



FLOOD:

Beyond Risk Transfer

Why closing the flood protection gap will take innovation and collaboration

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TABLE OF CONTENTS

	<i>Page</i>
From the CEO	2
Introduction	3
Loss Trends and Drivers	4
Demographics: Moving Toward the Risk	4
Extreme Weather and Climate.....	5
Risks to Mortgages and Securities.....	6
Closing the Protection Gap	7
Private Flood Insurance.....	7
Products Are Not Enough.....	9
Data, Technology and Innovation	10
Parametric Solutions.....	10
Innovate to Mitigate.....	12
Nature-based Protection.....	12
Affordability and Equity	13
The Resilience Movement	14
Endnotes	16

FROM THE CEO

Innovation is at the heart of solving every challenge — and seizing every opportunity — the insurance industry faces. Closing the flood protection gap is no different.

As the most frequent and severe of natural catastrophes, flood was long considered an untouchable risk for private insurers. For decades, the National Flood Insurance Program (NFIP) was practically the only available option. Before NFIP was established, mitigation meant building more dams and providing post-event recovery assistance.

How far our industry has come! Thanks to improved data, analytics, and sophisticated catastrophe modeling, insurers not only have become more comfortable writing flood policies — they increasingly see it as an area of growing opportunity. New products have proliferated, which should improve availability and affordability of coverage for this peril, which too often strikes the most vulnerable populations hardest.

But, as we note in this paper, new products alone will not close the protection gap. Risk transfer is just one tool in the resilience toolkit. Our understanding of loss trends and expertise in assessing and quantifying risk must be joined at the hip to technology, public policy and finance, and science. We need to partner with communities and businesses at every level to promote a broad resilience mindset focused on pre-emptive mitigation and rapid recovery.

This paper — written by Triple-I's Research and Education team with the support of subject-matter experts from among our member companies, non-resident scholars, and other resources — examines rising flood losses and their drivers and discusses how insurers are working with partners from across many disciplines to meet the challenges presented by a changing climate and shifting population trends. It highlights what's being done well and speaks to the limitations and challenges that remain to be met and addressed.

I am pleased to present this piece of research as part of the important conversation around weather- and climate-related risk. I thank all who contributed to it, hope you find it useful, and welcome your feedback.



Sean Kevelighan
CEO, Insurance Information Institute

INTRODUCTION

Half a billion people worldwide are affected by floods annually,¹ and about 90 percent of all U.S. natural disasters involve [flooding](#). Whether related to coastal and inland inundations due to [hurricanes](#), [extreme rainfall](#), [snowmelt](#), [mudflows](#), or other events, floods cause billions of dollars in losses each year.

According to the Federal Emergency Management Agency (FEMA), one inch of flood water can cause as much as [\\$25,000 in damage](#) to a home.*

Flood Insurance Cost Calculator

Just 1 inch of water can cause \$25,000 of damage to your home.

See how much a flood could cost you.

[GET STARTED](#)

Source: FEMA.gov, "Big Cost of Flooding".
Estimates based on national FEMA flood loss tables of cash value loss.

Between 2010 and 2018 the annual cost of flood damage in the United States was approximately \$17 billion, according to [testimony](#) that FEMA official Michael Grimm recently delivered to a House subcommittee on the environment. This is four times the approximately four billion dollars per year recorded in the 1980s, Grimm testified.

But direct economic losses are only part of the picture. Human costs are enormous, and it can take families, businesses, and communities years to recover. The more frequent and severe these events become, the more critical it is to have a resilience mindset and strategy.

And while insurance plays a key role in disaster mitigation and resilience, simply paying claims for incurred losses is not enough.

Current approach unsustainable

Butch Kinerney, Chief of Marketing and Outreach for the National Flood Insurance Program (NFIP), [said](#) that while 2019 was a relatively quiet flood year, the program still paid \$1.47 billion on 35,004 claims. In 2018 about 42,500 claims resulted in \$1.53 billion being paid, he said.² The NFIP is responsible for most flood insurance coverage written in the United States and is managed by FEMA.

"The NFIP has about 5 million flood insurance policies in force nationally," Kinerney said. "We are in every state, every territory, every tribal nation....We cover \$1.3 trillion in assets, all against flood."

For decades, flood was considered an "untouchable" risk for private insurers due to the difficulty of accurately quantifying exposures. This has begun to change, for reasons that will be discussed in this paper, but a substantial flood protection gap remains. A [recent analysis](#) by nonprofit [First Street Foundation](#) found the United States to be woefully underprepared for damaging floods. It identified "around 1.7 times the number of properties as having substantial risk," compared with FEMA's flood zone designation. "This equates to a total of 14.6 million properties across the country at substantial risk, of which 5.9 million property owners are currently unaware of or underestimating the risk they face."

A growing number of experts consider the existing approach to flood risk to be insufficient and unsustainable. This protection gap has to be addressed systematically and with the involvement and collaboration of a range of stakeholders.

This paper will discuss:

- Flood loss trends and what drives them;
- How improved data and analytical tools are helping communities and policymakers;
- How insurers may address these trends and close the flood protection gap; and
- The opportunities that new technologies and insurance products present, and the challenges they face.

Along the way, readers will gain appreciation for the complex nature of flood risk — driven by weather, climate and demographics — and the power presented to individuals, communities and businesses when they participate in the growing resilience movement.

*All figures are in U.S. dollars, unless otherwise specified.

Loss trends and drivers

Flood, for the purposes of this paper, [refers to FEMA](#) as: “A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder’s property).”

