, and salinity recovery inside the bay took about two months on average. To make things worse, many petrochemical facilities were flooded, resulting in chemical pollutant leaks or releases. Furthermore, Harvey was estimated to have caused the release of 0.57 × 106 tons of raw sewage and more than 22,000 barrels of oil, refined fuels, and chemicals to Galveston Bay. Harvey's aftermath lasted for a long time. For example, there was drastic mortality, slow recovery of oysters, and excessive skin problems for dolphins.

Economic consequences

As extreme storms intensify and the impacts are exacerbated by sea level rise, economic consequences increase rapidly (See Figure 7). In the immediate aftermath of a flood or hurricane, individuals and businesses face emergency response, evacuation, and temporary shelter expenses. After this, businesses and homeowners face repair and restoration costs for damaged property.

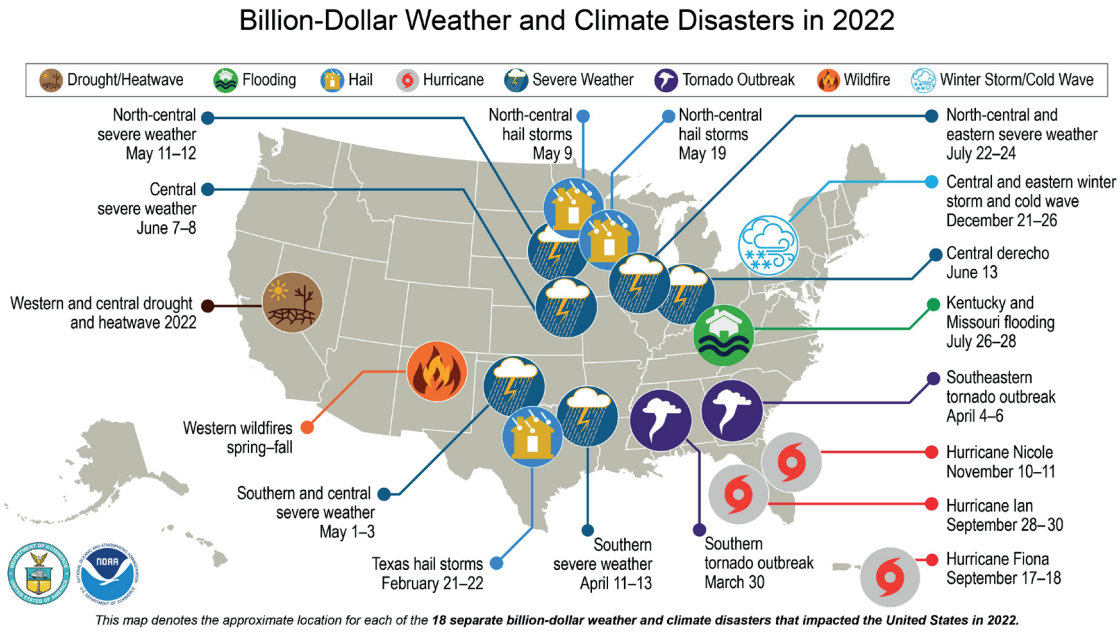


Figure 7: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2024)

In the long term, the financial impacts of flooding are significant for local economies. As the costs of repairing and rebuilding infrastructure can run into billions of dollars, public resources are strained, and other critical projects are delayed. Besides, insurance premiums will increase for flood-prone areas, making it hard for businesses and homeowners to buy insurance and leading to even more costs if they do not have insurance.

Furthermore, flooding can disrupt business operations by damaging facilities, cutting off supply chains, and displacing employees. This disruption can lead to a loss of revenue and increased operational costs as businesses struggle to recover. Even worse, businesses may not restart, and jobs may be lost due to the destruction of infrastructure and reduced consumer confidence. For example, on rivers, commercial navigation might face severe interruption, and on coasts, fisheries have to deal with shifted weather patterns and, in worse cases, damaged harbors.

Tourism and hospitality are affected by climate change, too, especially local businesses and communities that rely heavily on this sector. On one hand, floods damage ecosystems along coasts and rivers that provide tourism. It then becomes impossible to visit these areas as tourists and recreationists. On the other hand, more extreme and frequent floods or heat waves can reduce tourism traffic. Some places become more unattractive to tourists and recreationists because the weather affects the destination too much. Moreover, high temperatures can affect communities by increasing summertime peak energy demand and air conditioning costs.

Hurricane Helene

Hurricane Helene made landfall in the Big Bend area of the Florida Gulf Coast as a Category 4 storm late in the evening of September 26, 2024. Helene's most significant impacts were across the southern Appalachians, where widespread severe and unprecedented flooding occurred, causing hundreds of fatalities and billions in property damage. Strong wind gusts damaged property and blew trees and power lines from the Gulf Coast to the North Carolina mountains.

