INSURANCE INFORMATION INSTITUTE

SEVERE CONVECTIVE STORMS:

Evolving risks call for innovation to reduce costs, drive resilience

May 2020

Convective storms battered much of the United States in 2019. What are these storms? Are they becoming more frequent and severe? What are insurers, businesses and communities doing to mitigate the risks and build resilience?

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Average annual insured U.S. loss from convective storms, at around $17 billion, nearly equals that from hurricanes.

Varied risks, increasing losses

Severe convective storms are among the most common, most damaging natural catastrophes in the United States. The result of warm, moist air rising from the earth, they manifest in various ways, depending on atmospheric conditions – from drenching thunderstorms with lightning, to tornadoes, hail, or destructive straight-line winds.

These storms were among the most significant drivers of natural catastrophe losses for insurers in 2019, according to insurance broker Aon. As has been the case in every year since 2008, thunderstorms generating tornadoes, large hail and damaging straight-line winds resulted in public and private insurance payments that exceeded $10 billion. Aon says 2019 was the fourth straight year in which payouts related to these storms topped $20 billion (U.S.) globally.

As in most years, this total was mainly driven by U.S. hail and wind outbreaks.[1]

The start of this year's convective storm season coincided with the shutdown of much of the U.S. economy due to the coronavirus pandemic. This could complicate disaster response and claims handling as the season – already shaping up to be the deadliest in eight years[2] – continues.

Catastrophe modeling firm RMS says the average annual insured U.S. loss from convective storms nearly equals that from hurricanes, at around $17 billion.

"Unlike losses from hurricanes," RMS says, severe convective storm losses, especially hail, "accumulate over the course of a year; however, major outbreaks can make the difference between an 'average' year and a significant impact to the insurance industry."[3]

On the rise?

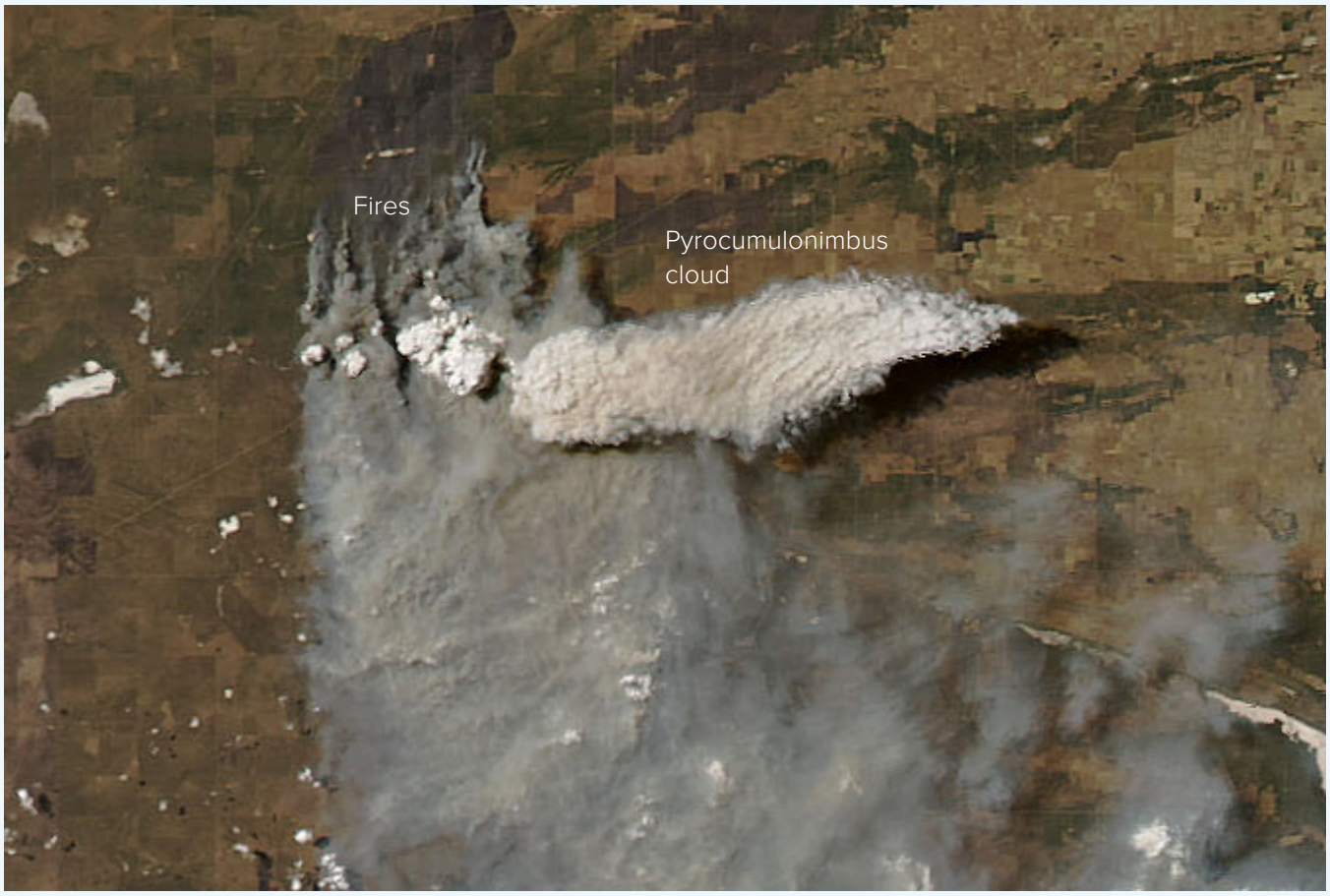
For reasons that will be discussed in the articles that follow, it is hard to say whether convective storm activity is increasing. However, changes are occurring, and one thing is clear: These storms are becoming more costly.

