

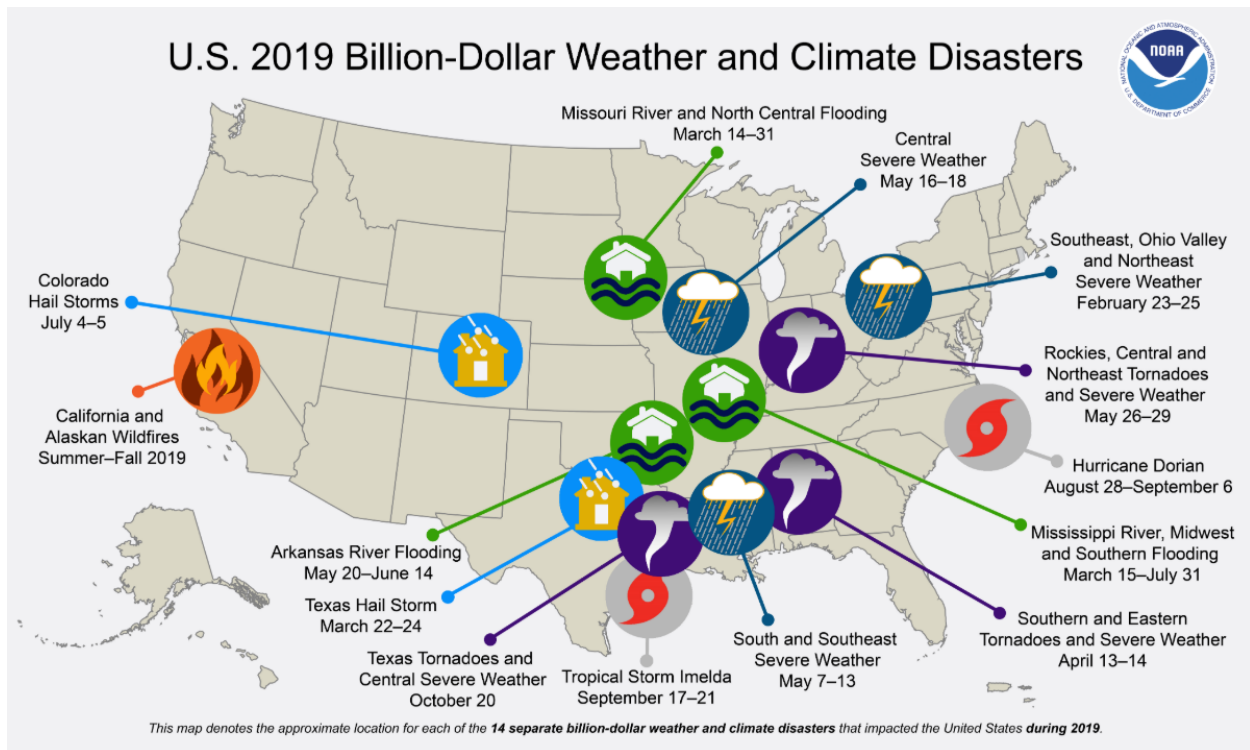
2010-2019: A landmark decade of U.S. billion-dollar weather and climate disasters

By: Adam B. Smith

NOAA's National Centers for Environmental Information

NOAA's National Centers for Environmental Information (NCEI) tracks U.S. weather and climate events that have great economic and societal impacts (www.ncdc.noaa.gov/billions). Since 1980, the U.S. has sustained **258 weather and climate disasters** where the overall damage costs reached or exceeded \$1 billion (including adjustments based on the Consumer Price Index, as of January 2020). The cumulative cost for these 258 events exceeds **\$1.75 trillion**.

During 2019, the U.S. experienced a very active year of weather and climate disasters. In total, the U.S. was impacted by 14 separate billion-dollar disasters including: 3 major inland floods, 8 severe storms, 2 tropical cyclones (Dorian and Imelda), and 1 wildfire event. 2019 also marks the fifth consecutive year (2015-19) in which 10 or more separate billion-dollar disaster events have impacted the U.S.



This map depicts the general location of the fourteen weather and climate disasters assessed to cause at least one billion dollars in direct damages during 2019.

Over the last several years costly disasters have been particularly destructive. The historic 2019 U.S. inland flooding across many Central states follows the historic 2018 and 2017 Atlantic hurricane and Western wildfire seasons, which set new damage cost records. These disasters have impacted dozens of Eastern, Central, and Western states, in addition to Caribbean territories (i.e., Puerto Rico and the U.S. Virgin Islands).

The number and cost of disasters are increasing over time due to a combination of increased [exposure](#) (i.e., values at risk of possible loss), [vulnerability](#) (i.e., how much damage does the intensity (wind speed, flood depth) at a location cause) and that climate change is increasing the frequency of some types of extremes that lead to billion-dollar disasters ([NCA 2018, Chapter 2](#)).