Economic consequences

In North Carolina, Hurricane Helene brought damage and devastation on an unprecedented scale. The impact on our infrastructure and economy has been staggering. An initial assessment conducted by the Office of State Budget & Management (OSBM) suggests that the overall effect of damage from Helene is likely to exceed $53 billion. In North Carolina, it is estimated that it will take several billion dollars to restore roads, bridges, and other transportation infrastructure, according to initial estimates. At least 140 bridges will require replacement, and as more debris is removed, more significant damage will be found, and this figure will be expected to increase.

Most of the damage from Hurricane Helene was concentrated in the western half of North Carolina. Western North Carolina has scenic parks and cultural attractions that drive tourism and support local hospitality, retail, and restaurant businesses. In this region, thousands of businesses suffered damage from rushing flood waters, landslides, wind, and falling trees. Even businesses spared from direct damage were often cut off from workers and customers due to washed-out roads or being unable to open due to extended outages of electricity, water, sewer, and communications. The preliminary findings by OSBM confirm that the economic devastation caused by Hurricane Helene in modern North Carolina has a total impact of nearly $16 billion. The total includes an estimated $2.8 billion in damages to business and nonprofit property, including structures and vehicles, and more than $13 billion in economic loss from reduced business revenue, resulting in billions of dollars less in income for workers and business owners.

Health consequences

Human health is at risk in multiple ways due to flood events, extreme drought, and urban heat. At worst, people die from flooding, during the event itself and in the days that follow when there is insufficient medical assistance, roads to hospitals are closed, or hospitals are without power. In those cases, people die from drowning or getting hit by falling debris.

Another health risk that comes with flooding is water supply contamination. Due to the rising sea level and more frequent HTF, salt water is brought into coastal communities' ground and water supplies. This effect is called salinization. Floods and heavy rains also pick up chemicals from industrial sites and pesticides from farms and transport them throughout the communities. Hurricanes may even disrupt water supply systems, stopping water access for communities.

Besides water-related human health risks, extreme heat and heat waves are dangerous as well. As temperatures rise, more intense and longer heat waves will occur during the summer months. Urban areas are particularly vulnerable to high temperatures. High temperatures can affect communities by increasing summertime peak energy demand, leading to air pollution and greenhouse gas emissions. Furthermore, people may suffer from heat-related illness and mortality as a result.

Heat-stress in Phoenix

Human-caused climate change is charging heat all over the country, but it's most intense in cities, where more than 260 million Americans live. That's because buildings, roads and sidewalks radiate more heat than grass and trees (urban heat island effect), which can add as much as 20 degrees Fahrenheit (ca. 10 degrees Celsius) to urban temperatures.

Health consequences

The country's 50 most-populated cities have gotten hotter over the past half century, and almost all are experiencing more "extremely hot" days above 95 degrees. One of those cities is Phoenix – the fifth largest city in the U.S. and the hottest metropolis. In 2023, 645 people died of heat or heat-related causes in Maricopa County (the central county of the Phoenix-Mesa-Chandler Metropolitan Area). By mid-August 2024, 114 people had died, and authorities were investigating another 465 deaths.

Social consequences

Not only do coastal and riverine floodings and droughts disrupt supply chains and damage infrastructure, but not everyone can prepare for or respond equally to climate change threats. Socially, severe weather events exacerbate inequality, disproportionally affecting low-income communities, people of color, and rural areas.

Vulnerable populations often lack the resources to recover, leading to long-term displacement, job loss, and worsened housing insecurity. For example, floods in New Orleans after Hurricane Katrina displaced thousands, and droughts in the West have led to job losses in farming, especially for migrant workers. These communities often face greater risks from future disasters, deepening cycles of vulnerability.

Hurricane Katrina

After Hurricane Katrina reached a Category 5 intensity over the central Gulf of Mexico, Katrina weakened to Category 3 before landfall on the northern Gulf coast. Even so, the damage and loss of life inflicted by this massive hurricane in Louisiana and Mississippi were staggering. Katrina is the costliest hurricane – it caused $200 billion in damage.

Social consequences

The affected area of Hurricane Katrina covered three states and approximately 90,000 square miles. In Louisiana alone, approximately 1.7 million people were affected by the storm and needed to be evacuated. This daunting task required evacuating the most densely populated area of the state to unaffected regions both within the state and in other states around the country. Louisiana evacuated approximately 1.5 million people, but 150,000 to 200,000 individuals remained during the storm. While many people chose to stay, others did not have an opportunity to evacuate because of unavailable resources.

