GuyCarpenter OliverWyman Marsh Mercer

Response to the U.S. Treasury Request for Information on the Insurance Sector and Climate-Related Financial Risks

November 15, 2021

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Mr. Steven E. Seitz
Director, Federal Insurance Office

U.S. Department of the Treasury
1500 Pennsylvania Avenue, NW
Washington, DC 20220

Attn: Ms. Elizabeth Brown
Senior Insurance Regulatory Policy Analyst

Re: Marsh McLennan Submission in Response to Request for Information on the Insurance Sector and Climate-Related Financial Risks

Dear Director Seitz:

Marsh McLennan is pleased to respond to this Request for Information on the Insurance Sector and Climate-Related Risks. Our firm, comprised of Marsh, Mercer, Guy Carpenter and Oliver Wyman, has a 150-year history of helping clients address their most pressing issues. Today Marsh McLennan is the world's leading professional services firm in the areas of risk, strategy and people.

As the leading global commercial insurance brokerage, we know the insurance industry has many roles to play in the climate battle. As part of a $1 trillion industry, we are a powerful group of brokers, carriers and governing bodies. Alongside our industry colleagues, advancements in technology and policy will shape the future and betterment of our world.

Marsh McLennan is itself committed to sustainable practices. We have pledged to be carbon neutral in 2021, showing how the firm embodies ESG principles in our work for clients as well as in our day-to-day business. In addition, we have committed to reduce carbon emissions by 15% below 2019 levels by the year 2025.

Thank you for the opportunity to provide input.

Executive Order on Climate-Related Financial Risk

1. Please provide your views on how FIO should assess and implement the action items set forth for FIO in the Executive Order on Climate-Related Financial Risk.

Marsh McLennan: Organizations of all sizes, and governments across the world, are working to reduce emissions and make a low-carbon future a reality. Understanding the trends and data surrounding climate-related risk is critical to reaching our shared goals. The Federal Insurance Office (FIO) is uniquely positioned to lead the insurance industry in these global discussions.

FIO has the opportunity to bring a holistic view of the impact of climate change to the global stage. FIO's insurance expertise, coupled with the information and perspectives the Office can gather through the Federal Advisory Committee on Insurance (FACI) and other industry engagements, makes FIO an ideal advocate to provide guidance and promote products that can build resilient economies and encourage behaviors that mitigate the impact of climate disruption.

Insurance creates the right economic incentives to drive change in society. With the correct solutions, and thoughtful engagement with the broader insurance industry, FIO can harness and promote risk management strategies to build a more resilient US economy.

Our broader response highlights key data and analytics tools that have proved successful in helping our clients manage and mitigate the risks associated with climate change. Scaled more broadly, they will be able to support the Federal Government's role, and FIO's charge to leverage the role of insurance to drive a healthier climate.

Analysis of Portfolios

FIO's Initial Climate-Related Priorities

2. Please provide your views on FIO's three climate-related priorities and related activities, particularly with regard to whether there are alternative or additional priorities or activities that FIO should evaluate regarding the impact of climate change on the insurance sector and the sector's effect on mitigation and adaptation efforts.

A. Insurance Supervision and Regulation: Assess climate-related issues or gaps in the supervision and regulation of insurers, including their potential impacts on U.S. financial stability

Marsh McLennan: Marsh McLennan has been involved in the Climate Risk Sub-Committee of the Commodity Futures Trading Commission. Our conclusions of the Sub-Committee were that "climate change poses a major risk to the stability of the US financial system and to its ability to sustain the American economy" and that a "major concern" is what regulators currently don't know. Accordingly, regulators should take urgent action to "decisively measure, understand and address these risks". We therefore welcome this proposed focus of FIO and stand ready to support it in this endeavor.

B. Insurance Markets and Mitigation/Resilience: Assess the potential for major disruptions of private insurance coverage in U.S. markets that are particularly vulnerable to climate change impacts; facilitate mitigation and resilience for disasters.

Marsh McLennan: Over time, climate change is likely to drive risk-based premiums in private insurance markets up significantly in particular "hot spots" for key climate-related perils, such as wildfire and flood. This has the potential for significant socioeconomic impacts (rising inequality) and financial losses (property depreciation) and will require nuanced policymaking to protect vulnerable communities and mitigate economic losses whilst not crowding out private insurance from markets it is able to serve.

Generally, there is no incentive for individual insurers to cover costs of resilience measures. We will speak further to enhancing incentives in question #15 and detail how programs can be implemented to encourage financial investments.

C. Insurance Sector Engagement: Increase FIO's engagement on climate-related issues; leverage the insurance sector's ability to help achieve climate-related goals.

Marsh McLennan: The insurance sector is in a unique position with respect to climate change and has significant potential to help achieve broader climate related policy and societal objectives. As an investor, it can guide investment to low-carbon, climate resilient infrastructure and companies. As a de-risker of investment, it can help enable investment and financing for low-carbon, climate resilient infrastructure. As a provider of insurance, it can encourage low-carbon, climate resilient behaviors and technology adoption through pricing. As a provider of protection, it can help build resilience to climate change.

Climate-Related Data and FIO's Data Collection and Data Dissemination Authorities

3. What specific types of data are needed to measure and effectively assess the insurance sector's exposures to climate-related financial risks? If data is not currently available, what are the key challenges in the collection of such climate-related data? In your response, please provide

your views on the quality, consistency, comparability, granularity, and reliability of the available or needed data and associated data sources.

Marsh McLennan: Present-day risk evaluation consists of the following techniques: profiling based on first-principle insight, hazard mapping of known perils, scenario modeling, catastrophe modeling, and economic modeling. Numerous data providers and capabilities exist for each of these tools, so they can be used to address different types of risk insight and transfer. (See Table 1.) These techniques can serve a variety of market constituents from end consumers, carriers, brokers, reinsurers and capital markets. Moreover, these forms of risk quantification are critical in third party constituents in the insurance ecosystem including policyholders, regulators, rating agencies and investors.