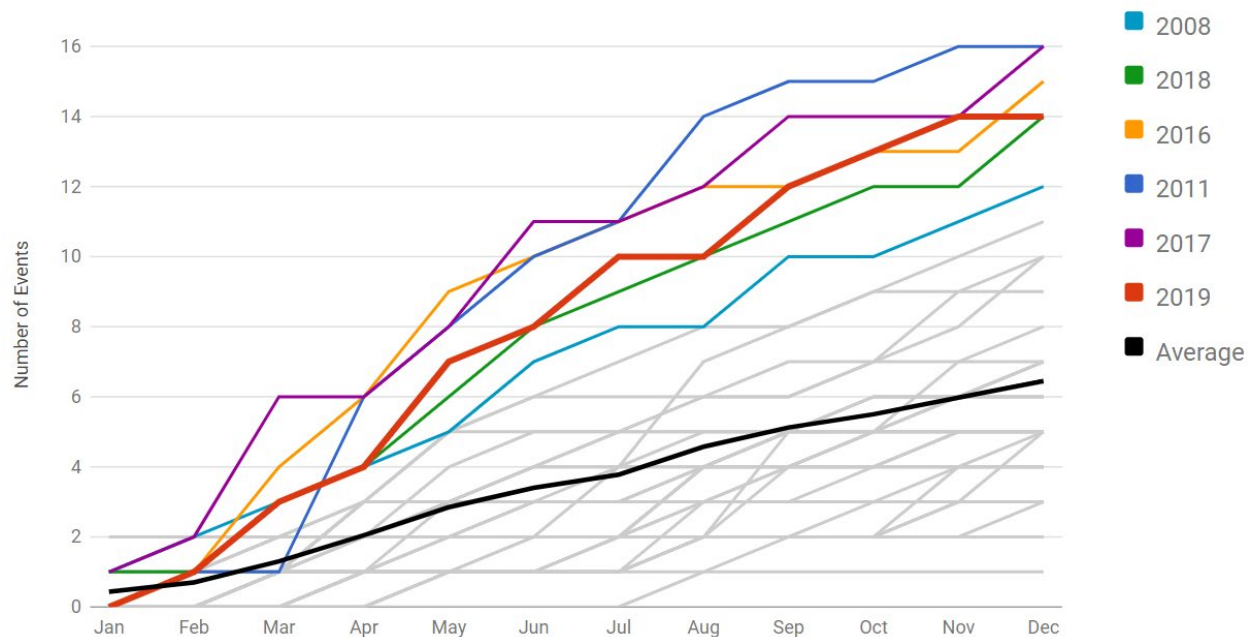
Number of events

The 14 separate U.S. billion-dollar disasters in 2019 represent the fourth highest total number of events (tied with 2018), following the years 2017 (16), 2011 (16) and 2016 (15). The most recent years of 2019, 2018 and 2017 have each produced more than a dozen billion-dollar disasters to impact the United States—totaling 44 events. This makes a 3-year average of **14.6 billion-dollar disaster events**, well above the inflation-adjusted average of **6.5 events per year (1980-2019)**.

On a slightly longer timeframe, the U.S. has experienced 69 separate **billion-dollar disaster** events over the last 5 years (2015-2019), an inflation-adjusted average of 13.8 events per year. Over the last 40 years (1980-2019), the years with 10 or more separate billion-dollar disaster events include 1998, 2008, 2011-2012, and **2015-2019**.

1980-2019 Year-to-Date United States Billion-Dollar Disaster Event Frequency (CPI-Adjusted)

Event statistics are added according to the date on which they ended.



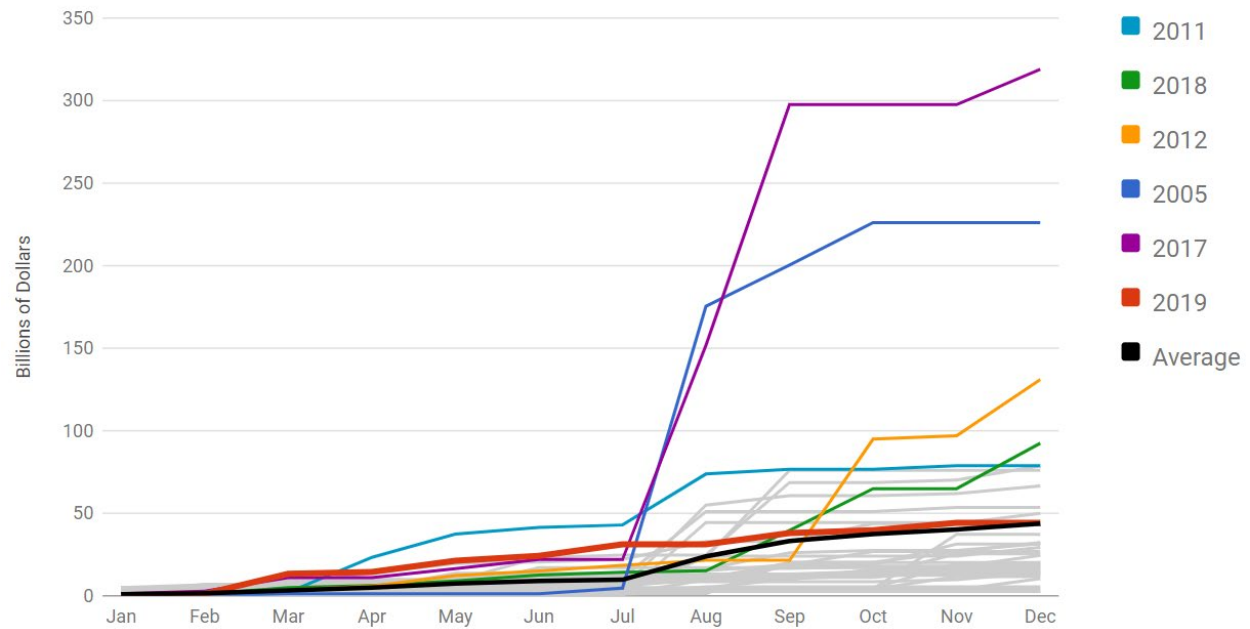
This graphic above shows the month-by-month accumulation of billion dollar disasters for each year on record. The value for a given year for a given month shows the total number of billion-dollar events that had occurred by that month. Note that there is considerable overlap, and some years' traces are obscured.