According to FEMA, a flood can be caused by any of the following:

- Overflow of inland or tidal water;
- Unusual and rapid accumulation or runoff of surface waters from any source;
- Mudflows caused by flooding; or
- Collapse or subsidence of land along a lake or similar body of water due to erosion or undermining caused by waves or currents “exceeding anticipated cyclical levels that result in a flood.”

Most floods fall into three categories: riverine; coastal; and shallow flooding. [Alluvial fan flooding](#) is more common in the mountainous western states.

Since 2000, flood disasters in the U.S. accounted for more than \$850 billion in damage and losses, according

to the Pew Trusts, a global nonprofit whose “[Flood-Prepared Communities](#)” project aims to reduce the impact of flooding through improved policies and planning at the federal and state levels.

Reinsurer [Munich Re](#) says floods have accounted for 40 percent of worldwide natural catastrophe losses since 1980, with global losses exceeding US \$1 trillion and only 12 percent insured.³ According to [Swiss Re](#), the number of and economic losses from extreme weather events have both increased in recent decades, with rising losses becoming more evident since the mid-1990s through improved data and more comprehensive and inclusive reporting of events.⁴

And data compiled by insurance broker Aon (**Figure 1**) show that global insured weather-related property losses have outpaced annual inflation by about 7 percent since 1950⁵ — an overall increase of more than 3,000 percent.

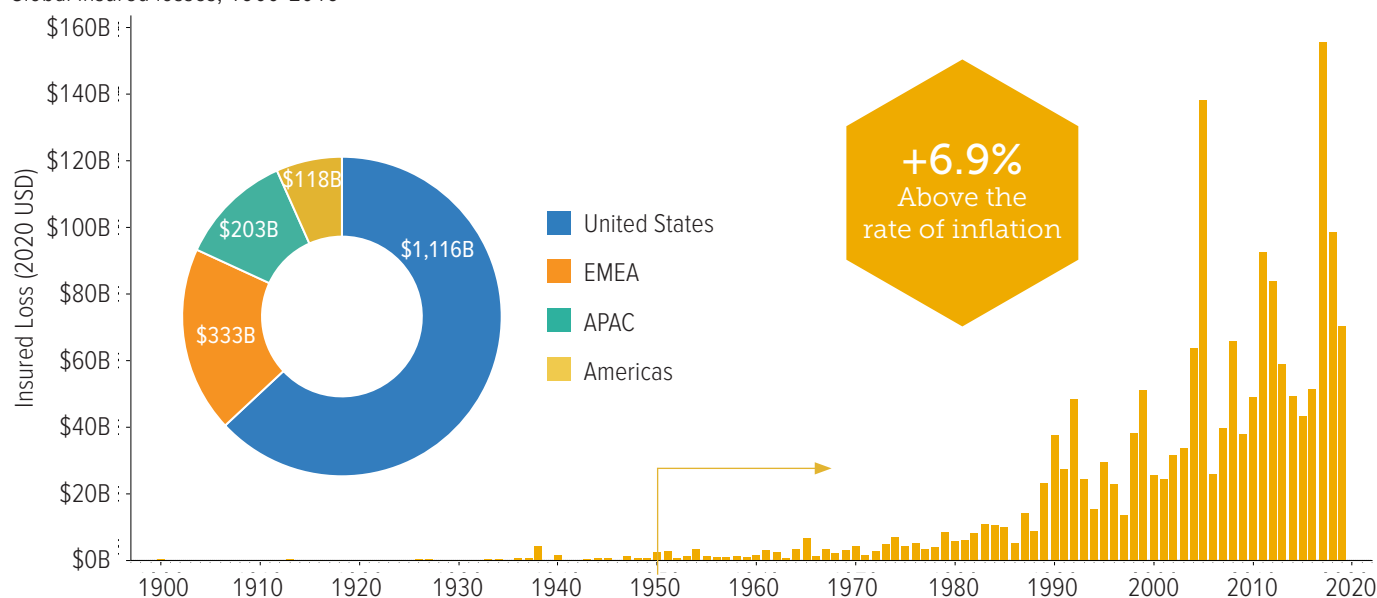
Demographics: Moving toward the risk

“There are many underlying drivers to the rising losses resulting from weather-related events,” Swiss Re writes. “The main factor is growing exposure as the world’s population continues to rise and, with economic growth, urbanization and asset values increase.”⁶