Table 1: List of industry use cases for different risk quantification tools

Industry Use Case	First principle insight	Hazard mapping	Scenario modeling	Catastrophe modeling	Economic modeling
Data profiling	●	●			
Underwriting	●	●	●		
Risk accumulation	●	●	●		
Physical risk stress testing		●	●	●	●
Reinsurance risk transfer	●	●	●	●	●
Capital adequacy				●	●

3a. Physical Risk

The advancement of mapping and modeling of physical risk has been key to advances in the ability to underwrite difficult to place catastrophe risk. Both the frequency and severity of natural catastrophe events are increasing. However, with more data, projections can be developed that are more consistent. This is important for carriers when approaching their balance sheets, as well as for the public sector.

A wide range of return periods for all physical hazards, expressed in physical severity, and relevant for a geography, is an essential underpinning for physical risk data analysis; there are many providers of this data and, while robust single-peril models exists today, and some global multi-peril models exist, not all vendors are equally equipped to forecast peril evolution due to climate change and the answers can be highly divergent (e.g., in some cases disagreeing on whether a given geography will experience more or less pluvial flooding by 2050).

Data relating the severity of natural catastrophe events to severity of property damage, for example, is not usually databased and is often a source of modelling uncertainty or simplification (e.g., HAZUS flood vulnerability functions remain industry standard but are based on high-level archetype specifications). The resilience of individual assets to risks such as flood is something insurers do not always recognize, which can lead to inaccurate risk pricing or lack of appetite to cover these perils.

Related to the above, few commercially-available physical risk models exist that seek to treat business interruption rather than property damage. There is great uncertainty in this translation–given that two similar firms may set up their operations/points of failure very differently–so it is unsurprising these models are not commercially available. As business interruption, in our experience, can have a bigger impact on business viability than property damage in the climate modelling we have conducted, this is a potential blind spot.

Climate models at present do not typically treat wide-area risks (e.g., access roads, power lines, etc.) which could cause non-damage business interruption. By focusing modelling efforts exclusively on a building's boundaries, there is likely an under-read of climate risk faced by the insured and the insurer.

A large uncertainty to the mapping and modeling component is acceptance by insurers. Even if new models are developed, carriers may not accept and/or agree with the data presented and thus will not write the cover.

The case for standardization must include completeness and accuracy of data, and the ability for use in different cases. In the market currently, there is a lack of standardization which leads to fragmented data and the above issues discussed around carriers.

First-principle insight: distance to coast

The physical and geographic characteristics of each location in a portfolio can provide valuable insight into its risk profile. By aggregating metrics of physical and geographic parameters, indicators can be developed of potentially untenable concentrations of risk. While these aggregations do not provide complete insight into the risk profile of a portfolio, they are often the first step in understanding it. They can also serve as key differentiators when considering risk-based transactions.

With the proliferation of remote sensing technology, commercial data providers have emerged to provide data points that assist in quantifying observable characteristics. Freely available open-source data provided by the USGS, the National Oceanic and Atmospheric Administration (NOAA) and other government-related scientific bodies also form datasets for specific locations. These include elevation, land use, land cover, satellite imagery and the location of water bodies.

Hazard mapping

Hazard maps are an effective way to provide quantitative risk-differentiating metrics for specific locations. Ultimately, this risk differentiation can aid in the understanding of risk aggregation, inform location-level risk valuation and support the development of site-specific reliance strategies. Commercial vendors and open-source providers are beginning to create hazard maps that reflect the impact of possible climate change scenarios. These maps help various industries understand the regional and site-specific impacts of specific perils resulting from different climate stresses.

Resolution is an important consideration when examining the utility of hazard mapping for a specific portfolio of risks. Hazard-map analysis can be applied in many resolutions, and the appropriate degree of precision will generally depend on the peril under consideration. For example, flood hazard mapping, including digital flood insurance rate maps (DFIRM), is most informative when the risk is shown down to individual structures, because flood hazard varies significantly with differences in elevation. Conversely, severe convective storm (SCS) hazard mapping, such as Guy Carpenter's STORMi map, assigns risk categories for different SCS sub-perils at the county level. Different resolutions are necessary to accommodate the differences in underlying data sources and the semi-random nature of the observations informing the risk metric. While hazard maps feature some mitigation, site-specific mitigation is generally absent. For example, known levees are mapped within the DFIRM database, but elevated houses are not. It is therefore important to pair the physical risk with detailed site specific exposure information with all available attributes, which still proves to be a challenge in today's insurance market.

Scenario modeling

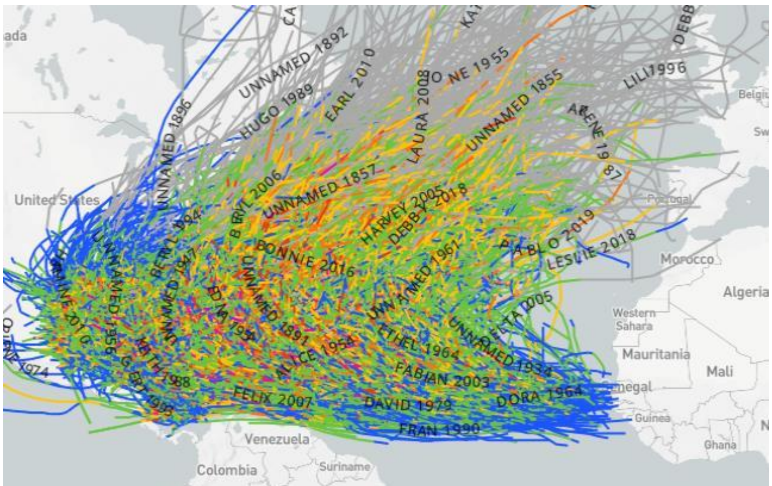
Hazard maps and first principles insight data do not account for correlation between locations. This is a limiting factor when examining how physical risks, such as flooding, may affect a region or a portfolio of risks, because not all locations will experience the same level of damage. Scenario modeling and mapping is a useful tool to examine how a portfolio of risks will respond to specific chronic and acute physical risks. This GIS-based exercise usually involves overlaying a particular hazard scenario footprint onto a portfolio of risks to identify which locations will be directly impacted. Loss estimation can also be incorporated into the modeling to estimate the financial impact of a particular scenario.

Scenario models represent either historic or hypothetical events used for a variety of risk quantification exercises. Historic event reconstructions provide valuable benchmarks for the resilience of a schedule of risks. Hypothetical events, such as the Realistic Disaster Scenarios published by Lloyds of London, are used to stress test portfolios and reinsurer balance sheets. Scenario modeling is also used to investigate event types that are expected to become more prevalent in a changing climate.