Cost comparisons

The year 2019 experienced a slightly above average year of costs (\$45.0 billion), as noted below in the data plot by the black line. In 2019, the U.S. experienced historically persistent and destructive flooding across the Missouri, Arkansas, and Mississippi River basins. The combined cost of the Missouri, Arkansas, and Mississippi River flooding (**\$20.0 billion**) was nearly half the total cost for all 14 of the billion-dollar disasters. The costliest U.S. disaster years on record are 2017 (\$318.9 billion), 2005 (\$226.1 billion), and 2012 (\$130.9 billion) when all years are inflation-adjusted to January 2020 dollars. The 40-year annual cost average for billion-dollar disasters is **\$43.9 billion** (CPI-adjusted), as noted by the black line in the following chart.

1980-2019 Year-to-Date United States Billion-Dollar Disaster Event Cost (CPI-Adjusted)

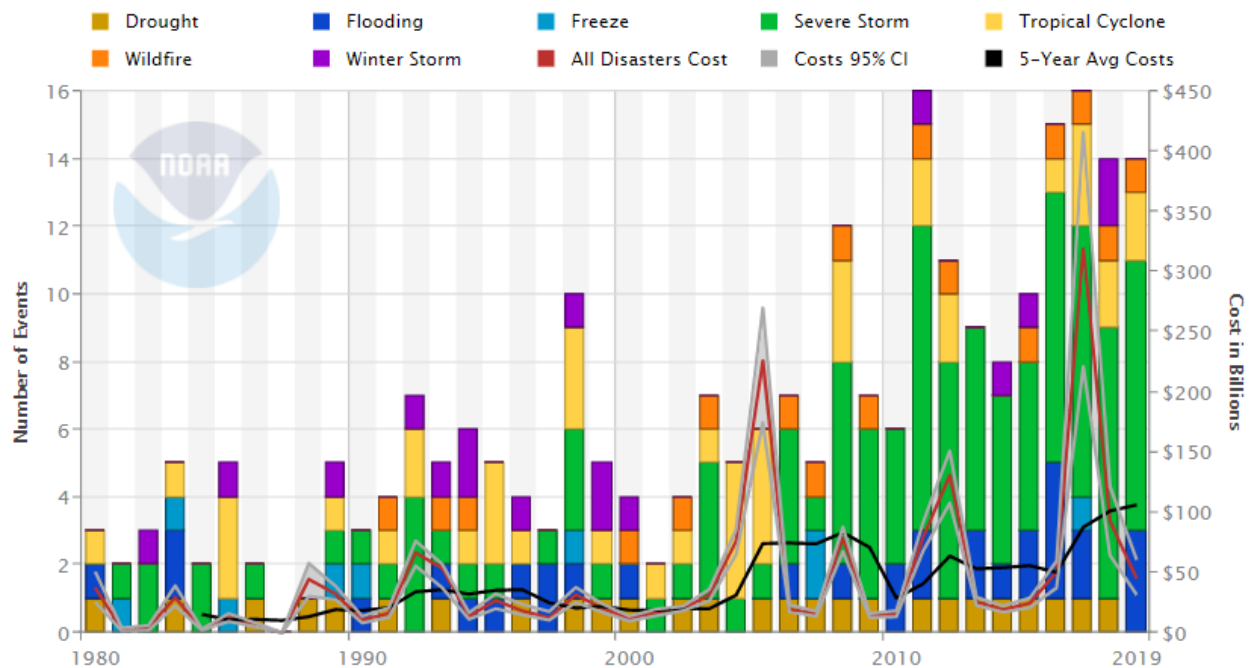
Event statistics are added according to the date on which they ended.



This graphic depicts the accumulation in the estimated cost of billion dollar weather and climate disasters on a monthly basis, for each year since 1980.

In broader context, the total cost of U.S. billion-dollar disasters over the last 5 years (2015-2019) exceeds **\$525 billion**, with a 5-year annual cost average of **\$106.3 billion** (CPI-adjusted), both of which are records. The U.S. billion-dollar disaster damage costs over the last decade (2010-2019) were also **historically large, exceeding \$800 billion** from **119** separate **billion-dollar** events. Moreover, the losses over the most recent **15 years** (2005-2019) are **\$1.16 trillion** in damage from **156** separate **billion-dollar** disaster events.

United States Billion-Dollar Disaster Events 1980–2019 (CPI-Adjusted)



- **2019** had the **4th highest number** of billion-dollar events (**tied with 2018**); average annual **costs (\$45.0 billion)**
- 1980–2019: 40-yr annual cost average \$43.9 billion (inflation-adjusted) → 6.5 events / year
- 2010–2019: 10-yr annual cost average \$80.2 billion (inflation-adjusted) → 11.9 events / year
- **2015–2019**: 5-yr annual cost average **\$106.3 billion** (inflation-adjusted) → **13.8 events / year**
- **2017–2019**: 3-yr annual cost average **\$152.2 billion** (inflation-adjusted) → **14.6 events / year**

(bars) The number (left vertical axis), type (colors), and annual cost (right vertical axis) of U.S. billion-dollar disasters from 1980-2019. (lines) Running annual cost (red line), along with the 95% confidence interval (grey line), and 5-year average costs (black line). The bars are much taller in recent years, indicating that the number and costs of disasters are increasing. Inland flooding (blue bars) and severe storms (green bars) are making an increasingly large contribution to the number of U.S. billion-dollar disasters.