Figure 1

Insured weather losses on the rise

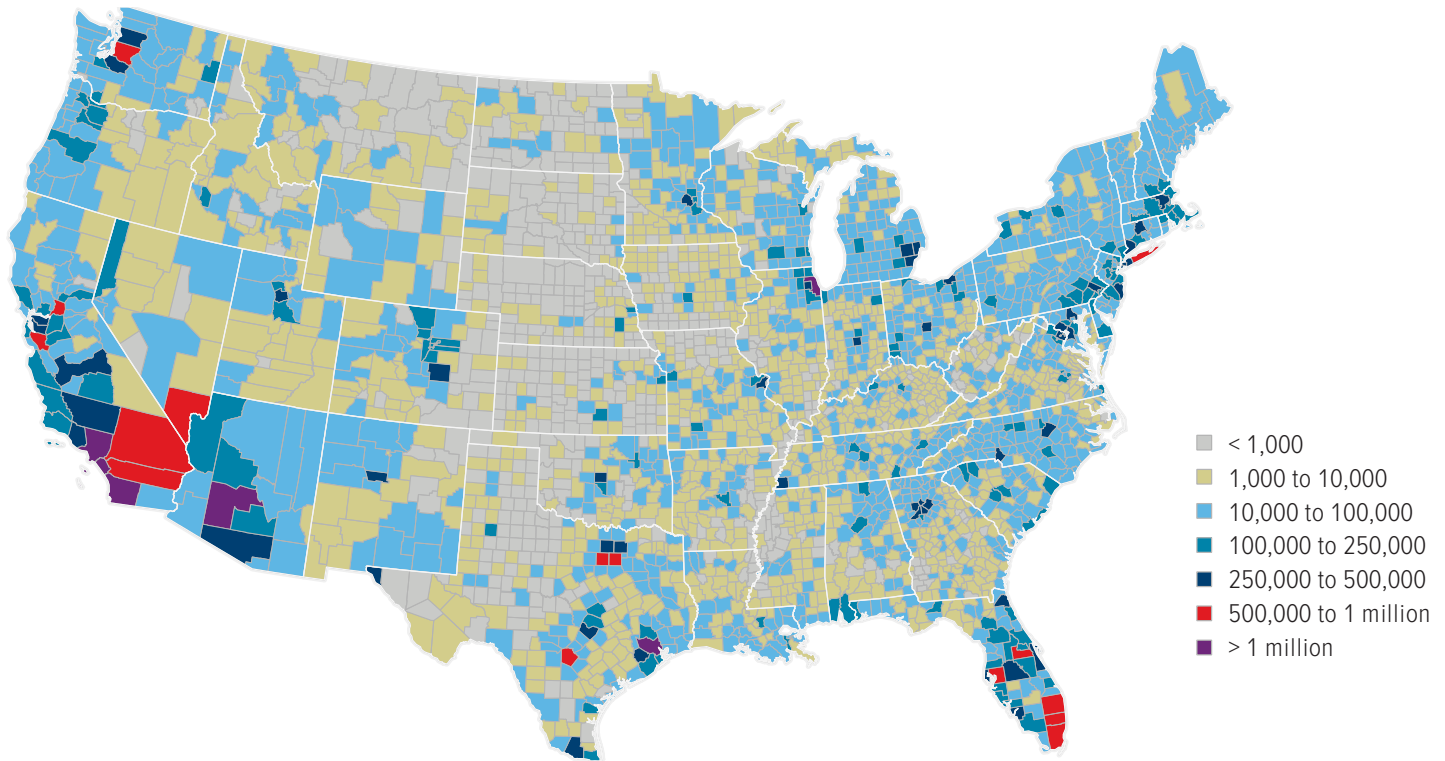
Global insured losses, 1900-2019



Data and graphic: Aon (Cat Insight). Compiled by Aon, used with permission. All losses CPI-Adjusted to 2020 USD.

Figure 2

More people moving into danger zones



Data: U.S. Census Bureau. Graphic: Aon (Cat Insight).

In 2020 six of the 10 costliest natural disasters occurred in the United States. The most destructive was Hurricane Laura, a Category 4 storm that caused substantial wind and storm surge damage and triggered widespread flooding that extended far inland. Losses came to \$13 billion, with insured losses of \$10 billion, [according to Munich Re](#).⁷

In the United States much of rising loss trend is due to people moving into risk-prone areas. More people, homes, businesses and infrastructure means more costly damage when extreme weather events occur.

As the map above indicates (**Figure 2**), the number of housing units in the United States has increased most dramatically since 1940 in many areas that are most vulnerable to weather and climate-related damage. Red and purple represent the greatest increases, and these colors disproportionately cluster around hurricane- and flood-prone areas in Florida and Texas, as well as parts of California, Nevada and Washington that are at an elevated risk of wildfire or drought — and, consequently, mudslides and flash floods.

Extreme weather and climate risk

It is difficult to distinguish how much of increasing losses are due to improved measurement and population shifts and how much are related to weather and climate trends.

A [study](#) by Stanford University researchers found that intensifying rainfall fueled by climate change over the past 30 years has caused nearly \$75 billion in flood damage in the United States.⁸ The report, which analyzed climate and socioeconomic data to quantify the relationship between rainfall trends and flood costs, found that losses from [worsening extreme rains](#) comprised nearly one-third of the total financial cost from flooding in the United States between 1988 and 2017.

These findings track with the observations of [Dr. Philip Klotzbach](#), an atmospheric scientist at Colorado State University and a Triple-I non-resident scholar, with respect to hurricanes. “As the atmosphere continues to warm, storms can hold more moisture and consequently bring more rainfall.”⁹

Klotzbach cited [research by Kerry Emanuel](#) at MIT¹⁰ that “looked at climate model simulations of future hurricanes in Texas and found that a current one-in-100-year rainfall event would be a one-in-5.5-year event by 2100.”

While that research was based on “fairly pessimistic assumptions” about greenhouse gas emissions, Klotzbach said, “Even if we do reduce emissions somewhat, it seems extremely likely that we will see heavier rainfall from tropical cyclones in the future, due to the warmer atmosphere.”

This trend could be exacerbated if, as some in the meteorological community anticipate, [hurricanes begin traveling more slowly](#), adding to the moisture they would pick up from the ocean and drop over land.¹¹

[Other research](#) seeks to tease out the relationship between snow-melt flooding and drought trends and a warming planet. A [recent study](#) published by the American Association for the Advancement of Science set out to find the effect of warming on [streams](#) and discovered increased extremes in both snow melt flooding and in periods of drought that appear to be tied to long-term climate change.¹²

Risk to mortgages and securities

Flood insurance protects homeowners and mortgage creditors against flood risks. But flood-related costs are rising rapidly, and research indicates that many properties that should be insured are not.

On average, nationwide only 30 percent of homes in the highest-risk areas have flood coverage, [according to](#) the Risk Management and Decision Processes Center of the Wharton School at the University of Pennsylvania, a [Triple-I Resilience Accelerator](#) partner.