Catastrophe modeling

Catastrophe models are a collection of acute physical risk scenarios (called a stochastic catalog) that have calibrated the frequency and severity of the events to historic observations. Their most common application is for probabilistic portfolio-level risk analysis, and they are one of the primary tools used to quantify physical risk for risk transfer solutions. However, advances in technology, specifically around computational efficiency, have made possible greater application of catastrophe models along the value chain of risk quantification and transfer value. For example, the National Flood Insurance Program (NFIP) is currently leveraging a number of catastrophe models in their Risk Rating 2.0 initiative, which is aimed at aligning their rating methodology with current industry best practices.[1] Major commercial model vendors include AIR Worldwide, RMS, KatRisk and CoreLogic, each of which provides its own suite of models addressing acute physical risk. Major perils include hurricanes, earthquakes, floods, wildfires and severe convective storms.

Figure 1: Map of all historical events used to build and calibrate catastrophe models stochastic catalog.



[1] https://www.fema.gov/flood-insurance/work-with-nfip/risk-rating.

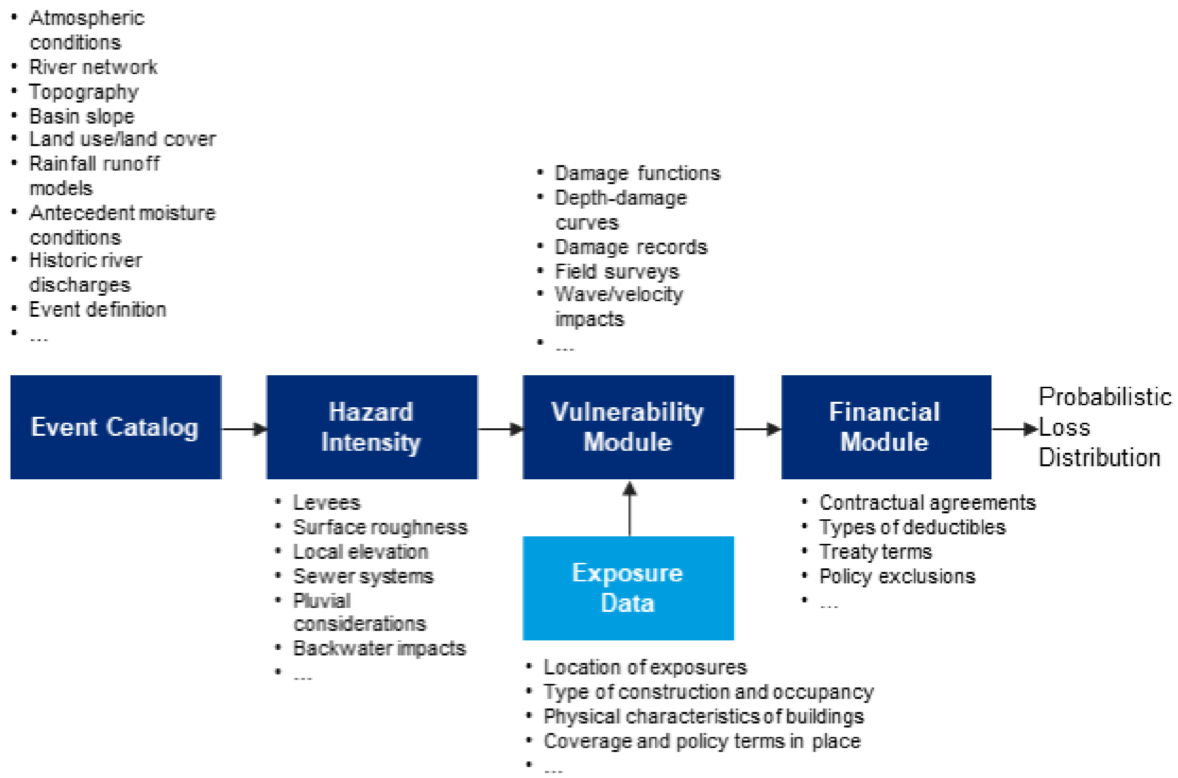
In addition to a catalog of hypothetical events, catastrophe models include a financial engine, which translates physical damage into structure and portfolio-level loss. This component is critical for indemnity-based risk transfer, as it allows both parties to correlate the loss magnitude to a certain probability. After a major catastrophic event, costs for material and labor generally increase as a function of availability. Catastrophe model providers include this in their loss estimates, by including loss adjustment factors calibrated on historical observations of increases in rebuild costs after events in different regions.

Catastrophe model vendors have experience in adjusting modeled frequencies to account for specific climate regimes. The most common adjustment accounts for different sea surface temperature scenarios, and provides valuable insight into potential financial losses at different stages in the La Niña-El Niño cycle. While specific scenario adjustments for near-term views are possible, comprehensive adjustments for different climate regimes have been stymied by the uncertainty over future projections of climate and its influence on the frequency and severity of specific perils. Another limitation is the ability to alter the specific attributes of a weather event that may shift in a future climate within a catastrophe model that is already in the marketplace; only the catastrophe modeling companies are able to update the hazard modules of their models.

The modeling of potential financial losses varies among perils, because different physical attributes have different sensitivities to the unique damaging element of each peril. In addition, while historical datasets used for calibration are generally consistent between model vendors, differences in modeling methodology can lead to significant differences.[2] Different model vendors take different views on the sensitivity of specific building characteristics. Marsh McLennan assists clients in understanding these views, so that they can make informed choices when they select the most appropriate combinations of perils and geographic factors for their specific goals. If necessary, they can make adjustments to align stochastic loss estimates with historical experience. A current limitation in many models is to augment the output to consider a range of mitigation techniques beyond location level attributes; community and regional man-made mitigation and resiliency efforts that may decrease loss potential in a future climate scenarios are not able to be accounted for in current catastrophe model technology.

[2] Franco, Guillermo, et al. “Evaluation Methods of Flood Risk Models in the (Re)Insurance Industry.” Water Security, vol. 11, Dec. 2020, p. 100069. ScienceDirect, doi:10.1016/j.wasec.2020.100069.