For the first time, the U.S. billion-dollar disaster website offers interactive, [state-level disaster frequency and cost charts](#) for the last 40-years, 1980-2019. This includes all 50 states, Puerto Rico and the U.S. Virgin Islands. These new, high resolution charts can also be downloaded.

2010-2019: an unprecedented decade of billion-dollar disasters

After adjusting for inflation, the U.S. experienced more than twice the number of billion-dollar disasters during the 2010s than the 2000s decade: 119 versus 59. Indeed, increased urbanization and material exposure to extreme event impacts is a large driver of the increasing losses, even after taking into account the rising cost of inflation, which we address.

	Number of billion-dollar disasters (average per year)	Associated Costs (average per year)	Associated Fatalities (average per year)
1980s (1980-89)	28 (2.8)	\$127.7B (\$12.8B)	2,808 (281)
1990s (1990-99)	52 (5.2)	\$269.6B (\$27.0B)	2,173 (217)
2000s (2000-09)	59 (5.9)	\$510.3B (\$51.0B)	3,051 (305)
2010s (2010-19)	119 (11.9)	\$802.0B (\$80.2B)	5,217 (522)
Last 5 years (2015-19)	69 (13.8)	\$531.7B (\$106.3B)	3,862 (772)
Last 3 years (2017-19)	44 (14.7)	\$456.7B (\$152.2B)	3,569 (1,190)
Overall (1980-2019)	258 (6.5)	\$1.754.6B (\$43.9B)	13,249 (331)

Four of the five most costly U.S. billion-dollar disasters occurred in the 2010s (i.e., Hurricanes Harvey, Irma, Maria, and Sandy). In addition, the two most destructive and costly wildfire seasons in U.S. history have taken place over the last three years, with losses exceeding \$40 billion, with much of this damage in California.

Worrisome trends

Keep in mind that these estimates do not reflect the total cost of U.S. weather and climate disasters, only those associated with events in excess of \$1 billion in damages. However, these extreme events do account for the majority (>80%) of the damage from all recorded U.S. weather and climate events (NCEI; Munich Re). These billion-dollar disaster events are becoming an increasingly larger percentage of the cumulative damage from the full distribution of weather-related events at all scales and loss levels. Clearly, the historically large U.S. losses from hurricanes and wildfires over the last few years have further skewed the total distribution of extreme weather costs. This increase reflects a combination of increased exposure, vulnerability and the fact the climate change is playing an increasing role in the frequency of some types of extremes that lead to billion-dollar disasters.

- **1980-2000** ... (~75% of full distribution of all disaster-related costs)
- **1980-2010** ... (~80% of full distribution)
- **1980-2019** ... (~85% of full distribution):
 - **\$1.75 trillion of \$2.05 trillion** in US weather and climate events costs since 1980

Historic U.S. billion-dollar disasters of 2019

Among the many weather and climate-related disasters to affect the U.S. in 2019, the following caused the most damaging impacts and broke numerous records.

Missouri River and North Central Flooding (March 2019): \$10.8 billion, 3 deaths

Historic Midwest flooding inundated millions of acres of agriculture, numerous cities and towns, and caused widespread damage to roads, bridges, levees, and dams. The states most affected were Nebraska, Iowa, Missouri, South Dakota, Minnesota, North Dakota, Wisconsin

and Michigan. This flood was triggered by a powerful storm with heavy precipitation that intensified snow melt and flooding. Of note, the Offutt Air Force Base in Nebraska was also severely flooded—the third U.S. military base to be damaged by a billion-dollar disaster event over a 6-month period (Sept 2018-Feb 2019). This historic flooding was one of the costliest U.S. inland flooding events on record.

Mississippi River and Midwest Flooding (March-July 2019): \$6.2 billion, 4 deaths

Additional major flooding impacted many Southern Plains states through the spring and summer, significantly affecting agriculture, roads, bridges, levees, dams, and other assets across many cities and towns. The states most affected were Oklahoma, Nebraska, Missouri, Illinois, Kansas, Arkansas, Kentucky, Tennessee, Texas, Mississippi, and Louisiana. Very high water levels also disrupted barge traffic along the Mississippi River, which negatively impacted a variety of dependent industries. Indiana and Ohio were also affected by persistent heavy rainfall that flooded farmland, which prevented and reduced crop planting by millions of acres.