Besides, approximately 40% of the evacuated residents in Louisiana, Mississippi, and Alabama did not return. Thousands were left homeless, and the population of New Orleans was reduced by half. In the 10 months following the hurricane, an estimated 95,000 New Orleans residents lost their jobs, and hundreds of thousands of homes were flooded The displacement led to large percentages of children and adults experiencing mental health issues as a direct result, including PTSD, depression, and anxiety. These numbers are higher among more vulnerable populations.

Appendices

Relevant federal laws and initiatives

Disclaimer: please note that parts of the text may be subject to change given the new administration in the U.S.

Bipartisan Infrastructure Law (BIL)

The Bipartisan Infrastructure Law (BIL), formally known as the Infrastructure Investment and Jobs Act, was enacted in November 2021 to modernize America's aging infrastructure and address critical challenges like climate resilience, equity, and economic recovery. With a historic budget of approximately $1.2 trillion, including $550 billion in new funding over five years, the BIL aims to rebuild roads, bridges, and transit systems, expand broadband access, upgrade water and energy systems, and tackle climate change impacts. The law was established to stimulate job creation, enhance competitiveness, and address systemic issues like water contamination and inadequate public transportation, ensuring long-term economic growth and environmental sustainability. The BIL's implementation spans multiple federal agencies, distributing funding to states and local governments.

Inflation Reduction Act

The Inflation Reduction Act (IRA), passed in 2022, is a landmark piece of U.S. legislation designed to combat climate change and accelerate the transition to a clean energy economy. With nearly $370 billion in funding, it represents the most significant federal investment in climate resilience and adaptation to date. The IRA allocates resources for water management and climate adaptation to address drought resilience, restore ecosystems, and implement nature-based infrastructure solutions like wetlands and floodplain restoration. It also provides tax credits and grants to support sustainable water use and protect critical resources from the impacts of extreme weather. The IRA's focus on reducing greenhouse gas emissions while enhancing resilience makes it a transformative tool for addressing the growing challenges of climate change.

Water Resources Development Act

The Water Resources Development Act (WRDA) is a key piece of U.S. legislation, reauthorized every two years, that governs water infrastructure projects carried out by the U.S. Army Corps of Engineers (USACE). It focuses on critical areas such as flood control, navigation improvements, ecosystem restoration, and coastal resilience. The WRDA provides funding and policy direction to modernize aging water infrastructure, address environmental challenges, and enhance climate adaptation efforts. Recent versions, including WRDA 2022, emphasize equity by prioritizing investments in underserved communities and advancing projects that mitigate climate risks like flooding and sea-level rise. By supporting various water-related initiatives, the WRDA plays a vital role in protecting communities, promoting economic growth, and fostering sustainable water management across the United States.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA), enacted in 1972, promotes sustainable use and conservation of coastal resources in the United States. It provides funding and guidance to states and coastal communities to address challenges like erosion, habitat loss, and rising sea levels. Through its grant programs, including those for climate adaptation and coastal resilience, the CZMA supports initiatives like stormwater management, wetland restoration, and the protection of natural shorelines. By fostering partnerships between federal, state, and local governments, the CZMA plays a critical role in helping communities adapt to the impacts of climate change while preserving vital coastal ecosystems.

Events

Water for Texas

January 2025 (next edition 2027) | Texas

The actions we take and decisions we make today to ensure a secure water future will have ripple effects for generations of future Texans. The Water for Texas 2025 conference will bring together industry experts, innovators, influencers, and leaders to discuss water issues impacting us now and in years to come. Join us for engaging panels, inspiring speakers, and crucial conversations that will help define and achieve a lasting water legacy for the Lone Star State.

More information >

Stormwater USA Summit

February 2025 (next edition: TBD) | California

During the Stormwater USA 2025 summit, stormwater experts and environmental professionals will meet to explore cutting-edge solutions and best practices in stormwater management. The escalating impacts of climate change, urban expansion, and aging infrastructure intensify stormwater challenges. The summit will showcase integrated models, green infrastructure, innovative AI, and big data to improve real-time monitoring, flood resilience, and pollution control. During the summit, there is a possibility to exchange insights, engage with pioneering technologies, and shape the future of stormwater management.

More information >

2025 Regional Resiliency Summit

May 2025 | Florida

The 5th Regional Resiliency Summit will be hosted by the Tampa Bay Regional Planning Council and its Regional Resiliency Coalition. This important event will take place on May 15 & 16, 2025 at the Palmetto Marriott Resort. And once again, the 31st Annual Future of the Region Awards will be the highlight of the Resiliency Summit luncheon on May 16, 2025.