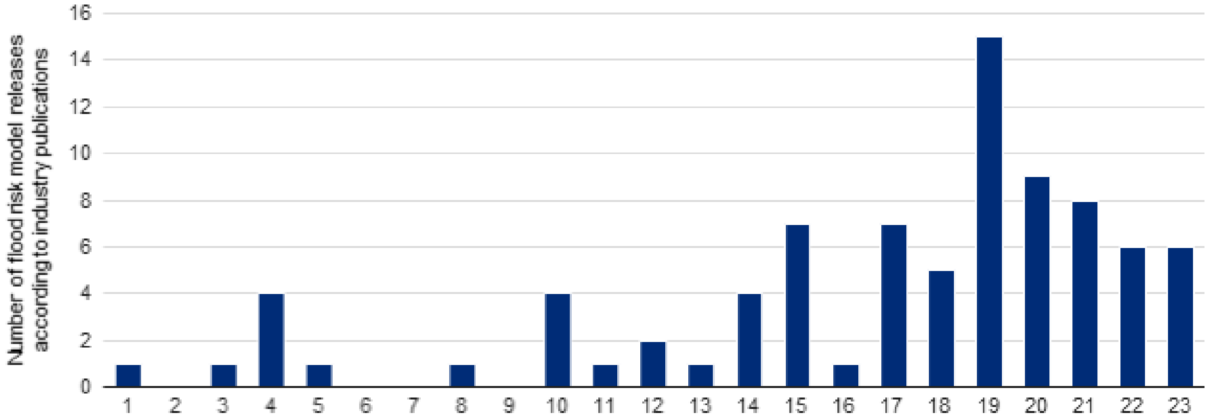
Figure 2: Modeling Catastrophe. Anatomy of a catastrophe model with necessary inputs for each section from Franco et al. 2020. Used to identify components suitable for adjustment to align with historical experience. This process is justified through extensive an analysis into historical portfolio losses.



Understanding the insurance sector's exposure to climate-related risks begins with an adequate quantification of today's risk (or baseline risk) prior to developing a future risk assessment. Individual insurers develop a baseline view of risk through sophisticated interpretation of location-specific risk metrics, actuarial models and catastrophe models. The understanding and trust of these catastrophe models has been gradually increasing since they were first introduced into the Florida insurance market in the mid-1980s. While initially viewed with skepticism, an accurate estimation of Hurricane Andrew loss in 1992 proved catastrophe model's utility and have since become engrained in insurance operations. However, not all perils have been proactively modeled.

Flood modeling, for example, while quantified at local scale, did not begin to emerge as a peak peril for the insurance industry until after Hurricane Katrina demonstrated the capability of storm surge to produce an industry loss as large as or larger than many hurricane wind events. This event specifically highlighted the deficiencies in existing technology and inspired many model vendors to enhance their modeling offering with flood perils (see Figure 3). In addition to the market demand, improved computing power, better data collection techniques and more efficient algorithms have allowed flood modeling efforts to improve accuracy and efficiency. Since Katrina, most insurers have some, but not complete, considerations in their view of risk to account for the potential for flood-related disruptions.

Figure 3: Flood model release by year.
Approximate number of new yearly releases of flood risk models deployed for usage within the (re) insurance industry as announced in global press releases (compiled via an internet search of insurance publications such as Insurance Journal, Intelligent Insurer, Artemis, as well as from cat modeling vendor firms' websites) A "new release" may include a new model or an updated model for a given country or region, as well as the inclusion of a new flood-related peril into other modeled perils, such as storm surge for hurricane models or tsunami for earthquake models.



In addition to catastrophe models to understand baseline risk, exposure data is paramount in accurately estimating potential loss in present day and in the future. While many insurers understand the benefit of collecting data such as rooftop geocoding, site-level flood protections and first floor height, recent events continue to reinforce the need for high quality location specific building information. Advances in machine learning, image recognition and predictive analytics continue to fill in gaps and allows insurers to operate at scale.

Hurricane Harvey, and recent hurricanes in the northeast including Hurricane Ida, demonstrate the catastrophic potential of flood even in areas outside of the Special Flood Hazard Area (SFHA). For Hurricane Ida, CoreLogic estimated residential damage between $6 and $9 billion[3], yet less than half of that damage will be insured. Despite continuing efforts to inform the public about the dangers and likelihood of flooding outside designated zones, the NFIP take-up outside of mandatory purchase zones is still far below the take-up inside the SFHA. While some of the risk is currently being assumed by private insurers, the vast majority of loss will ultimately be uninsured, and those home and business owners will be left with significant financial burden.

Climate change has and will play a critical role in financial risk quantification. While climate change can manifest differently across geographies with varying degrees of severity and across different time horizons by peril, the impending shifts require the insurance industry to contrast their baseline view of risk with potential future scenarios climate state risk. Sea-level rise is one of the most pronounced and observable climate change signals. Sea level rise can lead to increased storm surge, more frequency and more severe disruptions from nuisance or sunny day flooding, decreased drainage capacity through sewer systems, salt water intrusion on drinking water aquifers and many other disruptions. The magnitude of the rise can vary dramatically by geography. Higher density gauge networks improve the estimation of this highly localized phenomena. Better representation of tail risk through climate models and catastrophe model adjustment also helps quantify risk. Unfortunately, existing climate models are currently not well-tuned to capture future extremes. Longer simulation time frames with higher resolution are needed to adequately represent tail events. To accomplish this, increases in computing power and consistent funding for climate change-related research is needed. Additionally, we are limited in our ability to estimate future climate by our ability to observe historical events and train models. Continued improvements in the scientific community's ability to recreate major historical events will ensure robust calibration datasets[3].

The flood peril suffers from a risk communication gap that is well documented. Many homeowners and communities are unaware of their exposure, leading to low insurance take-up rates and an ultimately negative perception of the insurance industry when large events occur and many losses are ultimately uninsured. More robust risk communication must be paired with higher quality and detailed natural hazard data about industry-wide risk. Additionally, locations that have suffered severe repetitive loss must be identified more readily, to allow for property owners and municipalities to mitigate against those risks. Mitigation investment should be paired with greater balance of risk management and risk transfer based solutions; elected representatives at local, state and federal levels need to start leading by example. Community Based Catastrophe Insurance (or CBCI) is a promising financial instrument designed to spread risk over entire communities and enforce a high take up rate. In addition to higher resolution climate data and more robust location specific metrics, new and innovative solutions can supplement existing solutions to help build resiliency among communities at risk. FIO, together with FEMA and in concert with State regulators, can play an important role in promoting this new direction.

