



# Global Catastrophe Recap

April 2017

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## Executive Summary

- United States faces multi-billion dollar financial cost from April severe storms and flooding
- Cyclone Debbie prompts nearly USD1.0 billion insured loss in Australia and New Zealand
- Global flooding and landslides leads to a combined death toll of at least 500

Multiple severe weather outbreaks in the United States during the month of April ensured that the peril continued to drive global insured losses in 2017. No fewer than eight separate multi-day outbreaks impacted central and eastern portions of the country with the most prolific outbreak at the end of the month. From April 28 through May 1, a complex and broad storm system spawned violent tornadoes, straight-line winds, large hail and excessive rainfall that led to significant flooding in the Mississippi River watershed. At least 20 people were killed in parts of the Plains, Midwest, Southeast, Mid-Atlantic and Northeast. Total economic losses from this event alone were anticipated to exceed USD1.0 billion.

Aggregated costs to the insurance industry from the severe weather and flood events were likely to lead to a multi-billion dollar loss for public and private insurers. The overall economic tally will be even higher.

Elsewhere, severe weather outbreaks in China and Pakistan left thousands of structures damaged.

Cyclone Debbie left significant impacts across parts of the South Pacific Islands, Australia and New Zealand from late March into the first weeks of April, leaving at least 14 people dead. The storm's worst impacts were from high wind and widespread coastal and inland flood damage across eastern Australia. Total insured losses were anticipated to approach USD970 million. The remnants of Debbie would later trigger flooding in portions of New Zealand. Total insured losses were expected to reach into the tens of millions (USD). Debbie's overall economic cost was estimated around USD2.0 billion.

Other noteworthy tropical cyclone events during April included: Cyclone Cook (South Pacific Islands and New Zealand) and Tropical Depression 02W (Philippines).

An ongoing weather phenomenon deemed a "coastal El Niño" led to relentless rainfall in parts of Colombia. More than 400 people were killed in the Colombian towns of Mocoa and Manizales after separate massive debris flows wiped out dozens of neighborhoods. An estimated 400 people were left dead or missing in Mocoa alone, and a further 17 fatalities were reported in Manizales.

Major flooding in northeast Bangladesh led to extensive agricultural damage in at least seven districts. Total crop damage was cited in excess of USD350 million. Similar levels of flooding occurred in Iran that left 48 people dead and damage costs beyond USD353 million.

Significant flood events in April also occurred in Canada, Hispaniola, Indonesia, and Kyrgyzstan.

Frigid temperatures and frost across western and central Europe inflicted severe crop damage. Preliminary losses to vineyards and orchards were expected to reach into the hundreds of millions (USD).

A swarm of earthquakes struck the northern Philippines in early April that caused damage to roughly 5,000 homes, schools, and other buildings in multiple provinces.

A pre-monsoon season summer heatwave claimed 10 lives in the Indian states of Andhra Pradesh, Telangana, Maharashtra, and Odisha.

## United States

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
04/01-04/03	Severe Weather	Plains, Southeast	5	30,000+	350+ million
04/04-04/06	Severe Weather	Plains, Mississippi Valley, Southeast	0	70,000+	575+ million
04/07-04/08	Severe Weather	West	1	10,000+	125+ million
04/09-04/11	Severe Weather	Plains, Midwest	1	30,000+	325+ million
04/14-04/20	Severe Weather	Plains, Midwest	0	Thousands	100+ million
04/21-04/26	Severe Weather	Plains, Midwest, Southeast, Mid-Atlantic	1	Thousands	100s of millions
04/25-04/27	Severe Weather	Plains, Midwest, Southeast	0	Thousands	100+ million
04/28-05/01	Severe Weather	Midwest, Plains, Southeast, MS Valley	20	Thousands	1.0+ billion

A significant severe weather outbreak left extensive damage in parts of Texas, Louisiana, Mississippi, Alabama, Georgia, Florida, and the Carolinas from April 1-3 as strong tornadoes, up to softball-sized hail, straight-line winds gusting in excess of 70 mph (110 kph), and isolated flash flooding occurred. At least five storm-related fatalities were reported and several others were injured. The worst of the damage was reported from Louisiana and Mississippi on April 2. Total economic losses were estimated at upwards of USD350 million. Public and private insurers cited payouts nearing USD250 million.