Join us as we bring together leaders, experts, and community members to explore strategies for building resilience in our region. This conference will feature engaging keynote speakers, informative panel discussions, insightful sessions focused on addressing the challenges we face and identifying innovative solutions for a resilient future, and multiple networking opportunities with fellow attendees.

More information >

2025 ASFPM Annual Conference

May 2025 | Louisiana

The Association of State Floodplain Managers (ASFPM) will host the world's largest and most comprehensive floodplain management conference from May 18 to 8-22, 20,25, in New Orleans, Louisiana. This historic city isn't just a place for vibrant culture and delicious food – it's also a powerful symbol of resilience in the face of flood risk. Twenty years after Hurricane Katrina, we'll gather in New Orleans to reflect on the lessons learned, celebrate the city's remarkable comeback, and reimagine the future of flood risk management. The conference theme is "Extraordinary Lessons Below Sea Level: 20 Years of Innovation." It will feature insightful plenary speakers, informative workshops, and engaging discussions on the latest advancements in flood mapping, mitigation, modeling, nature-based solutions, and more.

More information >

Pennsylvania Stormwater Summit

September 2025 - TBD | Pennsylvania

Pennsylvania communities are experiencing the perfect storm - more intense rainfall events, yet increasingly limited resources to effectively manage stormwater. This conference is organized by the Pennsylvania Water Environment Association, and the 2024 Stormwater Summit is crafted to deepen the technical knowledge of professionals from around Pennsylvania involved with meeting regional challenges while managing stormwater as a utility and providing an in-person forum where related issues can be discussed. The Summit will include oral presentations, interactive discussions, exhibitors, and opportunities for networking in dynamic settings.

More information >

WATERS Summit

October 2025 | North Carolina

Message from the 2024 event: On Tuesday, October 1, 2024, Rep. Greg Murphy, M.D. will be hosting the fourth annual Water Adaptations to Ensure Regional Success (WATERS) Summit. Following three successful events, he looks forward to discussing innovative and effective strategies to mitigate flooding and address waterway challenges in the region. This bipartisan effort is designed to foster legislative solutions and develop strategies to tackle these issues for years to come.

Flooding Adaptation Symposium

October 2025 - TBD | Florida

Florida stands at the forefront of an unparalleled challenge. Over the next generation, Florida will experience inundation from coastal and inland flooding. It is not a question of if but when the next flood will occur. As flooding presents greater risk, how is Florida adapting its built environment to not only survive, but to thrive in these new conditions?

To address this question, the symposium convened 126 practitioners, researchers, advocates, and community stakeholders from throughout Florida and beyond, to discuss and address the pressing issue of flooding in Florida's coastal and inland areas.

More information >

Arizona Heat Summit

October 2025 - TBD | Arizona

The Arizona Heat Summit will bring together experts and stakeholders to discuss the 2025 heat season. Join us to continue the discussion of protecting communities from extreme heat. Conversations will focus on enhancing the state's resilience and ensuring the well-being of all Arizona residents.

More information >

North Carolina Coastal Conference

November 2026 | North Carolina

North Carolina Sea Grant's biennial conference serves as a platform for engaging with like-minded participants and potential collaborators dedicated to the prosperity of our state's coastal communities, environments, and economies. Join us for stimulating presentations and discussions featuring researchers, agency and business experts, community leaders, educators, students, and all individuals passionate about coastal topics.

More information >

National Adaptation Forum

2026 TBD | location TBD

The National Adaptation Forum is a biennial convening for adaptation professionals to innovate, network, and focus on established and emerging climate adaptation issues of the day. The Forum provides opportunities for professional development through training sessions, facilitated presentations and panels, and formal and informal networking sessions.
The Forum is cross-disciplinary, bringing together practitioners from various sectors, spanning natural, built, and social systems. Participants include representatives from federal, state, and tribal governments, nonprofit organizations, businesses, scientists, and frontline community groups. The Forum program covers over 35 adaptation-related topics and 12 geographic regions across the U.S. and beyond. We aim to bring together practitioners with various experiences and expertise, so as a field, we spend more time innovating rather than reinventing.

More information >

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Acknowledgement

This report was created through several conversations with partners to get the best possible picture of the situation and opportunities. These partners include: American Flood Coalition, Netherlands Water Partnership, Water Alliance Netherlands, United States Army Corps of Engineers (USACE), Arcadis, Invest International, the Dutch network in the U.S. consisting of consulates-general, Netherlands Business Support Offices and the Netherlands Innovation Network, and the Ministry of Infrastructure and Water Management. Through these conversations we determined the report's focus on coastal, riverine, and urban resilience.

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- Image Brazo River, Bryan Texas: Billy Hathorn
- Pixabay
- Pexels

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