Hurricane Dorian (September 2019): \$1.6 billion, 10 deaths

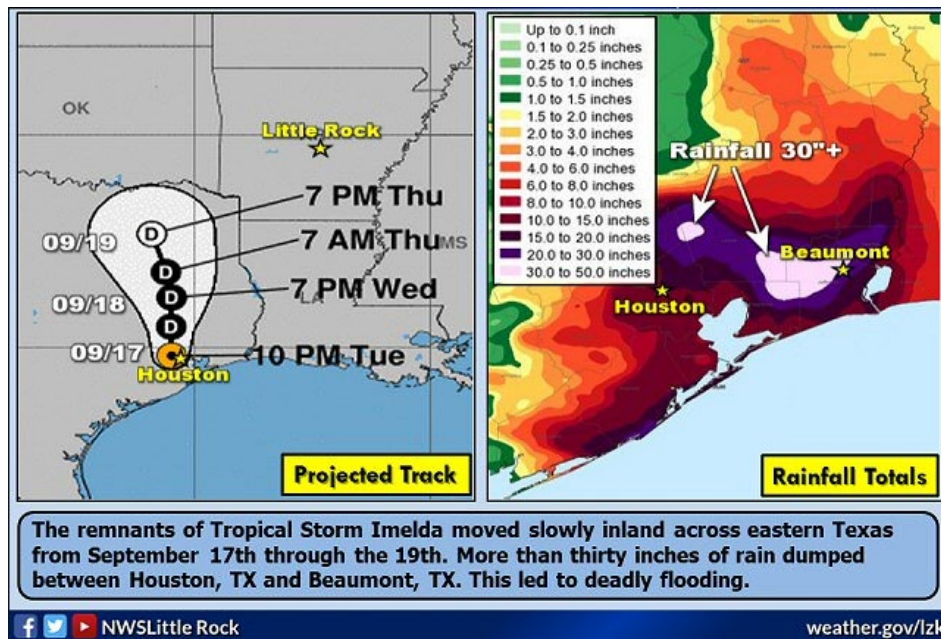
Category 1 Hurricane Dorian made landfall on the Outer Banks of North Carolina after devastating the northern Bahama Islands as a historically powerful and slow-moving hurricane. Dorian tracked offshore parallel to the Florida, Georgia, and South Carolina coastline before making a North Carolina landfall, bringing a destructive sound-side storm surge that inundated many coastal properties and isolated residents who did not evacuate. Significant flood, severe storm, and tornado damage to many homes and businesses occurred on the Outer Banks of North Carolina.

Dorian's intensification to a Category 5 storm marks the fourth consecutive year in which a Category 5 storm developed in the Atlantic basin—a new record. Dorian also tied the record for maximum sustained wind speed for a landfalling hurricane (185 mph) in the Atlantic, a record shared with the historic 1935 Labor Day Hurricane.



Tropical Storm Imelda (September 2019): \$5.0 billion, 5 deaths

Tropical Storm Imelda and its remnants caused 24–36 inches of rain over a 3-day period across a large area between Houston and Beaumont, Texas. The largest storm total, 43.39 inches, was reported at North Fork Taylors Bayou, Texas. Many thousands of homes, cars, and businesses were impacted by flood water due to this extraordinarily heavy rainfall. Imelda is yet another of the historically extreme rainfall and flood events that have become a regular occurrence across Southeast Texas over the last 5 years.



Source: NOAA NWS

California and Alaska Wildfires (Summer-Fall 2019): \$4.5 billion, 3 deaths

California experienced a damaging wildfire season in 2019, largely resulting from the Kincadee and Saddle Ridge wildfires. In addition, a key California electrical utility provider turned off power to millions of homes and businesses several times during days with forecasted high winds and extremely dry conditions. This step was designed to minimize wildfires, with some success, but it also caused billions of dollars in losses to those affected. Alaska also suffered a near-historic wildfire season with more than 2.5 million acres burned. These wildfire conditions were primed due to Alaska's record-breaking heat and dry conditions during the summer months. **July 2019 was the warmest month ever recorded in Alaska.**



Source: US Forest Service

Distribution of costs and fatalities by disaster type

The distribution of damage from U.S. billion-dollar disaster events from 1980–2019 is dominated by tropical cyclone losses. Tropical cyclones have caused the most damage (\$945.9 billion) and also have the highest average event cost (\$21.5 billion per event). Hurricanes are responsible for slightly more than half (53.9%) of the total losses for all U.S. billion-dollar disasters but represent less than one-fifth (17.1%) of all the billion-dollar events we have assessed since 1980.

Drought (\$249.7 billion), severe storms (\$247.8 billion) and inland flooding (\$146.5 billion,) have also caused considerable damage. Severe storms have caused the highest number of billion-dollar disaster events (113), while the average event cost is the lowest (\$2.2 billion). Tropical cyclones and flooding represent the second and third most frequent event types (44 and 32), respectively. Tropical cyclones are responsible for the highest number of deaths (6,502), followed by drought/heatwave events (2,993), and severe storms (1,642).


Billion-dollar events to affect the U.S. from 1980 to 2019 (CPI-Adjusted)

DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	CPI-ADJUSTED LOSSES (BILLIONS OF DOLLARS)	PERCENT OF TOTAL LOSSES	AVERAGE EVENT COST (BILLIONS OF DOLLARS)	DEATHS
Drought	26	10.1%	\$249.7 ^{ci}	14.2%	\$9.6	2,993 [†]
Flooding	32	12.4%	\$146.5 [§] ^{ci}	8.3% [§]	\$4.6 [§]	555
Freeze	9	3.5%	\$30.5 ^{ci}	1.7%	\$3.4	162
Severe Storm	113	43.8%	\$247.8 ^{ci}	14.1%	\$2.2	1,642
Tropical Cyclone	44	17.1%	\$945.9 ^{ci}	53.9%	\$21.5	6,502
Wildfire	17	6.6%	\$84.9 ^{ci}	4.8%	\$5.0	347
Winter Storm	17	6.6%	\$49.3 ^{ci}	2.8%	\$2.9	1,048
All Disasters	258	100.0%	\$1,754.6 ^{ci}	100.0%	\$6.8	13,249

[†]Deaths associated with drought are the result of heat waves. (Not all droughts are accompanied by extreme heat waves.)