Making matters worse, a [First Street Foundation analysis](#) identified “around 1.7 times the number of properties as having substantial risk,” compared with FEMA’s flood zone designation. These rising risks and costs have serious implications for property values, insurance rates, and mortgage-backed securities.

A more recent [First Street study](#) estimates economic damage due to flooding will grow over the next 30 years by 61 percent, to an average estimated annual loss of \$7,563 per property — for an estimated total loss of \$32.3 billion.¹³ The cost of flood damage was approximately \$17 billion annually between 2010 and 2018, according to [testimony](#) FEMA official Michael Grimm delivered to a House subcommittee on the environment.



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In a case study focused on the impact of Hurricane Harvey, [Dr. Carolyn Kousky](#) (Executive Director at the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania and a [Triple-I non-resident scholar](#)) and colleagues write, “Many recent storms, including Hurricanes Katrina, Ike, Sandy, and Harvey, all led to flooding that extended beyond the [FEMA [Special Flood Hazard Area \(SFHA\)](#)] and generated flood depths that exceeded...the expected elevation of water at a particular location in a 100-year event by several feet.”¹⁴

Kousky’s paper points out concern that the SFHA designation can be based on outdated data or methods and that discussing flood risk in terms of being “in” or “out” of the SFHA creates a false perception that outside the boundary people are “safe,” and that inside the SFHA the risk is uniform. “In reality, of course, flood risk varies continuously across the landscape, including beyond the SFHA.”

Residential real estate can be affected in many ways following a disaster. In strong markets, there may be an increase in quick sales to [disaster investors](#) at depressed prices.¹⁵



Increased demand for contractors can increase costs for construction and home improvements, and if reconstruction costs are high in relation to home value, individuals receiving flood insurance payouts or disaster aid may use those funds to pay off a mortgage, rather than rebuild. When borrowers repay principal early, they do not have to make interest payments on that part of the principal. As a result, investors in associated fixed-income securities will not receive interest paid on the principal.

Closing the protection gap

Flood damage is excluded under standard homeowners and renters insurance policies. However, flood coverage is available as a separate policy from the NFIP and from a growing number of private insurers. The NFIP, created in 1968, makes federally backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances.

Many people believe they do not need flood insurance if the bank providing their mortgage does not require it; others assume their homeowners insurance covers flood damage; and still others think they cannot afford it. Only one in six homes in the United States has flood insurance, [according to Swiss Re](#).



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“As a result, an average year of storms will produce uninsured losses of \$10 billion due to flooding, compared to insured losses of \$5 billion,” said Matt Junge, head of property solutions for the United States and Canada and of U.S. property underwriting for Swiss Re.

The NFIP owes [more than \\$20.5 billion](#) to the U.S. Treasury, leaving \$9.9 billion in borrowing authority from a \$30.43 billion legal limit.¹⁶ This debt is serviced by the NFIP and interest is paid through premium revenues. With flood losses on the rise, the existing approach is clearly not sustainable.

In December [FEMA proposed](#) “substantively” revising the “estimated cost of assistance” factor the agency uses to review governors’ requests for a federal disaster declaration to “more accurately assess the disaster response capabilities” of the states, District of Columbia and U.S. territories.¹⁷

This means that the federal government will likely ask states, municipalities, and some home and business-owners to shoulder more of the cost of recovering from natural catastrophes — making it even more important for every state to prepare for and insure against events that might have seemed unthinkable a short time ago.

“Our current system is just fundamentally not working for us anymore,” David Maurstad, senior executive of the flood insurance program, [said recently](#) while briefing journalists on [Risk Rating 2.0](#) — a new approach to measuring flood danger that looks at homes in terms of their specific replacement costs and individual risks, rather than simply whether they sit in a FEMA-designated flood zone.

FEMA officials said the new methodology — scheduled to be implemented in October 2021 — will also modify the NFIP’s finances to withstand the growing costs of climate change as the riskiest homes pay a greater share of premiums.

Private flood insurance

Flood was long considered an untouchable risk by private insurers because they did not have a reliable way to measure and price it. Until the advent of Doppler radar and satellite imagery, those wishing to forecast hurricanes and other weather events were confined to using historical data and ground-based observations and measurements. Doppler and satellites greatly improved forecasting, but insurers still struggled to price weather-related risk appropriately.

Another challenge was “adverse selection:” the only people who want to buy flood insurance are the exact people who suffer floods. This made it difficult for private insurers who might write flood coverage to diversify their risks.

However, insurers in recent years have become more comfortable using sophisticated models to underwrite and price coverage, and modeling firms are getting better at



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Swiss Re's Junge said there are three main reasons for insurers' increased willingness to write flood coverage:

- Improved understanding of hydrodynamics;
- More granular mapping capabilities based on satellite and aerial technology; and
- Increased computing power, supporting better image resolution.

All these factors have contributed to exponentially improved risk modeling.

"These advances haven't just made insurers more comfortable writing flood coverage," Junge said. "They've turned flood insurance into an area of real opportunity."

The more accurately insurers can measure a risk, the more incentive exists to make it available, and to price it competitively.

"A lot of progress has been made in terms of affordability," Junge said, "and more granular mapping enables insurers to more closely customize policies and pricing to the risk characteristics of specific properties."

Swiss Re, Munich Re, and other reinsurers have entered into agreements with primary insurers and managing general agents (MGAs) that enable residents to bundle flood coverage into their homeowners policy via endorsements. The increase in the number of private insurers improves competition and helps spread the economic risk of flooding. Private carriers also can offer higher coverage than NFIP policies, which are currently capped at \$250,000 for residential buildings and \$500,000 for nonresidential buildings.