An outbreak of severe weather occurred from April 4-6 that impacted parts of Alabama, Georgia, South Carolina, Kentucky, Tennessee, Oklahoma, Missouri, and Arkansas. The bulk of the damage was concentrated in the Southern Plains, Mississippi Valley, Southeast, and Midwest where large hail and straight-line winds left a high volume of homes, businesses, and vehicles with damaged roofs and windows. Multiple tornadoes also touched down and severely damaged numerous communities. In the aftermath, brisk synoptic winds led to further damage in parts of the Midwest. Total economic losses were estimated at up to USD575 million. Public and private insurers cited payouts nearing USD425 million.

A potent Pacific storm system came ashore in northern California and Oregon on April 7 and 8, causing wind and flood damage in each state. Winds gusting beyond 70 mph (110 kph) were recorded as trees and power lines were toppled onto homes, vehicles and businesses. One fatality was reported. Beyond structural damage, the flooding rains and wind led to some communities reporting infrastructure damage. Total economic losses were expected to reach USD125 million. Public and private insurers cited payouts nearing USD70 million.

Powerful thunderstorms associated with separate areas of low pressure along a slow-moving cold front led to consecutive days of damage in parts of the Midwest and southern Plains from April 9-11. One person died. Most of the damage was reported in parts of Texas, Illinois, Nebraska, Iowa, Minnesota, Missouri, Wisconsin, Indiana, and Michigan as clusters of storms spawned isolated tornadoes, up to baseball-sized hail and straight-line winds gusting beyond 70 mph (110 kph). Excessive rainfall nearing 8.00 inches (203 millimeters) also prompted flash flooding in parts of Texas. Total economic losses were estimated at USD325 million. Public and private insurers cited payouts topping USD225 million.

Additional rounds of severe weather tracked across central and eastern sections of the United States from April 14-20, bringing further damage to several Plains and Midwestern states. No serious injuries or fatalities were reported. The majority of the damage resulted from hail larger than baseballs, straight-line winds, tornadoes, and isolated reports of flash flooding as storms occurred. The hardest-hit states included Texas, Nebraska, Iowa, Kansas, Missouri, Illinois, Ohio, Indiana and Pennsylvania.

Severe thunderstorms impacted parts of the Plains, Midwest, and Southeast from April 21-26, leaving at least one person seriously dead. Widespread flooding – the worst since Hurricane Matthew in some spots—was also prevalent in portions of the Carolinas following prolonged torrential rainfall. The majority of the convective damage occurred due to hail nearing baseball-sized and damaging wind gusts in Oklahoma, Texas, Arkansas, Tennessee, Alabama, Mississippi, and Virginia. Multiple tornado touchdowns were confirmed in Alabama and Mississippi. Total economic and insured losses were expected to be in the hundreds of millions (USD).

Another round of severe weather affected the Plains, Midwest, and Southeast from April 25-27. The majority of damage from the worst-affected states of Kansas, Oklahoma, Texas, Missouri, and Arkansas occurred as the result of up to baseball-sized hail. Further damage from tornadoes and straight-line winds were noted in Oklahoma, Alabama, and Georgia. Isolated flooding was also reported.

A complex weather pattern led to widespread flooding, severe thunderstorms and blizzard conditions across central sections of the United States from April 28 into the first week of May that claimed at least 20 lives and left more than 70 others injured. Significant flooding was cited in the Mississippi River watershed, particularly in Missouri, Oklahoma, Illinois, and Arkansas, as excessive rainfall was recorded. The convective storm component of the event additionally led to major hail, straight-line wind and tornado damage in multiple states. Two especially strong long-track tornadoes (an EF4 and EF3) struck Van Zandt County, Texas on April 29 that led to extensive damage and casualties. Beyond the flood and convective storm impacts, the system also prompted heavy snow and blizzard conditions from the Rockies into the Plains and Upper Midwest. Total economic losses were expected to minimally exceed USD1.0 billion. Public and private insurers faced a minimal loss in the hundreds of millions (USD).