[§]Flooding statistics do not include inland flood damage caused by tropical cyclone events.

The confidence interval (CI) probabilities (75%, 90% and 95%) represent the uncertainty associated with the disaster cost estimates.

Monte Carlo simulations were used to produce upper and lower bounds at these confidence levels (Smith and Matthews, 2015 .

This table depicts the breakdown, by hazard type, of the 258 billion-dollar weather and climate disasters assessed since 1980.

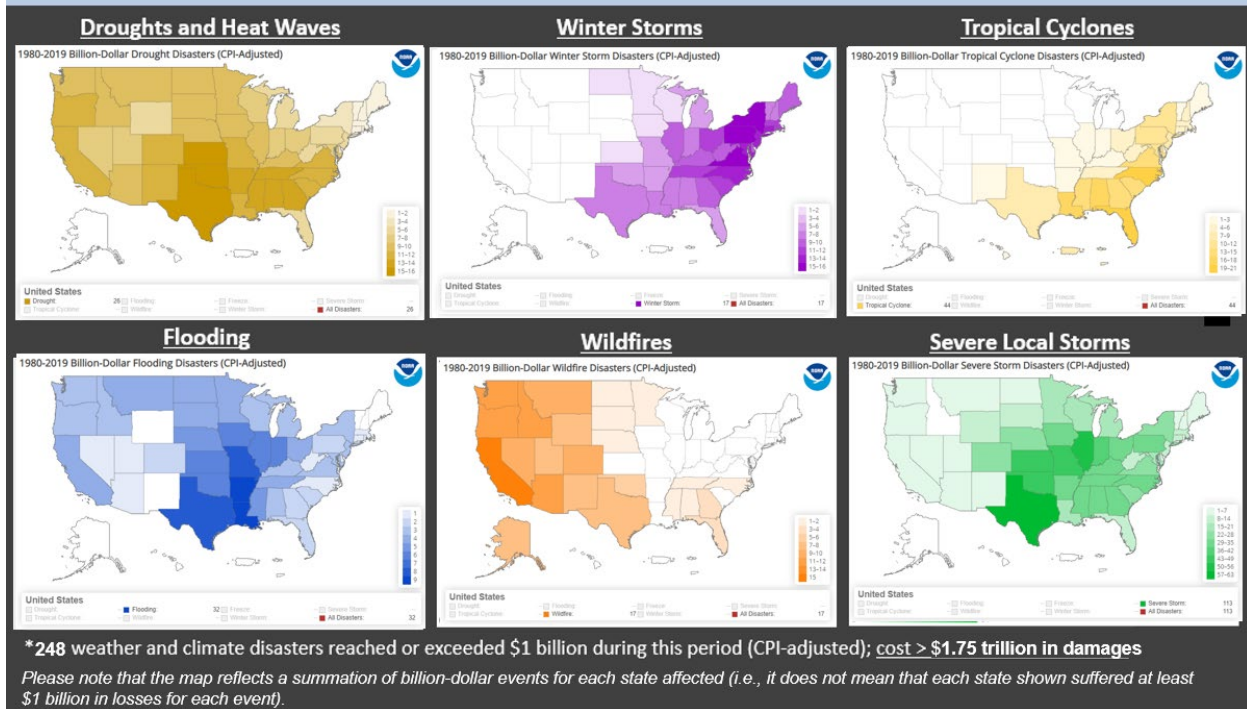
The increase in population and material wealth over the last several decades, are an important cause for the rising costs. These trends are further complicated by the fact that much of the growth has taken place in vulnerable areas like coasts and river floodplains. Vulnerability is especially high where building codes are insufficient for reducing damage from extreme events.

Climate change is also playing a role in the increasing frequency of some types of extreme weather that lead to billion-dollar disasters—most notably the rise in vulnerability to drought, lengthening wildfire seasons in the Western states, and the potential for extremely heavy rainfall becoming more common in the eastern states. Each of these changes in extremes are becoming more visible in relation to the influence of climate change ([NCA 2018, Chapter 2](#)).

The geography of billion-dollar disaster events by type:

The U.S. is weather and climate conscious for good reason, as each geographic region faces a unique combination of recurring hazards. In fact, billion-dollar disaster events have touched every U.S. state. The maps below reflect the frequency with which each state has been part of a billion-dollar disaster event (i.e., the totals do not mean that each state *alone* suffered \$1 billion in losses for each event).

Billion-dollar weather and climate disasters frequency mapping: 1980-2019



Maps depict the number of times each state has been affected by each of six types of billion-dollar weather and climate disasters. Note that each state did not necessarily experience a full billion-dollar cost for an event to be counted; it only needed to be part of a regional event that caused one billion dollars or more in direct damages.