RMS reported that storm-related personal lines insurance claims grew much faster than general inflation from 2001 to 2017: 11 percent, versus a little over two percent. During the same period, inflation averaged just over two percent.[4]

Population growth and economic development have contributed to increasing losses. At the same time, research suggests the geography, frequency and intensity of these storms also may be changing. In addition, thunderstorms generated by pyrocumulonimbus clouds resulting from wildfires (**see "When wildfires cause severe convective storms," p. 4**) could be seen more often if recent wildfire trends continue.[5]

This paper will examine these trends and how insurers, risk managers, individuals and businesses are responding to mitigate the risks and improve community resilience through:

- Improved forecasting
- Better building standards
- Early damage detection and remediation
- Increased risk sharing through wind and hail deductibles, and
- New structures, such as parametric insurance



Jeff Schmaltz, NASA Earth Observatory.

When wildfires cause severe convective storms

When fires get big enough, they can create their own weather systems. The fire-breathing dragon of clouds generated by the recent fires in Australia is just one example of how weather events can spawn intense fires.

The phenomenon's less-romantic name is pyrocumulonimbus.

Pyrocumulonimbus clouds are formed by the same forces that generate typical convective storms – heat from the ground, driving moisture upward until it forms clouds. Add smoke and ash to the equation, and the sun can be blotted out for miles around. Rain may fall, which could help squelch the blaze – but also likely are lightning and powerful winds that can increase the fire's intensity while driving it toward new sources of fuel. Australia's historic fires were barely extinguished before parts of the country were hit by terrible thunderstorms and "golf-ball-sized hail that destroyed car windshields, killed birds, and shredded the leaves off trees."[6]

According to Steve Bowen, a meteorologist at insurance broker Aon and director of Aon's Impact Forecasting unit, property damage from a pyrocumulonimbus within a fire's radius would be considered wildfire damage from an insurance perspective. If the damage occurs outside the perimeter, it would be considered convective storm damage.

The 2017 and 2018 wildfire seasons in the United States inflicted catastrophic shocks, particularly in California, which suffered the largest and most destructive wildfires in state history. The aftermath of these disasters has led to the question of whether catastrophic wildfires will be the "new normal" for California and other fire-prone states.

If this turns out to be the case, pyrocumulonimbus-driven convective storms may well be part of the mix.