## Remainder of North America (Non-U.S.)

<b>Date</b>	<b>Event</b>	<b>Location</b>	<b>Deaths</b>	<b>Structures/ Claims</b>	<b>Economic Loss (USD)</b>
04/15-05/10	Flooding	Canada	0	Thousands	Millions

An abnormally wet month of April in parts of Canada’s southern Ontario and southern Quebec provinces led to widespread flooding in multiple communities through the early portion of May. A series of storm systems originating in the United States led to excessive rainfall that combined with melting winter snow to allow several rivers to overflow their banks. In Quebec alone, the government noted that more than 1,300 homes were inundated by flooding across 124 cities and towns. Total economic losses were estimated well into the millions of dollars (USD).

## South America

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
04/01	Flooding	Colombia	329+	Hundreds	10s of millions
04/19	Landslide	Colombia	24	Hundreds	Millions
04/20-04/23	Flooding	Jamaica, Haiti, Dominican Republic	2	Thousands	Millions

The Colombian town of Mocoa was hit by a powerful debris flow in the early hours of April 1 as overflowing rivers, mixed with vast amounts of rocks and soil, swept through the town. Colombia's National Risk Management Unit confirmed 329 deaths, while 70 others officially remained listed as missing. Some 332 people were injured. The region had endured heavy rainfall dating to mid-February.

At least 17 people were killed in the Colombian city of Manizales following record-breaking rainfall that triggered a series of landslides in the early hours of April 19. Seven people were listed as missing and 31 others were injured. Nearly 60 homes were destroyed and numerous roads were left impassable. The majority of the affected homes were constructed on hillsides known to be at risk of landslides.

Heavy rainfall brought by a non-tropical area of low pressure prompted flooding on several Caribbean islands from April 20-23. In Jamaica, hundreds of homes were flooded, notably in Clarendon Parish. The flooding claimed at least two lives in Sud Department, Haiti. In the Dominican Republic, nearly 3,500 homes were damaged after more than 17,000 people were forced to evacuate.

## Europe

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
04/19-04/24	Winter Weather	Germany, Austria, Switzerland, Italy, UK	0	Thousands	300+ million

Falling temperatures across western and central Europe from April 19-24 inflicted severe damage to crops in portions of Germany, Austria, Switzerland, Italy, and the United Kingdom. The extent of damage ultimately depends on future meteorological conditions. Preliminary damage totals suggested aggregated damage to vineyards and orchards reaching into the hundreds of millions of dollars (USD). Insured losses were at least USD100 million.

## Middle East

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
04/14-04/15	Flooding	Iran	48	Hundreds	353+ million

Torrential rainfall led to major flash flooding across five northwestern Iranian provinces on April 14-15, killing at least 48 people and injuring many others. More than 50 settlements were impacted. The hardest-hit areas were in East Azerbaijan province where the majority of the casualties were reported. Officials reported at least USD353 million in damage. The breakout of losses included: USD300 million in damage to the flood water and sewage network; USD46 million in agricultural losses; and USD7.0 million in infrastructure damage. The overall economic cost for all provinces was set to push the total higher.

## Africa

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
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There were no significant natural disaster events in Africa during the month of April.

## Asia

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
03/28-04/15	Flooding	Bangladesh	0	Thousands	352+ million
04/01	Landslide	Indonesia	28	23+	11+ million
04/04-04/09	Earthquake	Philippines	0	5,000+	Millions
04/08-04/10	Severe Weather	China	2	2,300+	36+ million
04/15	TD 02W	Philippines	10	170+	Millions
04/15-04/17	Severe Weather	China	0	3,800+	41+ million
04/20-04/22	Heatwave	India	10	N/A	N/A
04/22	Severe Weather	Pakistan	11	Hundreds	Unknown
04/29	Landslide	Kyrgyzstan	24	11+	Unknown
04/29	Flooding	Indonesia	10	71+	Unknown

Multiple weeks of heavy rainfall led to major flooding across seven districts in northeast Bangladesh from March 28 to April 15. No casualties were reported. Some of the hardest-hit locales were in Netrokona, Kishoreganj, Itna, Mithamoin, Austagram, Habiganj, and Karimganj upazilas as flooding affected more than 100,000 people and caused significant crop damage. Farmers estimated that nearly 202,000 hectares (500,000 acres) of crops were destroyed after several major rivers overflowed their banks. Total economic damage to crops alone was estimated at BDT28.5 billion (USD352 million).