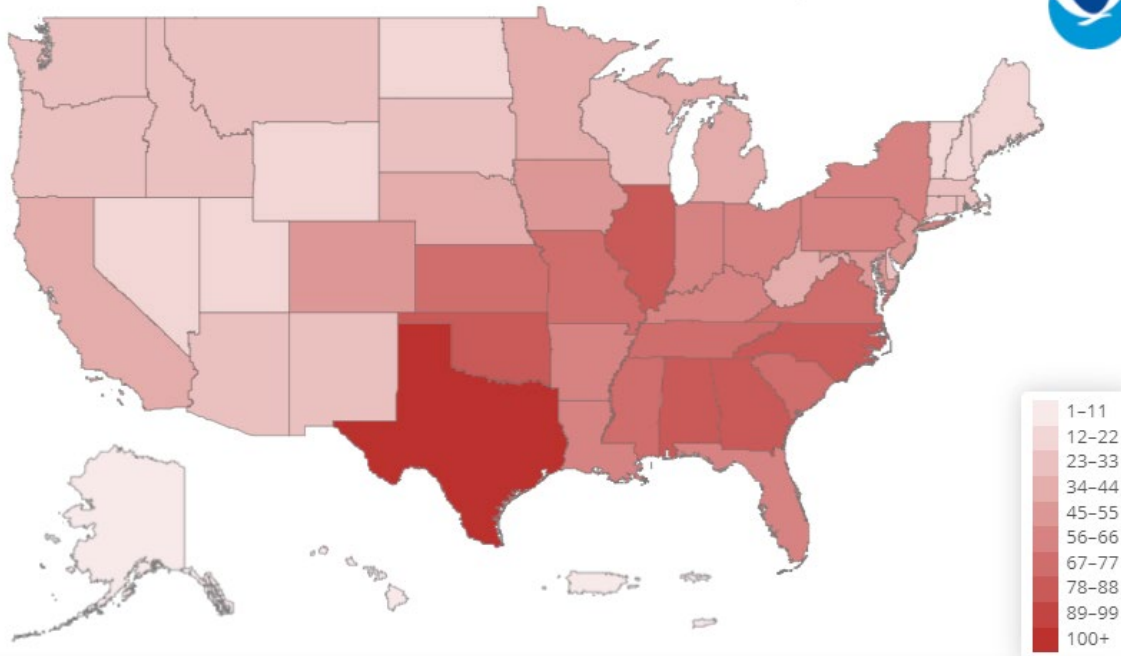
Each disaster type has a distinct footprint of impact over time. We see wildfire impacts largely west of the Plains states, with a few Southeast impacts. However, the most intense and destructive wildfires occur in California—most notably after the year 2000.

There is also a high frequency of inland flooding events that occur in states adjacent to large rivers or the Gulf of Mexico, which is a warm source of moisture to fuel rainstorms. Drought impacts are mostly focused in the Southern and Plains states where there are billions of dollars in agriculture and livestock assets.

Crop freeze events have become more sporadic since the early 1990s, but these events can still cause considerable damage in the fruit-producing states of California, Florida, and other southeastern states such as Georgia and South Carolina.

Severe local storm events are common in the Plains and into the Ohio River Valley states. Winter storm impacts are concentrated in the Northeast given the population density and more assets exposed to powerful Nor'easters bringing wind, snow, icing and storm surge. Tropical cyclones are the most costly disaster we assess that create impacts from Texas to New England, but also include many inland states, often as a result of extreme rainfall and inland flood damage.

1980-2019 Billion-Dollar Weather and Climate Disasters (CPI-Adjusted)



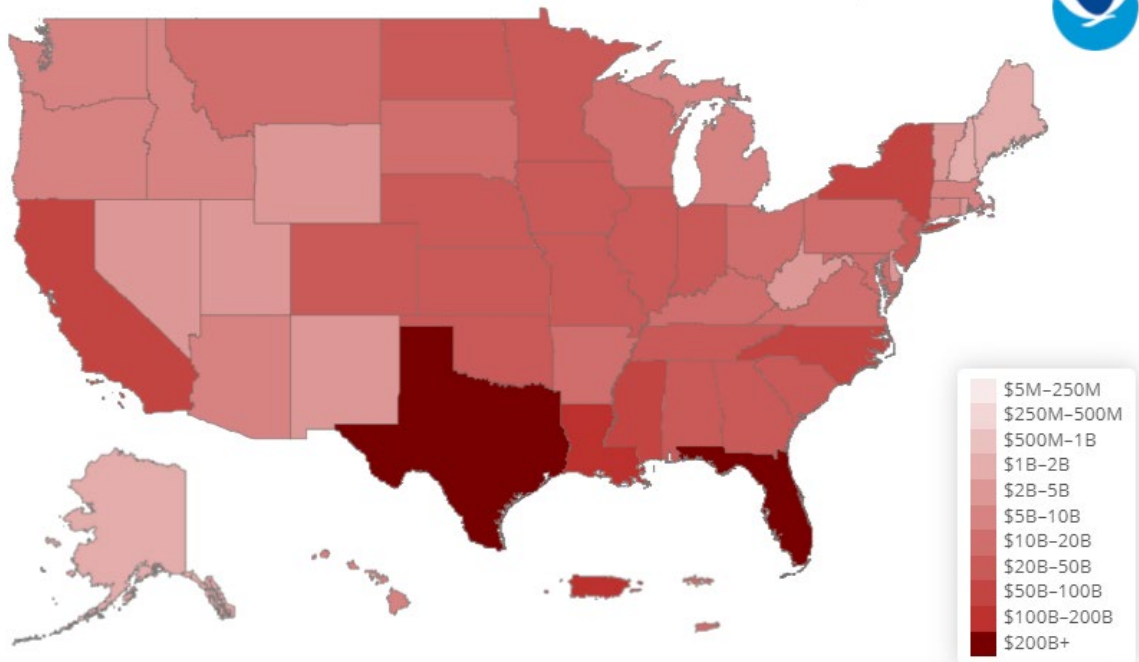
United States						
26	Drought:	32	Flooding:	9	Severe Storm:	113
44	Tropical Cyclone:	17	Wildfire:	17	Winter Storm:	258

This map depicts the number of billion-dollar weather and climate disasters affecting each state, since 1980, regardless of hazard type. Note that each disaster did not necessarily cause one billion dollars in damages in an individual state to be included in this total.

