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The Truth About Catastrophes

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The knowledge that climate change is real and that it contributes to disasters means that individuals, communities, counties, states and the country must first recognize the risks, then act to protect property and—insofar as possible—prevent losses.

Introduction

A look back at the severe weather events of 2023 reveals a roster of unusual catastrophes, some of which had never been seen on such a scale. The catalog of catastrophes features many broken records: Heat waves were hotter and longer-lasting, flash flooding was more destructive and wildfires incinerated more acres than ever before.

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Is the long list of unusually destructive natural disasters in 2023 an outlier, or is it a harbinger of a trend we shall continue to experience? Views on this anomalous year range widely, with lawmakers and expert witnesses at congressional hearings openly disagreeing on whether there has been a change in the frequency and severity of natural catastrophes and whether catastrophe trends may be attributed to climate change. The varying voices include those of think tank scholars, government scientists, civilian scientists, university professors, other academic researchers, insurance industry executives, insurer data scientists, members of the House of Representatives and the Senate, lobbyists, environmentalists and consumer activists. Perspectives presented by this array of interested parties span the gamut from alarmist "the sky is falling" pessimism to outright denial of any change. Some even maintain that a warming climate is auspicious because it means fewer people are freezing to death.[1]

The number and intensity of severe weather events has, first and foremost, humanitarian consequences. Unfortunately, too many of the catastrophes affected communities and individuals with the lowest resilience and least resources for repair

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and recovery. Moving forward, it is vital to clarify the facts regarding catastrophe frequency and severity trends in order to properly guide catastrophe-related discussions and debates. This research paper aims to elucidate these facts.

To understand natural disaster trends and to help bridge the gap among divergent voices, this paper reviews the conclusions of 18 professional, objective meteorological and climate data organizations, reinsurers and reinsurance brokers regarding catastrophe frequency, severity and attribution. While there is not consensus among the 18 sources, the direction of their comments points to natural catastrophes having increased in frequency and severity and indicates that this rising severity can be attributed to climate change.

Changes in Disaster Trends

Studies on disaster trends show that the risk profile has changed. Our analysis reviewed disasters going back to 1980, where such data was available, and focused on the United States. This data demonstrated that natural catastrophes have traditionally been dominated by the "primary perils" of hurricanes and earthquakes because these events caused the most damage. Primary perils, like hurricanes in Florida or earthquakes in California, typically strike in areas in harm's way, with known historic exposure to natural catastrophes. Notably, in 2023, catastrophes largely occurred in areas not generally considered at risk for disasters. Many of these disasters were "secondary perils," such as floods, wildfires, severe convective storms (SCS), flooding, mudslides, tornadoes, heat waves and droughts.[2]

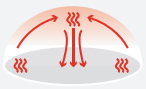
Notably, in 2023, catastrophes largely occurred in areas not generally considered at risk for disasters. Many of these disasters were "secondary perils," such as floods, wildfires, severe convective storms (SCS), flooding, mudslides, tornadoes, heat waves and droughts.

Despite the nomenclature, such secondary perils did significantly more damage in 2023 than they had historically. Flash flooding across Vermont washed out roads and bridges, causing mudslides in Montpelier, Ludlow and numerous other towns.[3] Torrential rains in Pennsylvania and Kentucky dumped 12 inches or more to the hardest-hit regions within 24 hours.[4] In New York City, flooding paralyzed subways and commuter trains, trapping people in their homes and requiring rescue operations.[5] A heat dome in Texas scorched the state, with week after week of unrelenting temperatures well over 100 degrees Fahrenheit lasting almost the entire summer.[6] As of Nov. 10, 2023, the number of billion-dollar catastrophes stood at 25, exceeding the previous national record of 22.[7] Through the third quarter of 2023, damage from severe convective storms exceeded $50 billion, also breaking all prior records.[8]