Twenty-eight people were killed when a landslide struck Banaran village on the flanks of Indonesia's Mount Wilis on April 1. The resulting debris flow was up to 20 meters (65 feet) deep in places. A further 17 people were injured and at least 23 homes were destroyed. Indonesia's Social Affairs Ministry distributed IDR151 billion (USD11 million) worth of aid.

A swarm of earthquakes struck the northern Philippines from April 4-9, causing widespread damage in multiple provinces. The tremors were clustered around the Verde Island Passage between Luzon and Mindoro Islands. The largest was registered at magnitude-5.9 on April 8 at 03:09 PM PHT (07:09 UTC) with an epicenter near Talaga in Calabarzon region. At least twelve earthquakes were registered at magnitude-4.5 or greater during the period. The Philippines National Disaster Risk Reduction and Management Council (NDRRMC) reported that roughly 5,000 homes, schools and other buildings were damaged or destroyed.

Severe thunderstorms impacted the Chinese provinces of Chongqing, Hubei, Henan, Jiangxi, Hunan, and Fujian from April 8-10. Two people were killed. The Ministry of Civil Affairs (MCA) noted that more than 2,300 homes were damaged or destroyed and 43,250 hectares (106,875 acres) of crops were affected by hail and high winds. Total economic losses were listed at CNY250 million (USD36 million).

Tropical Depression 02W, locally named “Crising” by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), brought heavy rainfall to central portions of the Philippines archipelago when it came ashore on April 15. Worst affected was the island of Cebu where 10 fatalities were reported. Several others were injured as the flooding rains prompted damage to more than 170 homes and other structures throughout the Central Visayas region.

Powerful thunderstorms impacted the Chinese provinces of Chongqing, Henan, Hubei, Shaanxi, and Sichuan from April 15-17. According to the MCA, more than 3,800 homes were damaged or destroyed while further damage was cited to the agricultural sector, with an estimated 30,200 hectares (74,600 acres) of crops impacted. The bulk of the crop damage was sustained in Hubei. Aggregated economic losses were listed at CNY280 million (USD41 million).

A pre-monsoon season heatwave gripped portions of India from April 20-22 as temperatures soared above 44°C (111°F). Among the worst affected states were Andhra Pradesh, Telangana, Maharashtra, and Odisha. At least 10 people died due to extreme heat conditions while authorities in several areas ordered schools, government offices, and businesses closed.

Eleven people were killed as thunderstorms hit the Pakistani provinces of Punjab and Khyber Pakhtunkhwa on April 22. Localized flooding was reported that washed away portions of local infrastructure. Numerous communities further endured lengthy power outages.

At least 24 people died after a landslide buried part of Ayu village in Kyrgyzstan’s Osh region during the evening of April 29. The Kyrgyz Ministry for Emergency Situations additionally reported that the landslide buried 11 homes.

Ten people were killed and two others were listed as missing following flash flooding in portions of Indonesia’s Central Java province on April 29. Five hamlets and two villages in Magelang district were affected including Nipis and Sambungrejo (hamlets) where all 10 fatalities were reported. Two missing people were reported from Citrosono (village) while four others were severely injured. A total of 71 homes were damaged or destroyed.