3b. Transition Risk

In order to model transition risk, estimate the emissions footprints of their portfolios and develop approaches to steer investment and underwriting activities in line with stated decarbonization objectives (such as net-zero portfolio emissions), insurers need comprehensive, granular and robust data on emissions and other transition-related indicators. Examples include:

Company-level data on current and future emissions (Scope 1, 2 and 3*) for insureds (to estimate current and future underwritten emissions) and investments (to estimate current and future financed emissions). Particular challenges for company-level data include the availability of Scope 3 emissions (which are often unavailable/not disclosed) and an absence of data for mid-caps, SMEs and for private markets.

Asset-level data on current and future emissions (Scope 1, 2 and 3*) for insureds and investments, recognizing of course that insurers may insure and own individual assets as part of their activities. Asset level data may be particularly challenging to access, although efforts are underway to increase transparency for high-carbon assets (see, for example, Asset Resolution and Oxford University's Spatial Finance Initiative).

Revenue and output data at company and asset levels. Insurers may use economic emissions intensity (emissions per unit revenue) or physical emissions intensity (emissions per unit output) to set portfolio level metrics and targets, thus requiring information on revenue and production (e.g., MWh for a power plant, or tons of grain for an agribusiness) in addition to emissions data. This data may face similar availability challenges (e.g., for individual assets, unlisted companies, etc.).

Depending on their business mix, insurers may have significant non-life personal lines in high carbon sectors, such as buildings and auto. These lines may make important contributions to underwriting emissions that the insurer wishes to address. Of course, individuals do not measure or disclose their emissions, so for personal lines insurers require estimates for (e.g., building emissions from construction and operation or driving). These estimates can be improved with additional contextual

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[3] https://www.nature.com/articles/s41558-020-00984-6?proof=tr

***Scope 1** covers direct emissions from owned or controlled sources. **Scope 2** covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company. **Scope 3** includes all other indirect emissions that occur in a company's value chain.

data from insureds that may be readily available to insurers (e.g., size, age and location of property; type, age and miles driven for an automobile).

Mercer has a handful of tools that may be useful to FIO and their constituents in seeking this data:

Table 2: Mercer climate transition tools.

Tool	Uses	Output
Analytics for Climate Transition "ACT"	Enables investors to assess climate risk across all assets	Data will be used to prioritize and detail improvement. Outline climate strategy.
Climate Risk Analyzer "CRA"	Test resiliency of portfolios under certain asset allocation	Undertake climate scenario analysis and stress testing for client awareness of climate on portfolios.
MercerInsight	Database of low carbon and climate transition investment strategies	Support for clients in implementing climate change investment strategies.
Climate and ESG Peer Benchmarking	Database of ESG and climate change practice of asset owners	Benchmark leading practices to enable clients to implement and measure their own.

4. What are the key factors for the insurance sector in developing standardized, comparable, and consistent climate-related financial risk disclosures? In your response, please discuss whether a global approach for disclosure standards needs to be adopted domestically for insurers. Please also address the advantages and disadvantages of current proposals to standardize such disclosures, such as those set forth by the Task Force on Climate-Related Financial Disclosures or the NAIC's Insurer Climate Risk Disclosure Data Survey.

Marsh McLennan: Insurers have made strong progress on climate-related financial disclosures in recent years, reaching an average TCFD-aligned disclosure level of 34% in 2021, compared to 28% for banking.[4] However, climate risk disclosures present many challenges for insurers, and those we are working with view this as a process of continual improvement, refinement and increasing sophistication. Key factors to consider in developing standardized, comparable and consistent climate-related financial risk disclosures include:

Modeling of physical risks for large property portfolios. Insurer catastrophe models are not appropriate to estimate forward-looking physical risk impacts without adjustment, because they are calibrated using historical loss data which is not representative of the future climate. To extract estimates of regulation-relevant metrics such as average annual loss and 1-in-100 year loss, these models must be adjusted, based on climate science, to approximate future climate scenarios. Guy Carpenter has assisted numerous insurers in this process.

[4] TCFD, *2021 Status Report*, October 14, 2021.

One limitation in adjusting catastrophe model output for current day weather and climate is the few options a user has to adjust the model output. It is not possible to alter the fundamental characteristics of an event that could be altered by a future climate (rate of forward speed, intensification, rainfall, hail size, tornado outbreak, etc.). Rather, end users need to adjust the probabilities of the individual events already present in the catalog for future projected outcomes. Thus, few variables can be adjusted without cross-correlation issues that will start to degrade the integrity of the catastrophe model due to the manner in which calibration of catastrophe models takes place.

A number of “climate services” vendors offer physical risk data estimating how the frequency and severity of natural hazards are expected to change under different climate scenarios and in different timeframes, and some also offer financial modelling for geocoded property portfolios, thus providing insurers with another possible approach.

The strength of the current climate services vendors is location-level intelligence, albeit with an approach that can lack transparency in assumptions to create future climate views at a given location, for a given peril, and a time in the future. Additionally, these vendors lack proven techniques to aggregate individual location data across all risks within an insurance portfolio, in order to provide a holistic view of future views of risk that is attained with catastrophe model techniques.

Without leveraging the probabilistic catastrophe model techniques prevalent in the marketplace to assess capital adequacy, appropriate levels of risk transfer between insurers and reinsurers and drivers of increased volatility potentially caused by shifts in correlation of loss across risks, a fully proven analytical capability to transfer risk through the marketplace at a portfolio level is still in nascent and incomplete stages.

Modeling transition risk for underwriting portfolios. The profitability of insurers’ underwriting activities is exposed to the transition to a low-carbon economy. Profitable lines of business in high-carbon sectors will decline, while lines in low-carbon sectors will grow, but potentially with exposures to poorly understood new technologies and business models with less attractive underwriting performance and limited loss histories. Insurers’ exposures will be determined by the mix of their existing portfolios and the actions they take to steer their underwriting to manage transition risks. Insurers will need to undertake scenario analysis to understand the potential impacts of different transition scenarios on different books of business and put in place metrics and targets to track risks and steer the portfolio profitably.