Tornadoes: improved measurement clouds trend assessment

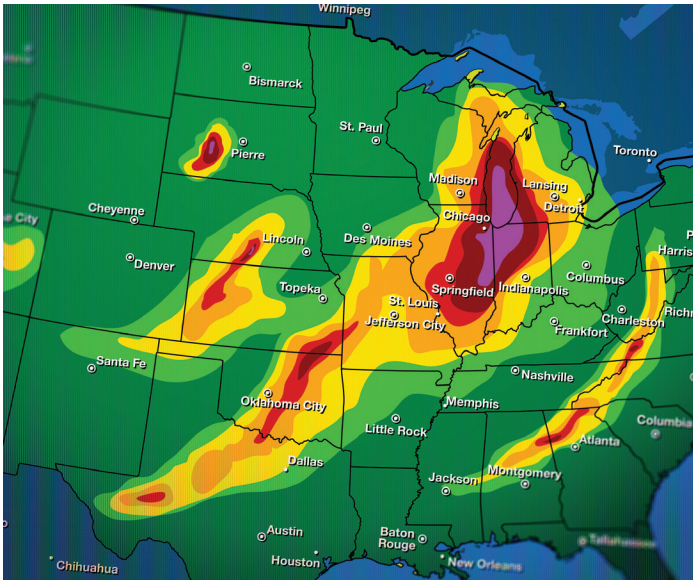
Preliminary National Oceanic and Atmospheric Administration (NOAA) reports show there were 1,520 tornadoes in the U.S. in 2019, up from 1,126 for the same period in 2018. In May alone, 556 tornadoes were recorded, claiming seven lives. Throughout the U.S., tornadoes killed 41 people in 2019, compared with 10 in 2018.[7]

Despite these numbers, it is difficult to say whether tornado activity is increasing. If tornadoes are not spotted and reported by someone, they do not officially exist – therefore, improved tracking and reporting can "reveal" non-existent trends.

> Preliminary NOAA reports show there were 1,520 tornadoes in the U.S. in 2019, up from 1,126 for the same period in 2018.

According to a NOAA report examining tornado trends over the past three decades, in the 1970s there were about 150 days per year with at least one confirmed tornado in the United States. NOAA says that number has fallen to between 90 and 100 days in recent years but "the number of days with dozens of tornadoes – 30 or more – have increased by a factor of five, from one day every other year to 2.5 days annually."[8]

The report says an apparent increased frequency during the early 1990s corresponds to the implementation of Doppler weather radar and "the growing 'hobby' of tornado chasing." It also points to the advent of cellular phones and camcorders, which "not only provides documentation of many weak tornadoes, but also, on occasion, shows the presence of multiple tornadoes immediately adjacent to each other."



In October 2019 a severe thunderstorm outbreak ripped through Texas, Oklahoma, Missouri, Arkansas, Tennessee and Louisiana, and produced several tornadoes, including an EF-3 (**see "Enhanced Fujita Scale," p. 6**) affecting the Dallas, Texas, area. Artemis estimates insured losses from the Dallas event to be around $2 billion, making it the costliest tornado outbreak in Texas history.[9]

Improved reporting may explain increases in tornadoes in some areas – but what about decreases? Twisters are reported to be spawning less often in western Texas and Oklahoma, part of the area known as Tornado Alley.[10] This could indicate a shift to the east, in which case they could affect more populous regions near the Mississippi River.

In 2019 a team of scientists reported that they accurately predicted the tornado outbreak of late May 2019 nearly four weeks before it began. The team's study was published in the journal *Geophysical Research Letters*.[11]

"This is the first documented successful long-range forecast for an extended period of tornado activity in the U.S.," said lead author Victor Gensini, a professor of meteorology at Northern Illinois University. "It's important to note that this was a single successful extended-range forecast – we're not going to get every one of these correct, but our work does create a pathway to forecasting severe weather with these extended lead times."

If these results can be reproduced and generalized, the work could help communities, response teams, insurers and others get out in front of these events with mitigation and resilience efforts.

The Enhanced Fujita (EF) Scale

The Enhanced Fujita (EF) Scale has been used to rate tornadoes since 2007. It was devised by meteorologists and engineers convened by the Wind Science and Engineering Research Center at Texas Tech University.

Scale	Estimated wind speeds	Typical observations
EF-0	65 to 85 mph	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF-1	86 to 110 mph	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF-2	111 to 135 mph	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF-3	136 to 165 mph	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF-4	166 to 200 mph	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF-5	Over 200 mph	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100m (109 yards); high-rise buildings have significant structural deformation.

Source: The Weather Channel.