"We are seeing more than a 25 percent take-up rate on flood-eligible new business among independent agents," said [Locke Burt](#), chairman and president at Security First Insurance. "Customers are becoming more aware of their true risk to flood damage; and since the price more accurately reflects the risk, they're now making the good decision to obtain this new coverage."

Despite this, educating homeowners about flood risk and available solutions remains a challenge.

Daniel Kaniewski, managing director for public sector innovation at Marsh & McLennan and former deputy administrator for resilience at FEMA, put it plainly during a [Triple-I webinar](#) last year: "Any home can flood. Even if you're well outside a floodplain, get flood insurance. Whether you're a homeowner or a renter or a business owner — get flood insurance."

To illustrate his point, he compared the average FEMA payout to an uninsured flood survivor following Hurricane Harvey with that of someone who had bought flood insurance from the NFIP. Uninsured victims, on average, received \$3,000, whereas people who bought flood insurance in advance received a payment of more than \$110,000.

"What a tremendous difference," he said. "You're not going to be able to recover with \$3,000, but with \$110,000 you're well on the path to recovery much more quickly than someone without insurance."

He added that if the homeowner is not located in a FEMA-designated flood zone the premium would be very reasonable, reflecting the lower risk. With [more than 20 percent](#) of NFIP claims coming from outside high-risk flood areas, those who live in areas with low-to-moderate flooding risk should understand their risk and consider flood insurance.

Part of the challenge — related to consumer psychology — is getting homebuyers to include a flood insurance endorsement in their homeowners policy at the point of initial sale.

“Nobody wakes up and says, ‘Today I will buy flood insurance,’” said Raghuv eer Vinukollu, senior vice president and natural catastrophe solutions lead at Munich Re. “If someone isn’t required to have it, it’s going to be very hard to explain the risk and the value of the product at any other time than the point of sale.”

This is one reason why closing the protection gap will require a lot of collaboration at the prevention and mitigation end.

“Most of the private market is still offering products to existing flood insurance buyers,” Vinukollu said. “This isn’t addressing the protection gap.”

Products are not enough

“Risk transfer on its own isn’t risk reduction,” said Michael Szőnyi, flood resilience program lead for Zurich Insurance. “You can’t close the protection gap with product alone.”

The insurance industry can play a wider role in reducing risk by working with governments to promote improvements in zoning, land use, and building codes. The [Zurich Flood Resilience Alliance](#), for example, is a “multi-sectoral partnership” focused on helping communities in developed and developing countries strengthen their resilience to flood risk. It consists of humanitarian, nonprofit, research, and private sector partners who collaborate to increase public and private investment in community-based flood resilience.

They key to closing the protection gap, Szőnyi said, is to do it “both from the top down and the bottom up.”

He explained that reducing economic losses through improved zoning, land use and building standards would reduce claims generally — which, in turn, could allow insurers to increase coverage in areas that need it the most while keeping the price of coverage affordable.

Investments in physical resilience can be hard for communities with budgetary constraints to justify to taxpayers because they do not produce direct monetary benefits like other forms of community infrastructure.¹⁸ Munich Re’s Vinukollu spoke about the role of public-private partnerships that take advantage of governments’ ability to ensure adequate loss prevention, build resilient structures and implement municipal planning.



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“If people reside in and build more resilient structures, not only can it help save lives, but insurance could be more accessible/affordable, and the probability of loss and recovery time will be less for communities,” he said.

[Community-based catastrophe insurance](#) (CBCI) is one such approach. In a CBCI arrangement, a local government, public-private partnership or a community group provides insurance for individual properties in the community. CBCI offers multiple delivery models — ranging from helping members arrange insurance coverage to the establishment of a [captive insurer](#) to retain the covered risk. In addition to improving financial recovery for communities, CBCI can provide more affordable coverage and could be linked directly to financing for hazard mitigation.

Data, technology, and innovation

Better data are essential for improved decision-making and discovering new opportunities.

“Whether it’s building codes or pre-emptive risk mitigation, it costs money,” said [Dr. Michel Léonard](#), CBE, Triple-I vice president and senior economist. “Whether it’s new construction or public or private, you have to have people ultimately say, ‘It’s worth the money.’ The better the data at your disposal, the more accurately you can justify the expense.”

FEMA, for example, recently unveiled its [National Risk Index](#) (NRI) for natural hazards. The online mapping application identifies communities most at risk for 18 types of events, including flood. It visualizes the risk metrics and includes data about expected annual losses, social vulnerabilities and community resilience.

A wide range of established and start-up companies are using technology to provide more granular, targeted data to support decision making.

Part of an effort to reduce costs and eliminate inconsistent risk assessments in planning, the NRI uses a national baseline risk assessment to identify areas that offer high returns on risk-mitigation investment. NRI enables FEMA to talk with communities about specific risks, identify high-impact mitigation opportunities, and learn how they can make the best use of their risk-management resources.

“NRI wasn’t built in a silo,” said Casey Zuzak, senior risk analyst at FEMA, in a recent Triple-I [Resilience Town Hall](#). “We brought in local and county and state governments, [and] tribal and territorial governments to make sure we had the best available data. We also brought in academia, nonprofit organizations and private industry to make sure we had everyone’s input.”

NRI can help communities update emergency plans; improve hazard-mitigation plans; prioritize and allocate resources; identify needs for more-refined risk assessments; and encourage communication and engagement around risk.

“Nothing like this — a free, consistent, comprehensive nationwide risk assessment tool that addresses multiple hazards and includes social vulnerability and community resilience — existed before,” Léonard said. “This is an important addition to the tool kit of risk managers, insurers, policymakers and others working to create a safer, more resilient world.”