Modeling physical and transition risks for the investment portfolio. Insurers also face physical and transition risks to their investments. Various models exist to help insurers and other asset owners estimate physical and transition risks for investment portfolios—for example, Mercer’s suite of investor climate models or the physical risk models of climate services companies. A key goal here is ensuring consistency with approaches applied on the liability side of the balance sheet; this relates not only to financial modeling (e.g., common scenarios, model assumptions) but also to the coherence of investment and underwriting strategies, particularly with reference to climate sensitive sectors such as energy.

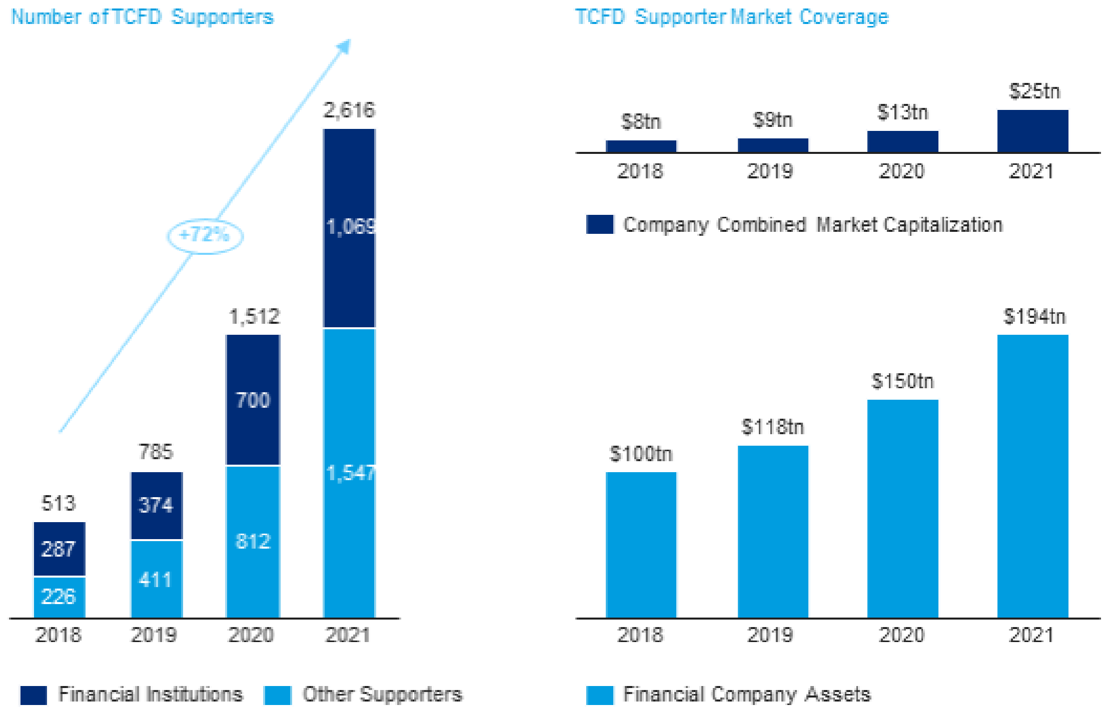
Consistent measurement of GHG emissions associated with underwriting and investment. In order to accurately model transition risk, insurers must be able to account for the GHG emissions associated with their underwriting and investment portfolios. Currently, both types of GHG emissions fall under Category 15 of the GHG Protocol. There has been some progress recently by the Partnership for Carbon Accounting Financials (PCAF) to develop standardized, GHG-Protocol-aligned methodologies for certain classes of loans and investments. PCAF plans to publish methodologies for GHG emissions related to underwriting or for GHG emissions for financial products such as investment funds, green bonds, sovereign bonds, loans for securitization, exchange traded funds, derivatives and initial public offering underwriting.

As with accounting standards, there is a powerful logic for adopting global standards for the disclosure of climate-related risks and opportunities. Such disclosure better enables investors and regulators to analyze insurers' climate risk exposures, engage with them and make informed comparisons between them. A single common framework also helps insurers by streamlining the risk disclosure process, and mitigates against the risk of climate disclosure becoming a "tick box exercise" because a single framework is more likely to become embedded in business operations and inform decision-making.

The NAIC's Insurer Climate Risk Disclosure Data Survey helped raise awareness for and interest in climate-related disclosures but has had limited regulatory uptake, with only six states requiring participation.[5] In addition, beginning in 2019, US insurers were given the option to submit their TCFD-aligned disclosures instead of the survey, showing an increased recognition for the support TCFD has achieved worldwide.

Therefore, we believe the TCFD framework is the leading candidate for a global climate risk disclosure regime, but that it will need to be coupled with more specific guidance to make climate-related disclosures fully standardized across the industry. Through Oliver Wyman's work this year supporting the TCFD secretariat, we have tracked the strong international momentum behind the TCFD framework. Today, over 1,000 financial institutions worldwide, responsible for $194 trillion of financial assets, support the TCFD framework (see Figure 4).[6]

Figure 4: Growth in support for TCFD



Source: Task Force on Climate-related Financial Disclosures, *2021 Status Report*

In addition, a growing number of financial regulators and policymakers have integrated TCFD into frameworks, expectations, policy proposals or new regulations.[7] TCFD also has broad support among

[5] NAIC, Assessment of and Insights from NAIC Climate Risk Disclosure Data, November 2020.
[6] TCFD, *2021 Status Report*, October 14, 2021.
[7] Ibid.

important international bodies and standards setters, including the G7, the G20, the IFRS Foundation, and IOSCO.

It is clear from the latest developments outlined in the TCFD's *2021 Status Report* that governments and regulators around the world see the TCFD recommendations as a compelling, credible foundation from which to base regulation of climate-related financial risks. That said, the TCFD is not itself a standard-setting body and has defined their four recommendations, 11 recommended disclosures, and associated implementation guidance broadly with the view that jurisdictions will develop more specific guidance.

The TCFD's 2021 *Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures (2021 Annex)* includes supplemental guidance for the insurance sector but does not always provide enough detail, including around modeling and emissions measurement noted above, to ensure comparable and consistent reporting. To give just one example, it notes that (re)insurers *"that perform climate-related scenario analysis on their underwriting activities should provide the following information:*

- description of the climate-related scenarios used, including the critical input parameters, assumptions and considerations, and analytical choices. In addition to a 2°C scenario, insurance companies with substantial exposure to weather-related perils should consider using a greater than 2°C scenario to account for physical effects of climate change and
- time frames used for the climate-related scenarios, including short-, medium-, and long-term milestones."[8]

However, the supplemental guidance does not include guidance on whether specific scenarios (e.g., IEA, NGFS) should be used, what "greater than 2°C scenario" is most appropriate for physical risk assessment or what perils should be considered. As noted above, such information on common scenarios and model assumptions are key factors required for comparability.