Unusually severe weather events also occurred outside the United States. Wildfires raged across Canada, dumping unprecedented emission volumes into the atmosphere, which darkened skies hundreds of miles away from the conflagrations.[9] Storms known as medicanes (hurricanes in the Mediterranean) wrought havoc in central Greece, resulting in the worst flooding since records began in 1930.[10] In Pakistan, additional flooding exacerbated the damage from massive flooding in 2022 that left a third of the country under water.[11]

Many of the severe weather events we have seen in recent years are so unprecedented that obscure meteorological words have entered our working vocabulary. Examples include:

- **Heat dome.** Heat domes prevent air under a high-pressure system from escaping, resulting in temperatures rising to dangerous levels and remaining elevated for a prolonged period. A 2003 heat dome in western Europe, with an epicenter in France, caused 30,000 deaths.



- **Atmospheric rivers.** River-like streams of moisture in the atmosphere that carry saturated air from tropical climes to northern latitudes, where they dump enormous quantities of water. Severe atmospheric rivers were thought to be 1-in-1,000-year events. Current research finds that their frequency is increasing and that they can occur much more frequently.

- **Derechos.** Straight-line winds, sometimes called "inland hurricanes" because of associated heavy rainfall and hurricane-force wind. The Midwest experienced derechos in 2022 and 2023 so severe that they weakened the financial position of insurance companies operating in the region.[12]

- **Medicane.** A Mediterranean hurricane. In addition to the two that struck Greece within a three-week period this summer (Daniel and Elias), Daniel also precipitated Libyan dam collapses and caused severe destruction in Bulgaria and Turkey.

- **Severe convective storms.** Extreme thunderstorms that bring lightning, heavy rain, large hailstones, strong winds and tornados.[13] The collective impact of these storms now exceeds damage from hurricanes.

Catastrophes and Insurance

The severe events of 2023 show that tail events are not as rare as they used to be. While the focus of natural catastrophes has traditionally been on landfalling hurricanes in Florida and the Southeast United States, in 2023, we witnessed several rare disasters occurring in unexpected locations, including a California hurricane (Hilary) and Vermont flooding. The torrential Sept. 30, 2023, New York flooding was also a lesson in potential flood magnitude. New York's drainage pipes, designed and installed over a century ago, were constructed to handle up to 1.75 inches of rainfall per hour.[14] In the recent flooding event, rain fell at an estimated 2.75 inches per hour in parts of the city, which far exceeded the capacity of the pipes. The 1.75 inches per hour measurement was long considered to be at the upper end of how much it could rain in the New York metropolitan area, but the September flood demonstrated how inaccurate past assumptions can be in relation to today's disaster events. In addition, in October, Hurricane Otis, which struck Mexico, accelerated remarkably quickly from a tropical storm to a category 5 hurricane with 165 mph sustained winds.[15]

If disasters are now more common and more costly, the cost of insurance rises as well.

The profusion of unusually destructive catastrophes in 2023 has implications for insurance—both for insurance companies that are post-catastrophe, financial first responders and for insurance buyers. If disasters are now more common and more costly, the cost of insurance rises as well.

Data Challenges

One of the challenges with comparing current catastrophes with historical severity trends is normalization—a way for past catastrophe data to be compared with current data. Several factors impede accurate analyses; for instance, increased

building activity and rising populations mean that there is more property at risk of loss than there was previously. Inflation must also be considered when comparing current and historical losses. For example, if there were a $700-million event in 2013, it would not reach the billion-dollar database today when adjusted for inflation. However, if there was population growth in the area of the event, with concomitant residential and commercial construction, an event of identical magnitude to the 2013 event would likely make the billion-dollar list because there is now more property subject to destruction.