A wide range of established and start-up companies are using technology to provide more granular, targeted data to support decision-making. [HazardHub](#), for example, creates, models, deploys and supports large geospatial databases and translates huge amounts of geospatial digital data to help insurers and risk managers make real-world decisions. It also makes its data sets [available to consumers](#) to generate high-level risk assessments for their properties.

Parametric solutions

Just as better data and analytical tools opened the door to private flood insurance, they also have ushered in [parametric insurance](#). Unlike traditional indemnity insurance, parametric structures cover risks without the complications of sending adjusters to assess damage after an event. Instead of paying for damage that has occurred, it pays out if certain agreed-upon conditions — or *parameters* — are met. If coverage is triggered, a payment is made, regardless of damage.

Key advantages of parametric insurance



- Broad cover provides wide range of protections
- Quick payouts (typically less than 30 days)
- Significantly fewer restrictions and exclusions
- Pays out with or without policyholder sustaining any damages or losses
- Guaranteed payout when conditions are met
- Compliments tradition insurance coverages

Parametric policies are subject to the same regulatory framework as traditional indemnity policies, [according to the National Association of Insurance Commissioners](#). The greatest risk related to parametric coverage is basis risk — the possibility that a policyholder’s losses could differ significantly from the amount covered or that the policyholder could have losses without the parameter being triggered. Accurately structuring and pricing the product requires a firm understanding of the exposures and most important — selecting the best trigger. In the case of flood coverage, Swiss Re’s Junge said, “Water depth would seem the right trigger, but it’s tricky.” Water depth is not as straightforward and uniform a measurement as, for example, local wind speed, he said. Composition and pitch of the flooded ground are significant variables, as is the surrounding infrastructure.

Nevertheless, parametric coverage is being applied to flood risk, mainly outside the United States. FloodFlash, based in the United Kingdom, is writing parametric flood coverage, with each policy linked to a mobile-connected sensor installed at the insured property. When the agreed-upon trigger depth has been reached, FloodFlash is alerted, and the claims process is initiated without any documentation or inspection required.

“The great advantage of parametric insurance is that it removes so much uncertainty from the underwriting process,” [said FloodFlash co-founder Adam Rimmer](#). “For an underwriter, it is a much more appetizing problem to work out what the chances are of there being six inches of water or so inside, rather than working out if six inches of water means I’m paying \$2,000 for new carpets or \$2 million because you had your new stock in that day.”¹⁹

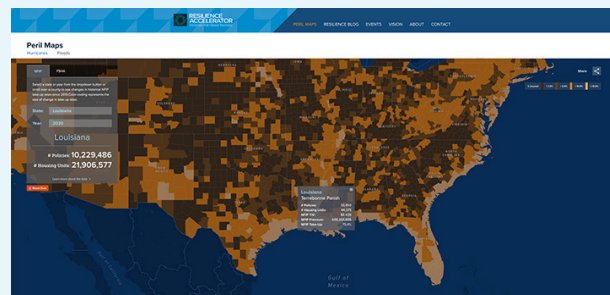
Reduced uncertainty for the underwriter means the price can be reduced for the property owner, Rimmer said. It also puts more of the responsibility for mitigation in the property owners’ hands.

Rimmer says FloodFlash hinges on two pieces of technology:

- A portal that allows any retail broker to log into to instantly generate a parametric insurance price for any building in the United Kingdom; and
- The sensors that monitor flood depth and facilitate the rapid payments.

He calls the portal “the underwriting department” and the sensors “the claims department.”

As well as improving affordability, parametric increases the speed with which claims can be paid. “We had a series of big floods in the U.K.,” Rimmer said. “The storm happened on a Sunday, and we paid all but one of our



Expanded Triple-I Flood Risk Maps Provide Richer Perspective

The [Triple-I Resilience Accelerator](#)’s flood risk visualization tool was enhanced this year with [National Flood Insurance Program \(NFIP\)](#) data on take-up rates by U.S. county from 2010 to 2021 and differences between take-up rates inside and outside of flood zones and in different proximities to flood zones.

Insurance take-up rates represent the percentage of people eligible for a particular coverage who take advantage of it. In the case of flood insurance, they are calculated as the number of policies in force in a certain geography over the total number of eligible properties for which insurance can be bought.

Understanding take-up rates is essential to assessing and improving communities’ ability to rebound from damaging events. But supporting meaningful action requires comprehensive, granular data only the NFIP can provide. It also requires the data to be available in easy-to-use formats.

This is where the Triple-I/NFIP collaboration comes into play.

[Dr. Michel Léonard](#), CBE, Triple-I vice president and senior economist, says: “We’ve worked closely with NFIP to ensure that our visualizations reflect the most current, accurate information available on flood insurance take-up rates. In addition, we wanted to add to the discussion surrounding NFIP take-up rates by providing less common yet insightful ways to understand and visualize take-up rates, such as take-up rates for properties in flood zones only, or the share of a country’s property in different proximities to flood zones.”

claimants on Monday. For those businesses, that speed allowed them to recover and to get their business operating again so much faster than if they were going through a traditional claims process.”²⁰

Innovate to mitigate

Risk transfer through insurance is only part of the solution to manage the impact of flooding. Some of the most interesting innovations now focus on preventing and mitigating flood damage to property.

Houston-based [FloodFrame USA](#), for example, offers a custom-installed system that surrounds a building and deploys a waterproof cloth barrier when waters reach a certain level. The barrier, propelled by the rising waters, climbs the sides of the structure to protect it and its contents from damage.