## Oceania (Australia, New Zealand, South Pacific Islands)

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
03/28-04/05	CY Debbie	Australia, New Zealand	14	50,000+	2.0+ billion
04/09-04/14	CY Cook	Vanuatu, New Caledonia, New Zealand	1	Thousands	Millions

Cyclone Debbie spawned extensive flood damage across eastern Australia from March 28 to April 5. Fourteen fatalities were reported. The hardest-hit areas were in New South Wales and southern Queensland where significant damage to property, vehicles, infrastructure and agriculture was cited. The remnants of Debbie also brought torrential rain and flooding to New Zealand where floods in the Bay of Plenty region were listed a “1-in-500 year” event. Preliminary data from the Insurance Council of Australia cited roughly 47,000 claims with an estimated value of AUD1.3 billion (USD970 million). The overall economic cost was estimated around AUD2.4 billion (USD1.8 billion). The Insurance Council of New Zealand anticipated claims reaching into the tens of millions (USD).

Cyclone Cook tracked across several South Pacific Island nations—including Vanuatu and New Caledonia—before its remnants brought heavy rainfall to New Zealand. At least one person was killed. The cyclone made its only official landfall on April 10 in New Caledonia as a Category 2 storm on the Saffir-Simpson Scale and caused widespread wind and flood damage. Damage to property and infrastructure was additionally noted in Vanuatu and New Zealand. Total economic losses were estimated in the millions of dollars (USD).

## Appendix

### Updated 2017 Data: January – March

#### United States

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/01-01/03	Severe Weather	Southeast, Plains	6	10,000+	250+ million
01/06-01/13	Winter Weather	Pacific Northwest, Southwest, Rockies	5	40,000+	700+ million
01/06-01/08	Winter Weather	Southeast, East Coast	5	Thousands	Millions
01/13-01/18	Winter Weather	Plains, Midwest	7	Thousands	Millions
01/17-01/19	Winter Weather	West, Rockies	4	Thousands	Millions
01/18-01/23	Severe Weather	Southeast, Plains, West, Northeast	21	100,000+	1.3+ billion
01/19-01/25	Winter Weather	West, Rockies, Plains, Midwest	5	Thousands	Millions
02/07-02/08	Severe Weather	Southeast	1	10,000+	175+ million
02/08-02/09	Winter Weather	Mid-Atlantic, Northeast	1	Unknown	Millions+
02/12-02/14	Flooding	California	0	N/A	200+ million
02/12-02/14	Winter Weather	Upper Mid-Atlantic, Northeast	1	Thousands	Millions+
02/14	Severe Weather	Texas	0	Hundreds	Millions+
02/16-02/18	Flooding	California	7	25,000+	800+ million
02/19-02/21	Flooding	California	1	10,000+	500+ million
02/19-02/20	Severe Weather	Texas	0	20,000+	225+ million
02/24-02/25	Severe Weather	Northeast, Mid-Atlantic	0	Thousands	Millions+
02/27-03/02	Severe Weather	Midwest, Southeast, Mid-Atlantic	4	130,000+	1.3+ billion
03/06-03/10	Severe Weather	Midwest, Plains, Southeast	0	200,000+	1.7+ billion
03/07-03/09	Wildfires	Plains, Rockies, Florida	7	Hundreds	100+ million
03/13-03/15	Winter Weather	Plains, Midwest, Southeast, Northeast	11	Thousands	1.0+ billion
03/20-03/22	Severe Weather	Southeast, Midwest	1	75,000+	700+ million
03/26-03/28	Severe Weather	Plains, Southeast, Midwest	0	180,000+	1.8+ billion
03/28-03/31	Severe Weather	Plains, Southeast, Midwest, Mid-Atlantic	1	30,000+	325+ million

#### Remainder of North America (Non-U.S.)

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/24-01/27	Winter Weather	Canada	2	Hundreds	10s of Millions
03/08	Severe Weather	Canada	1	10,000+	125+ million
03/11	Winter Weather	Canada	0	Thousands	Millions

## South America

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/01-02/01	Wildfire	Chile	11	2,500+	870+ million
01/01-04/01	Flooding	Peru	120	245,000+	3.1+ billion
02/24-02/26	Flooding	Chile	6	Hundreds	Millions
02/17-04/01	Flooding	Colombia	328+	2,500+	Millions+