Hailstorms: hidden damage, staggering costs

"Hail is a form of precipitation that occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere, where they freeze into ice," the National Severe Storms Laboratory website says.[12]

Property damage from hail can be devastating. Steve Bowen, a meteorologist at Aon and director of the broker's Impact Forecasting unit, has said hail can contribute as much as 50 percent to 80 percent of severe convective storm losses in any given year, with tornadoes, wind and flooding providing the rest.

Bowen says that over the past decade hail damage to vehicles, buildings, and crops has averaged $8 billion to $14 billion annually.[13] According to an analysis by Location Inc., hail claims account for $6.2 billion per year in insurance losses.[14] During 2017, the worst hail year on record, hail damage in the U.S. was approximately $22 billion, according to the Insurance Institute for Business and Home Safety (IBHS).[15] In that year, a Verisk report estimates that more than 10.7 million U.S. properties were damaged by hail events.[16]

"People are moving from the urban areas to the suburbs, and from the suburbs to the exurbs," said Patrick Marsh, a warning coordination meteorologist at the NOAA's Storm Prediction Center. "Cities are getting bigger. And as cities expand, that is more area for severe storms to impact."[17]

Hail is hard to insure because the damage it inflicts is often hidden, and many property owners do not file claims until months or years after the storm. Its frequency and severity vary over time, making it extremely difficult to predict future loss, and its geographic reach may be changing.

"Hailstorms in the United States are no longer just striking buildings in Hail Alley, a region where the states of Colorado, Nebraska, and Wyoming meet," the Verisk report notes. "Significant storms are also affecting other areas, including states in the West and Northeast."

In addition to the geographic shift, hailstorms seem to be generating larger stones capable of inflicting greater damage. In August 2019 the Colorado Climate Center reported in a tweet that a stone with a 4.83-inch diameter fell in Colorado, exceeding the previous state record of 4.5 inches.

Sam Childs, a Ph.D. student in Colorado State University's Atmospheric Science Department researching wild weather trends, warns that more hailstorms with bigger stones are on their way.[18] Childs is working to "assess where and how much the greatest human risk from large hail is expected to be in the future."

As with Northern Illinois University's work on tornado forecasting, the work of Childs and others aims to help communities, insurers and others cost-effectively mitigate and recover from damage.

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High costs of hail

Roofs are the part of residential and commercial buildings most vulnerable to hail – and that damage can progress to wall system damage, particularly if not discovered in a timely fashion. Damage severity — and, consequently, replacement or repair cost — varies by the roof materials and composition.

Damage to cars also is a large component of hail costs. *AutoTrends Magazine* found the average cost of hail damage for a private passenger automobile is about $2,500.[19] If policyholders have comprehensive coverage that protects them from natural disasters, including hail, their insurers will likely cover the damage. But suppose a policyholder is a car dealer or has a business that involves a fleet of vehicles. If they are located in Hail Alley – which, is vaguely defined and may be on the move – coverage for this risk is going to cost dearly.

"Hail is wreaking havoc in the market for auto dealer lot insurance," *Insurance Journal* reported late last year.[20]

The article cites Zurich North America's 2018 decision not to renew policies with hundreds of dealerships in the central U.S., citing 'catastrophic' losses due to hail damage."

Zurich says it remains one of the largest providers for auto dealers, including those in hail-prone states.

"Everybody that I know is faced with a very expensive change," *Insurance Journal* quotes David Ditgen, a broker at AutoRisk Dealer Financial Services in Denver. The article also quotes Nick Pacifico, who has worked at his family's Cadillac dealership in Denver since 2003 and says he has never seen insurance costs so high: "Getting coverage is nearly impossible."

Pacifico says two years ago he paid about $160,000 to insure $20 million worth of vehicles on his lot, where about a third of the inventory is kept outside.

This year, he says, he is paying almost $600,000.

Mitigation and resilience: what to do?

How can individuals, communities, and businesses get ahead of risks that seem so capricious and whose costs can vary so wildly? How are risk managers and insurers integrating convective storm resilience into their strategies and operations?

The answers are multi-faceted and require a collaborative, holistic approach. Nearly 40 percent of small businesses never reopen following a natural disaster, the Federal Emergency Management Agency (FEMA) says.[21] But a 2018 study by the National Institute of Building Science shows that every $1 spent on hazard mitigation can save the nation $6 in future disaster costs.[22]

Secure the property, build in resilience

When managing risks related to wind, water, and fire, it is important for homeowners and businesses to make sure their property and buildings are well constructed and maintained and that any objects that might become projectiles in high wind are secured – especially in areas where tornadoes or destructive straight-line winds tend to arise suddenly.