As such, it is our view that the broad support for TCFD and the growing familiarity with its recommendations within the insurance sector makes it the best framework from which to build, but FIO should consider what additional guidance is needed to ensure comparability.

[8] TCFD, Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures, October 14, 2021, p. 33.

Insurance Markets and Mitigation/Resilience

10. What factors should FIO consider when identifying and assessing the potential for major disruptions of insurance coverage in U.S. markets that are particularly vulnerable to climate change impacts?

Marsh McLennan: This is a challenge for individual consumers, businesses, local governments, state governments and at the federal level. Populations have different exposure to natural catastrophes and loss characteristics prior to introducing climate-related risk, which future events will only further stress and amplify future losses to life, infrastructure and GDP.

Capital is an essential cornerstone. Who are the constituents driving the direction of capital, what is the level of capital required for different lines of coverage, what are the rating agency views of certain markets and what is the required industry return on capital? Which leads to different questions, one of which is—who drives these discussions on solvency?

Prior to climate considerations, there was historical profitability in this sort of vehicle for investors. It was met with a bit of volatility, but this sort of investment provided diversification from other financial instruments. The structure of the industry was one of traditional indemnity. For large-scale catastrophe risks, we saw the emergence of new mechanisms to transfer risk. Fair plans, are essentially run like state insurance pools, and in instances have become much larger than initially anticipated. Other sorts of pooling programs in order to group together risks of a certain likeness. Marsh McLennan has been instrumental in putting together several government schemes:

- FONDEN—Quake and Hurricane, Mexico
- National Flood Insurance Program, FEMA—Flood, United States
- California Wildfire Fund, CEA—Wildfire, United States
- SEADRIF—Typhoon and Flood, ASEAN

Catastrophe schemes include elements of traditional indemnity as well as alternative risk transfer. Advances in parametric to catastrophe bonds and other insurance-linked securities are showcasing innovation is at the forefront of battling a changing climate.

As the climate continues to change, we will have more data, but we will also have more uncertainty as to what is next. With more uncertainty will come higher capital requirements to compensate for certain risks. We are seeing this in real time with the peril of wildfire, for example. This uncertainty is leading to more retained risk on company and/or government balance sheets. Higher deductibles, as well as lower limits, are adding to this issue even if coverage is available.

BenchmaRQ, a tool by Guy Carpenter, translates collected data and breaks down what it could mean for the insurance marketplace and how different regions or insurers are impacted.. As an example, the increasing severity of convective storms can be modeled, and the results may show certain pockets of a geography or lines of coverage and/or carriers that are deeply exposed. If models are shifting towards more frequency and severity, this could equate to more capital needed for the same risks. With this could come changes to required financial strength as well as solvency issues, which governing bodies need to closely monitor.

The mapping/modeling element is only part of the puzzle. Disseminating the data and tracking to see who will take on the majority of the volatility, and where, can help prepare the insurance industry prior to large catastrophe events. Without this sort of analysis on the back end of the data, the industry could face a lack of competition and much uncertainty around pricing and coverage availability.

The overarching view is that the insurance industry cannot manage this alone. Government, private sector companies and the insurance industry must each take on critical roles in order to orchestrate a solution. This includes infrastructure investment by the federal government, and capital providers to curtail risk selection and write business for some perils that may be more risky than others.

An example would be the performance of the Army Corps of Engineers Hurricane Storm Damage Risk Reduction system, built to withstand a 100-year flooding event from rainfall and storm surge through reconstituted levees, floodwalls, permanent canal closures and fortified pumping stations. Most notably, the 1.8 mile long, 26 foot tall Inner Harbor Navigation Canal Surge barrier held Ida's 15-foot surge from inundating the city 16 years after Hurricane Katrina flooded nearly 80% of the city.

The risk of an emerging "green protection gap" should also be considered. New clean technologies, such as offshore wind and utility scale solar PV, are critical to decarbonization efforts but are typically more exposed to extreme weather than traditional energy and power infrastructure. This is resulting in a more conservative underwriting environment for renewable technologies and the beginnings of a green protection gap that may increase project and financing costs. Climate change may exacerbate this dynamic—for example, by contributing to an increase in hurricane strength, leading to increased threat to offshore wind farms in at-risk areas. During the progression of the "green protection gap", investments in grid reliability remain essential to ensure communities are able to recover as quickly as possible with reduced time for grid restoration. Insured and economic losses escalated in Hurricane Ida due to the extensive amount of power poles destroyed, more than Hurricanes Ike (2008), Rita (2005) and Laura (2020) combined. The 30,600 poles damaged or destroyed during Ida was 75% higher than in Katrina (2005).

The risk of a green protection gap is also relevant to critical breakthrough technologies needed in hard to abate sectors—such as carbon capture, utilization and storage (CCUS), hydrogen and low carbon building materials such as novel cements and cross-laminated timber. These may have poorly understood risks and a lack of historical loss data that together contribute to a lack of capacity.

11. What markets are currently facing major disruptions due to climate change impacts? What markets are likely to be at risk for major disruptions due to climate change impacts in the future? When discussing markets at risk for future disruption, please estimate the likely time horizons (e.g., 5, 10, 20, or more years) when these disruptions may occur.

Marsh McLennan: While one region could experience major physical changes, the impacts on other regions could be restricted to more modest economic or recreational impairments. The resilience of regional infrastructure and its performance under climate change will be crucial to the health of local markets, given the impact electrical, water and sewer systems have on quality of life. In addition, major components of power grids, transportation infrastructure, water supply and sewers are vulnerable to climate change, and the damage or loss of these components could take years to recover. For regional, state and ultimately the scale of the federal government, the scale of material losses will be informed by the peril, the region, and the category of physical risk—whether it is acute, chronic or an accumulation of severe acute threats.

The interconnections of a range of societal variables in conjunction with the severity of impact of a physical risk event will ultimately give rise to consequences that have not yet been contemplated—or, at least, that have not yet been recorded. Seven key social variables are spatial footprint, infrastructure repair, supply chain, liability of utilities, economy and employment, home price depreciation and population migration.