Rates of exposure to catastrophe can also decrease over the years if values in a catastrophe-struck area are lower than they were previously. If new construction is done to code and existing structures are hardened and rendered more catastrophe-proof, future storms may exhibit declining severity. For example, a recent report by RMS, the catastrophe modeling unit of rating agency Moody's, found that improvements to Florida's building codes have had an ameliorating impact on disaster losses, but such improvement was more than offset by population and exposure growth in the state.[16]

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Some views regarding natural catastrophe frequency and severity trends may be shaped by politics or culture wars, or financed by radical environmental or corporate interests. For this reason, we do not include sources whose research may be biased. Our analysis of the published literature was supplemented by discussions with many of the scientists whose work we analyzed. It is worth noting that we do not consider all sources not included here as fundamentally biased or problematic.

The 18 catastrophe research sources we consulted have varying definitions of what qualifies as a disaster or natural catastrophe and have varying dollar thresholds. For example:

- EM-DAT data covers events causing $100 million or more (CPI-adjusted) in damages.
- The NOAA Storm Events database covers a wide range of catastrophes, including blizzards, coastal floods, droughts, flash floods, floods, frosts/freezes, hail, heavy snows, high winds, hurricanes, typhoons, ice storms, lake-effect snows, storm surges/tides, strong winds, thunderstorm winds, tornados, tropical storms, wildfires and winter storms.
- The NOAA Billion-Dollar Disasters database covers events causing $1 billion of damages or more. This includes physical damage to residential, commercial and municipal buildings; time element losses; and damages to vehicles and infrastructure.
- Munich Re's threshold for a catastrophe is an event causing at least $3 million in damages or 10 deaths.

Findings

The data table below summarizes what the 18 sources report in their publications regarding catastrophe frequency, severity and attribution. Each of these sources present significantly more granular detail on trends for individual catastrophe types, filling numerous data tables. In the interest of readability, clarity and economy, we have compiled the detailed findings into this single data table.

Source	Database Description	Frequency	Severity	Attribution	Temperature
2014 National Climate Assessment[17]	300 experts guided by 60-person Federal Advisory Committee. Reviewed by National Academy of Sciences.	Increasing for rain, SCS	Intensity of severe rainfall increasing	Climate change for higher temperatures and extreme precipitation	U.S. average temperatures up 1.3-1.9 degrees F; most of increase since 1970
Aon[18]	Insurance and reinsurance broker. Publisher of "Impact Forecasting"	Increasing for medium-sized SCS	Higher intensity of tail events	Socioeconomic factors	Increasing. **Attribution:** climate change
Climate.gov charts[19]	NOAA arm, Tracks heat waves, temperatures, CO2 arctic glacier mass, greenhouse gases	Increasing number of heat waves in major cities			Since 1880 global temperature up 0.14 degrees F per decade; since 1981 the rate has almost doubled. Heat waves last longer
CRESTA (Catastrophe Risk Evaluation and Standardizing Target Accumulations)[20]	Tracks insurance industry losses outside the U.S.	Increasing for SCS	Increasing for SCS		
Curry, Judith[21]	Maintains extreme climate change scenarios have been proven false, and maintains we do not have a climate crisis.			Difficult to identify any role for human-caused climate change in extreme event intensity or frequency.	
EM-DAT[22]	Global, including U.S. data on events causing $100 million (CPI- adjusted) since 1980.	Frequency of events with over $100 million in damages increasing		Not clear if it is climate change or other factors, such as inflation	
Gallagher Re[23]	Reinsurance broker. Publisher of quarterly natural catastrophe report	Overall number of events stable, but frequency of higher intensity/ higher loss events increasing	Increasing	Combination of climate change, socioeconomics and exposure management	Increasing **Attribution:** climate change
Hannover Re[24]	Global reinsurance company	Frequency of events with over $100 million in damages increasing	Increasing temperature, increasing precipitation	Climate change, inflation	Increasing **Attribution:** climate change. "The evidence is unequivocal: the climate is warming globally."