## Europe

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/02-01/13	Winter Weather	Central, Eastern, Southeastern Europe	76	Thousands	10s of millions
01/12-01/13	WS Dieter & Egon	France, Germany, Belgium	0	Thousands	350+ million
01/18	Earthquake	Italy	30	Hundreds	TBD
01/20-01/24	Severe Weather	Spain, France, Italy	3	Hundreds	Millions
02/03-02/06	EU Windstorms	Spain, France	2	Thousands	Millions+
02/23-02/24	WS Thomas	Western & Central Europe	3	Thousands	475+ million
03/06-03/07	WS Zeus	France	2	Thousands	300+ million

## Middle East

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
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## Africa

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/05-01/12	Flooding	South Africa, Angola	7	5,000+	Millions
01/01-03/01	Flooding	Zimbabwe	246	2,000+	100+ million
02/15-02/16	CY Dineo	Mozambique	7	107,204+	17+ million
01/01-03/31	Drought	Somalia, Ethiopia, Kenya	100s	N/A	1.9+ billion
01/01-03/31	Flooding	Zimbabwe	271	Thousands	200+ million
03/07	Cyclone Enawo	Madagascar	99	85,000+	20+ million
03/19	Severe Weather	Ghana	19	0	N/A
03/21-03/24	Flooding	Angola	11	5,300+	Millions

## Asia

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/01-01/31	Flooding	Thailand	96	585,000+	860+ million
01/01-01/23	Flooding	Malaysia	0	Thousands	132+ million
01/12-01/16	Flooding	Philippines	11	Hundreds	Unknown
01/16-01/31	Flooding	Philippines	11	1,000+	8.1+ million
01/20	Landslide	China	12	One	Unknown
01/22-01/24	Flooding	Pakistan	5	Hundreds	Unknown
01/24-01/25	Winter Weather	Afghanistan	31	N/A	Unknown
01/25-01/26	Winter Weather	India	11	N/A	Unknown
01/25-01/30	Flooding	Indonesia	1	2,000+	Millions
01/28	Earthquake	China	0	14,000+	55+ million
02/01-02/05	Winter Weather	Afghanistan, Pakistan	159	325+	Unknown
02/09-02/12	Flooding	Indonesia	12	18,000+	Millions+
02/10	Earthquake	Philippines	8	7,200+	40+ million
02/17-02/19	Winter Weather	Afghanistan, Pakistan	58	N/A	N/A
01/01-05/01	Drought	Sri Lanka	N/A	N/A	10s of millions
03/01	Severe Weather	China	7	13,700+	28+ million
03/03	Flooding	Indonesia	8	3,482+	19+ million
03/14-03/29	Severe Weather	Thailand	3	6,000+	Millions
03/27	Earthquake	China	0	45,000+	50+ million

## Oceania (Australia, New Zealand, South Pacific Islands)

Date	Event	Location	Deaths	Structures/ Claims	Economic Loss (USD)
01/20-01/23	Flooding	French Polynesia	0	1,000+	Millions
02/09-02/13	Wildfires	Australia	0	1,200+	10s of Millions
02/09-02/16	Flooding	Australia	2	Thousands	100s of Millions
02/17-02/19	Severe Weather	Australia	1	48,000+	350+ million
03/07-03/12	Flooding	New Zealand	0	7,000+	10s of millions

## Additional Report Details

TD = Tropical Depression, TS = Tropical Storm, HU = Hurricane, TY = Typhoon, STY = Super Typhoon, CY = Cyclone

Fatality estimates as reported by public news media sources and official government agencies.

Structures defined as any building – including barns, outbuildings, mobile homes, single or multiple family dwellings, and commercial facilities – that is damaged or destroyed by winds, earthquakes, hail, flood, tornadoes, hurricanes or any other natural-occurring phenomenon. Claims defined as the number of claims (which could be a combination of homeowners, commercial, auto and others) reported by various public and private insurance entities through press releases or various public media outlets.

Damage estimates are obtained from various public media sources, including news websites, publications from insurance companies, financial institution press releases and official government agencies. Damage estimates are obtained from various public media sources, including news websites, publications from insurance companies, financial institution press releases and official government agencies. Economic loss totals include any available insured loss estimates, which can be found in the corresponding event text. Specific events may include modeled loss estimates determined from utilizing Impact Forecasting's suite of catastrophe model products.

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