Likewise, in hail-prone areas it is important to put vehicles and equipment that could be damaged indoors or under cover.

Zurich Risk Engineering Services, part of Zurich Insurance, recently replaced its own standard for assessing exposures to customer buildings and new construction with the FORTIFIED Commercial™ standards and compliance program[23] created by the Insurance Institute for Business & Home Safety (IBHS).[24]

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IBHS is a nonprofit research and communications organization supported by property/casualty (P/C) companies that insure or reinsure risks in the U.S. Its scientists and risk communicators deliver strategies to build safer and stronger homes and businesses – helping insurers and property owners avoid losses. It has developed methods for producing artificial hailstones and simulating hail impacts, including the ability to conduct full-scale hail testing.[25]

IBHS research contributes to product and standards improvements aimed at reducing damage and losses due to hail, wildfire, hurricanes, tornadoes and rain. Zurich encourages all its customers to adhere to FORTIFIED Commercial standards, which it says makes new and existing commercial buildings stronger against severe weather, including high wind.

"Most local building codes are designed primarily for human safety—not to preserve buildings," said Adam Hurley, head of Property Risk Engineering Services for Zurich North America. "FORTIFIED Commercial goes further. The benefits of building to the IBHS Fortified for Commercial standard have been recognized by modeling programs used by many insurance companies to help develop rates and premium. The financial incentive to apply these standards lies in the potential for fewer damages and the ability to recover more quickly."

Identify damage quickly

Because wind and hail can expose structures to further damage due to water seepage or animal intrusion, it is important to detect damage from these events as early as possible. Historically, it has been difficult, time-consuming and dangerous for insurance adjusters to get up onto every insured building in an area affected by convective storms in order to look for damage.

Advances in aerial imagery are helping to address this deficit. Whether using drones, manned aircraft or satellite technology, it is getting easier and less expensive for insurers to assess rooftop damage due to convective storms.

The National Insurance Crime Bureau's Geospatial Intelligence Center (GIC) is a consortium of insurers formed to help rapidly identify damage from large-scale weather events that would otherwise take a long time to discover. It provides insurers with geospatial support and data collected annually, as well as to first responders in disaster situations.[26]

Geomni, a subsidiary of insurance data and analytics provider Verisk, uses remote sensing and machine learning technologies to capture, store, process and deliver aerial imagery and geospatial data to industries that include P/C insurers, government and urban planners, engineering and construction firms, and other clients to help them detect damage, identify hazards, assess risk and perform valuations.[27]

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Evolving insurance approaches

As a result of significant storm-related losses in recent years, some insurers are obligating policyholders to take on increased risk-sharing of storm losses through deductibles. For each loss paid by the insurer, the policyholder contributes dollars through the application of a deductible.

Property insurance policies often have multiple deductibles. The all other perils (AOP) deductible applies to all insured perils unless a specific deductible otherwise applies. If perils like hurricanes or named storms, floods, or earthquakes are insured on the policy, they commonly have their own specific deductible because they are considered excessive risks. Insurers sometimes require a specific deductible for hail or wind in areas that have generated significant losses for those perils. A convective storm deductible replaces the AOP deductible for elements of a thunderstorm system.

According to AmWINS, a distributor and servicer of specialty insurance solutions, the use of storm deductibles is on the rise, and the number of storm categories is also increasing: "In addition to the storm deductible categories of named storm, hurricane, flood, and wind/hail, policyholders must now contend with the newer (and broad) convective storm deductible, as well as the ever-expanding geographic scope of the wind/hail deductible."[28]

The issue with the hail deductible, the AmWINS website says, is whether it will apply only to higher-risk geographic areas or...to all insured locations, regardless of where they are located."

The answer will lie in the deductible language, and how it is applied.

"Increased risk sharing through deductibles should occur when the risk to hail is excessive and not simply because the risk exists," AmWINS says.

Another emerging method is parametric insurance. Parametric policies cover risks without the complications of sending adjusters to assess damage post-catastrophe. Speed of payment and reduced policy administration costs may ease the burden on both insurers and policyholders.