In total, from 1980–2019, the U.S. South/Central and Southeast regions experienced a higher frequency of billion-dollar disaster events than any other regions, as shown in the red total disaster frequency map. The South has also suffered the highest cumulative damage costs, reflecting the diversity, frequency, and severity of weather and climate events impacting the region.

Each state has been affected by at least 1 billion-dollar disaster since 1980. Texas has experienced the highest number of events (111) and is one of the few states that have been impacted by all seven types of the billion-dollar disasters we analyze.

1980-2019 Billion-Dollar Weather and Climate Disaster Cost (CPI-Adjusted)

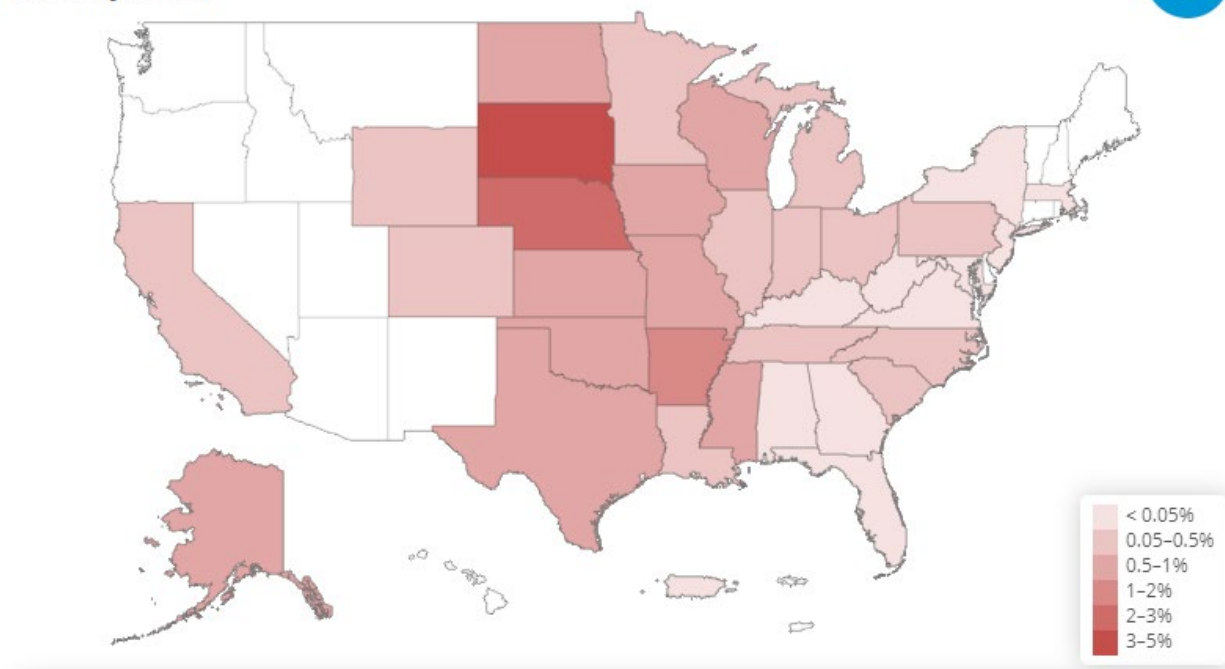


United States					
Drought:	\$250B+	Flooding:	\$100B-200B	Freeze:	\$20B-50B
Tropical Cyclone:	\$750B+	Wildfire:	\$50B-100B	Winter Storm:	\$20B-50B
				Severe Storm:	\$250B+
				All Disasters:	\$1.7T+

This map depicts the total estimated cost borne by each state, from billion-dollar weather and climate events.

Adjusted for inflation, the South/Central and Southeast regions of the U.S., including the Caribbean U.S. territories, have suffered the highest cumulative damage costs, reflecting the severity and widespread vulnerability of those regions to a variety of weather and climate events. In addition to the highest number of billion-dollar disasters experienced, Texas also leads the U.S. in total cumulative costs (~\$250 billion) from billion-dollar disasters since 1980. Florida is the second-leading state in total costs since 1980 (~\$225 billion), largely the result of destructive hurricane impacts.

2019 Billion-Dollar Weather and Climate Disaster Cost as % of State GDP (CPI-Adjusted)



Yet, another way to examine damage is to compare each state's annual disaster losses relative to their Gross State Product (GSP), which represents economic output. In 2019, the Midwest states suffered extensive losses from the worst flooding since 1993.

All of the tables and maps shown in this article are screenshots from NCEI's interactive Billion-dollar Disasters webpage. Visit the page to create your own summaries or download source data. In 2020, NCEI will continue to incorporate new layers and filters that offer added flexibility to the online tools for additional context and analysis. For additional context on data sources, methods, metrics and caveats see: [Calculating the Cost](#) of Weather and Climate Disasters.