“During Hurricane Harvey, I remember watching the water inch towards my parents’ house,” said [Tasha Fuller](#), FloodFrame USA CEO and co-founder. “It was such a hopeless feeling because we couldn’t stop this force of nature at the time. I remember thinking that there must be some solution out there for people who want to protect their homes.”

Another Houston company, [Climaguard](#), has taken a similar approach to protecting vehicles. Like Fuller, Climaguard founder and CEO [Rahel Abraham](#) was inspired by personal experience with Hurricane Harvey. “I lost my car, and there was a shortage of rental vehicles,” Abraham said. “Living in Houston, I depend on my mobility — being vulnerable post the hurricane was a challenge. I realized that I needed help, and so did many of my neighbors.”

Made with a military-grade, waterproof, recyclable material, ClimaGuard coverings can be used to protect property other than cars. “I have a client who used it to protect a grandfather clock that was passed down through generations,” Abraham said. “I wanted the covering to be large enough to fit a car, but easy enough to use for quickly packing other valuable items in the home.”

Many new barrier-type solutions to prevent or minimize flood damage are emerging for residential, commercial and community applications, alongside well established techniques like using French drains and sump pumps to prevent water from accumulating around a structure’s foundation before a major rainfall can trigger seepage into the basement.

But such approaches can only go so far in the absence of farther-reaching strategies.

Nature-based protection

A healthy [coral reef](#) can reduce up to 97 percent of a wave’s energy before it hits the shore.²¹ [One study](#) quantified the global flood-prevention benefits of coral reefs at \$4.3 billion.²² But reefs — especially those that have been weakened by pollution, disease, overfishing, and ocean acidification — can be damaged by severe storms, reducing the protection they offer for coastal communities.



Fast claims turnaround is essential for preserving and restoring reefs and other natural features that protect coastal properties from storm surge. After a hurricane, a lot of work needs to be done to prevent further damage and set up a successful recovery period.²³ Combinations of parametric and traditional indemnity insurance might prove to be [the best solution](#).

Last year, Hurricane Delta triggered a 17 million peso (US\$800,000) [insurance payout](#) to the Trust for the Integrated Management of the Coastal Zone, Social Development and Security for the State of Quintana Roo, Mexico. The parametric policy cost the trust nearly 5 million pesos (US\$230,000), covering 150 square kilometers (58 square miles) of coastal ecosystems for the entire 2020 hurricane season.

Quintana Roo partnered with hotel owners, the Nature Conservancy and the National Parks Commission to pilot a conservation strategy that included coral reef insurance. The one-year parametric policy paid out when wind speeds greater than 100 knots hit a predefined area. The swift payout allowed for quick damage assessments, debris removal and initial repairs to be carried out.

Parametric coverage also might be applied to [protect mangrove forests](#), which frequently fall victim to development that creates the greatest potential for storm-related losses. In many places, [mangroves](#) are the first line of defense, their aerial roots helping to reduce erosion and dissipate storm surge. In Florida a [Nature Conservancy study](#) found that mangroves alone prevented \$1.5 billion in direct flood damage and protected more than half a million people during Hurricane Irma in 2017, reducing damage by nearly 25 percent in counties with mangroves.²⁴ Another study found that mangroves prevent more than \$65 billion in property damage and protect more than 15 million people every year worldwide.²⁵

Unlike coral reefs, mangroves do not usually require rapid post-storm interventions to survive. A variety of insurance products are available that might be tailored to meet the specific needs of mangroves — with initial payouts made quickly through parametric arrangements and assessed payouts made through indemnity coverage at a later stage.

Before a mangrove insurance policy can be developed and deployed, a full feasibility study would need to be conducted. The Nature Conservancy report recommends that this includes “higher-resolution flood-risk models, estimation of the wind-reduction benefits of mangroves, and the construction of fragility curves to show the relationship between damage to a mangrove forest and some component of a storm event, such as storm surge or wind speed.”

Affordability and equity

Concern has been growing among policymakers that low and middle-income households that need the financial protection of flood insurance are unable to afford it, and research generally finds that take-up rates are higher in areas where the hazard or risk perception is greater and increase with higher levels of education, income, and home values.²⁶

Given the difficulty many American families reportedly would experience in the face of an [unexpected \\$400 expense](#), and in light of the rising flood-related costs described above, affordability and equity have to be part of any discussion that uses innovation to close the protection gap.²⁷

Kousky has written extensively on the “ongoing tension between [homeowners’] requests for affordable insurance and the need for the private insurance sector to price catastrophic lines of coverage at premiums that reflect risk.”²⁸ During Triple-I’s 2021 virtual Joint Industry Forum (JIF), [she said](#), “We’ve not seen in the U.S. the use of risk



Carolyn Kousky speaking during the Triple-I’s 2021 virtual JIF.

transfer almost anywhere to help that segment of the population...Paper after paper shows that that’s a group that’s often left out of recovery and direct government assistance isn’t sufficient right now.”

Providing protection for lower-income households and communities, Kousky said, “is an area that would benefit from the public and private sectors working together.”

“Some of these ‘target communities’ that we’re most concerned about might not have enough disposable income to pay any amount of premium,” she said.

One approach she suggested might be an option is [microinsurance](#), which could provide low-cost insurance to individuals generally not covered by traditional insurance or government programs. Microinsurance tends to be much less costly than traditional products and thus can extend protection to a much wider market. Typically offered in the developing world, it often is distributed in cooperation with rural banks, savings and credit cooperatives, and humanitarian organizations providing nonfinancial services. Some programs rely on parametric triggers, as described above.