Source	Database Description	Frequency	Severity	Attribution	Temperature
IPCC[25]	United Nations Intergovernmental Panel on Climate Change	Low confidence in long-term (40 years or more) increases in tropical cyclone activity frequency	Low confidence in long-term (40 years or more) increases in tropical cyclone severity	Some to anthropogenic climate change	Increasing **Attribution:** climate change
KCC[26]	Karen Clark and Cop. Risk Modeling Firm	Higher frequency of severe storms	More severe hurricanes	More and more powerful storms a "clear signal of climate change"	Increasing **Attribution:** climate change
McCoy, Amy[27]	University of Arizona scientist, researcher	Some weather events that used to be rare in a region are now more frequent	Some weather events that used to be rare in a region are now more intense	Climate change	Increasing
Munich Re[28]	Global reinsurance company	Increasing for some events in some regions	Increasing for some events in some regions	Climate change, exposure growth, inflation, mitigation efforts	Increasing
NOAA Billion Dollar Disasters[29]	Events causing $1 billion or more in damages. U.S., 1980-2023	Increasing, especially extreme precipitation and drought		Climate change is increasing some events (also increased exposure and vulnerability)	Increasing
NOAA Climate Extremes Index[30]	Index is average of values from specified set of extreme events		Increasing severity for temperature, extreme precipitation. High temperatures increasing, low temperatures decreasing		Increasing
NOAA Hurricane Data[31]	U.S. hurricanes from 1980-2023	Data does not support that frequency is increasing		Rising concentrations of population and infrastructure in coastal regions	
NOAA Storm Events[32]	National Oceanic and Atmospheric Administration	Increasing, especially extreme precipitation			
Swiss Re[33]	Global reinsurance company	Increasing	Increasing	Climate change	Increasing **Attribution:** climate change
Verisk[34]	Insurance analytics, modeling and data provider			Exposure growth, construction in high-hazard areas, inflation, climate change	Rising **Attribution:** climate change

Most (13) of the 18 sources found catastrophe frequency to be increasing. Most (11) also found catastrophe severity to be increasing. Fourteen of the sources reported rising air temperatures. Most attributed these frequency, severity and temperature trends to climate change. Almost none of the sources indicated that there is no observable trend in catastrophe frequency or severity. Those that did not comment on any of the trends did not comment because it was not within the scope of their research. For example, NOAA's billion-dollar disaster database is, as its name suggests, a catalog of catastrophe events causing at least $1 billion dollars in damage. As such, it does not include a time series of historical temperatures.

Category	Number of Sources Reporting Increase
Frequency	13
Severity	11
Attribution to Climate Change	11
Higher Temperatures	14

The 18 sources whose work we analyzed have produced and are continuing to produce voluminous and valuable literature on catastrophe events and trends. This review of their work attempts to reduce the ocean of information into some simple statements about catastrophe frequency, severity and climate change (in contrast to the 3,068-page 2022 IPCC Climate Change report).[35] Our hope is that our analysis of the body of literature on catastrophes from a wide array of professional sources may support our contributions to debates and public policy discussions with objective, independent, fact-based research.

The implications of the trend of more numerous and more destructive catastrophes should send a message that more frequent and more powerful catastrophes can be expected.

Conclusion

Our review of catastrophe data and research from 18 climate analysis organizations finds that, from 1980 to the present, both catastrophe frequency and catastrophe severity have increased. We have also found that most studies attribute the increases to climate change. The attribution to climate change also affirms that they hold that climate change is real. Our review shows that climate professionals maintain that climate change, evidenced by rising temperatures, is a cause of worsening catastrophe trends. The implications of the trend of more numerous and more destructive catastrophes should send a message that more frequent and more powerful catastrophes can be expected. The year 2023 was notable in that it featured numerous catastrophes in areas that are not historically prone to such disasters. The knowledge that climate change is real and that it contributes to disasters means that individuals, communities, counties, states and the country must first recognize the risks, and then act to protect property, and—insofar as possible—prevent losses.

About the Author

Jerry Theodorou is the director of R Street's Finance, Insurance and Trade Policy Program and the author of major R Street studies on social inflation and insurance regulation.

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