A parametric policy pays a fixed amount to policyholders if an event that meets agreed-upon criteria (wind of a certain speed, for example, or an earthquake of a specific magnitude) triggers the terms of the policy, regardless of whether the policyholder's property experiences any damage.

Parametric insurance has not yet gained traction in the U.S., but it has a track record in developing countries, where traditional insurance based on claims data was impractical because that data didn't exist.

According to risk and insurance services consultant Marsh & McLennan, parametric policies are not intended to replace traditional insurance but to complement them and speed up recovery.

"They can be designed to cover both specific catastrophic losses and frequency losses – for example, the business interruptions caused by a hurricane or the impacts of decreased snowfall," Marsh vice presidents Tom Markovic and Steve Harry write. "As such, it is

important to consider how the combination of traditional indemnity policies can work together with parametric solutions to achieve the best results."[29]

Late last year, Understory, a Wisconsin-based provider of sensors for parametric insurance products covering severe weather risks like hail, launched Auto - Hail Safe, a data-driven hail insurance product for auto dealers to address hail damage. Targeting auto dealers in hail-prone geographies, Understory's Auto - Hail Safe offers hail coverage "to bridge the financial gap of long restocking timelines and cash flow to repair damaged inventory."

Founded in 2012, Understory has developed on-the-ground weather sensors – called "dots" – to gather data from a multitude of weather conditions, including rain, wind and hail. CEO Alex Kubicek said those sensors can reduce insurance costs for dealers.[30]

Dealers who purchase Hail Safe install a dot on their lot and pay an annual premium, then receive an automatic payout if the sensor detects a hailstorm that meets an agreed-upon threshold. The payout happens regardless of actual damage.[31]

Dealers can reduce their open-lot policies, saving on premiums and taking on greater risk, then rely on Understory to hedge against the remaining risk.

Better building codes could help – but public attitudes are an obstacle

"Relatively simple and inexpensive enhancements to building codes could reduce tornado-related costs by 30 percent or more," according to a report by the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania.[32]

It goes on to say that, as of the time of publication (April 2017), only one city in the U.S. had adopted more stringent codes recommended in response to costly tornado damage. The study cites public attitudes about risk governance and perceived tradeoffs between risk reduction and regulation as a reason for the failure of enhanced codes to gain traction.

The authors explore the issue by researching homeowner support for the proposed building code enhancements. It focuses on Oklahoma, which experiences a high number of tornadoes annually that impose significant costs on homeowners and where political conservatism creates resistance to increased regulation.

"The Republican Party in Oklahoma explicitly opposes infringement on individual property rights," the report says. "Enhanced building codes are at the intersection of the tradeoff between risk reduction and protection of private property rights; they would provide a prospective benefit (risk reduction), but they would also impose a state-mandated requirement and cost on homebuilders and buyers."

This clash of risk and ideology, the report says, makes Oklahoma an ideal case for studying the dynamics that push and pull public support for mandatory mitigation policies.

Public perceptions may be the most challenging obstacle to mitigation and resilience, particularly given public discourse linking extreme weather to climate change. Indeed, the study found homeowners who are skeptical about climate change "are significantly less supportive of enhanced building codes than homeowners who are worried about climate change."

These attitudes may shift if studies suggesting Tornado Alley is moving are borne out. If more populous areas are being hit by increasing numbers of tornadoes, it may inspire an increased sense of urgency around mitigation and resilience.

"Absent proactive efforts to encourage support and/or limit opposition," the Wharton study says, "widespread adoption of building codes that reduce losses from tornadoes in states like Oklahoma will be difficult to accomplish. Instead, we will likely see a patchwork of reactive mitigation policies that are adopted in the wake of major disasters."

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Acknowledgments

Triple-I's research draws from a wide range of insurance industry and other providers of data. Our relationships with these resources help us serve as a trusted source of data-driven insights for consumers, media, and professionals seeking insurance information.

We'd like to acknowledge and thank the information providers below, who are referenced in this paper:

Aon
Federal Emergency Management Agency (FEMA)
Insurance Institute for Business and Home Safety (IBHS)
Marsh and McLennan Cos.
National Insurance Crime Bureau (NICB)
Verisk/ISO
The Weather Channel
Wharton Risk Management and Decision Processes Center at the University of Pennsylvania
Zurich North America

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