[Susan Holliday](#), an advisor to the International Finance Corporation (IFC) and the World Bank, also speaking at JIF, said, “We need think more broadly than insurance and risk transfer” and referenced a number of start-ups that are using aerial imaging and artificial intelligence (AI) “to look at vulnerability, literally down to the level of a building.” Such data-driven approaches can guide prevention and mitigation strategies in advance, informing decisions about whether, where, and how to build — thereby reducing the size of potential losses and claims and perhaps, enabling areas once considered uninsurable to get affordable coverage.

She also cited companies that are using [gamification](#) to help improve financial literacy among people who may not even know what insurance is. Gamification uses game techniques and elements to influence individual behavior. Most use cases involve prizes and points, competition, teamwork, and scorekeeping to motivate people to meet specific goals.

The United States could learn from some of these approaches that have been implemented in other countries, she said, though the state-by-state regulatory system presents some challenges in terms of uniform practices and concerns about privacy and consumer protection.

Tim Adams, President and CEO of the Institute of International Finance (IIF), concurred.

“There’s so much to be learned from so many other parts of the world,” he said. “A lot of innovation is going on in emerging markets because the regulatory regimes are a bit loose, and with their resource constraints sometimes you have to be a little creative in dealing with problems.”

Adams said the challenge is finding the right balance between state and federal jurisdictions and the benefits of a global approach. “We have to be really careful with any kind of regulation that we allow for innovation,” he said.

In response to a lack of federal policy, a small number of communities around the country have adopted their own flood insurance affordability programs. Kousky cites Portland, Oregon as one example. After NFIP pricing changes and several years of rising premiums, the city began to see flood insurance as a destabilizing force in some neighborhoods. The Portland Housing Bureau developed a three-part program to lower the costs of flood insurance for residents of older homes — those most impacted by increasing rates.

Portland’s [Flood Insurance Savings Program](#) helped participating residents lower their insurance costs through elevation certificates and insurance consultations that helped qualify them for reduced premiums through the NFIP: the program achieved an average savings of more than \$700.²⁹

This was accomplished without the use of direct support, such as through insurance vouchers, which Kousky and her co-authors said could be a useful complementary policy.³⁰



The resilience movement

A National Institute of Building Sciences [study](#) — based on the results of 23 years of federally funded mitigation grants provided by FEMA, the U.S. Economic Development Administration and the U.S. Department of Housing and Urban Development — found that [mitigation funding](#) can save the nation \$6 in future disaster costs for every \$1 spent. In the case of riverine flood, the savings are a \$7-to-\$1 benefit for such proactive steps as acquiring or demolishing flood-prone buildings.³¹

As flood loss trends worsen and awareness of the threat increases, a community of resilience has begun taking shape. It includes the private sector, government, nonprofits, academics, and others who recognize the pressing need for — and opportunities presented by — a robust resilience movement.

The Pew Charitable Trusts’ [Flood-Prepared Communities](#) project is focused on reducing the impact of flooding on communities by improving policies and planning at the federal and state levels to:

- Limit effects and cost of floods by directing resources toward proactive approaches like removing properties from flood-prone areas, increasing green space and restoring and protecting flood plains;
- Improve community resilience and reduce taxpayer losses by updating roads, bridges, schools, hospitals, and other critical infrastructure to better withstand future floods;

- Reduce the severity of floods, boost states' ability to withstand future storms, and lower disaster costs through systematic planning and adoption of nature-based solutions to address flood risks;
- Reform the NFIP to reflect current and future threats; remove incentives for development in flood-prone areas; and break the costly cycle of flooding, damage and repair.

In North Carolina, for example, "[The Action Plan for Nature-Based Stormwater Strategies](#)" — developed with Pew support — outlines the policy change, educational resources, community technical assistance, and continued research needed for state and local leaders to maximize the benefits of nature-based solutions.

Conventional stormwater approaches and traditional development that relies on concrete and asphalt cause rainwater to run off these surfaces, contributing to flooding and carrying pollutants into waterways. Nature-based solutions that preserve and replicate natural hydrology help capture and filter stormwater near where it falls. Backyard rain gardens and large-scale watershed restoration and land conservation projects are economical, effective approaches that can reduce flooding and improve water quality at the same time.

Like many states, North Carolina has seen an increase in heavy rainfall events. 2020 was the state's second-wettest year on record, with more intense and frequent rainstorms that inundated neighborhoods, damaged infrastructure, and disrupted local economies. With its long coast and many flood-prone areas within its coastal plain and mountain region, [planned changes in NFIP premium rates](#) would likely have a major impact on homeowners in the state, as more accurate risk assessments are implemented.

The action plan was informed by [four stakeholder working groups](#) that began meeting virtually in March 2020 to identify ways to expand the use of natural stormwater management in new construction, stormwater system upgrades, roadways and agricultural and forest land. The groups, consisting of regulators and practitioners, environmentalists and developers, local government representatives, and state agency officials, met to develop recommendations for a more ambitious and uniform approach to reducing flood risk and improving water quality.

North Carolina is just one state working with Pew, and Pew is just one organization facilitating resilience efforts. The [Zurich Flood Resilience Alliance](#) is globally engaged, and through its [Flood Resilience Portal](#), provides practitioners who live and work in flood-affected communities with easy access to the resources they need to build resilience. The [American Flood Coalition](#) is a nonprofit alliance of elected officials, civic groups, military leaders, and municipalities advocating for national solutions to flooding and sea level rise.

The energy behind such alliances — recognition of the threats and opportunities presented by the realities of a warmer, wetter world — also helps power the entrepreneurship to drive the development of new products, business models, strategies and expectations. While the resilience movement is still in its infancy, there can be no doubt of its existence or that the insurance industry is playing a critical role in its development.

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