Table 3: The full spectrum of climate change risk for local to super-regional areas of the United States

Variable	Limited	Minor	Moderate	Major	Massive
Spatial footprint	Neighborhood to community	City	Metro regions	State(s)	Super regional
Infrastructure repair	Limited	Weeks to months	Quarters	Years	Irreversible damage
Supply chain	Negligible	Price increases	Lack materials	Breakdown	No available sources
Liability of utilities	None	Tougher legislation	Increased utility costs	Bankruptcy	Government takeover
Economy and employment	Strength on rebuilding	Stagnation/ reduced growth	Reduced employment opportunities	Recession with interest rate implications	Depression
Home price depreciation (HPD)	Negligible	Temporary HPD/incidental defaults	Extended HPD/ moderate defaults	Multi-year and widespread HPD-widespread defaults	Severe HPD amid lack of demand-widespread defaults
Population migration	None	Temporary relocation for affluent	Affluent homeowners relocate	Increased migration of all demographics	Permanent population reduction

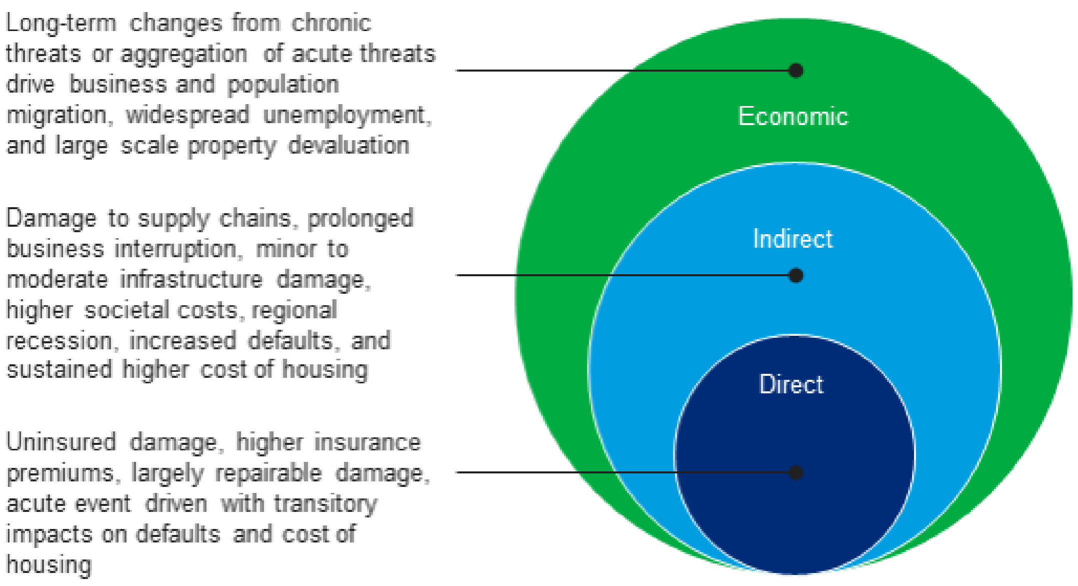
Surveying the three manifestations of physical risk—chronic risks, acute risks and the accumulation of severe acute risks—indicates a multitude of plausible ways by which major and massive impacts can transpire, identified in Table 3 above). Combining the type of physical climate risk in concert with the seven societal variables results in a taxonomy of potential impacts on certain elements, with the scale growing from the direct to the indirect and ultimately to the economic scale.

Direct impacts are typical for catastrophes and natural disasters that currently occur across the United States. Common financial consequences are uninsured damage and higher insurance premiums for insured perils. A current example of direct impacts would be wildfire insurance coverage in California and other states that have seen elevated activity over recent years. While severe on a local to regional scale, these catastrophes are anticipated to be the norm, subject to natural volatility of peril frequency and severity, for at least the next ten years.

Indirect impacts can have a larger scale. Supply chains can be impaired, and prolonged business interruption claims can follow minor to moderate infrastructure damage. These higher societal costs can result in a regional economic recession, accompanied by increased potential for loan defaults and a sustained higher cost of housing. An example of a catastrophe triggering indirect impacts would be a large earthquake, or possibly a major hurricane hitting a major metropolitan area of the United States. Indirect impacts could be expected from a severe single event, which most likely would be more largely driven by natural variability than climate change.

Economic impacts have the scale and severity to have a significant impact on a city or potentially region. Long-term changes from chronic threats can drive the migration of both population and businesses. The migration of population and the exodus of commerce can cause widespread unemployment and large-scale property devaluation and increased default.

Figure 5: The rippling financial impacts of climate change



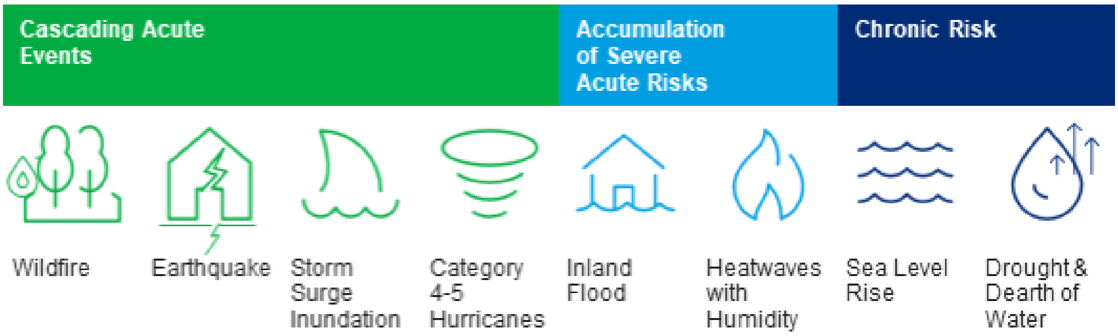
What perils influenced by climate change can give rise to economic impacts severe enough to drive large-scale property devaluation?

Among chronic risks, the irreversible rise of sea levels will render some coastal property uninhabitable. Before the seas rise enough to trigger economic impacts such as population migration and large-scale property devaluation, challenges with ingress and egress for these communities could result in direct and indirect impacts threatening the insurability of these areas. Even under aggressive warming scenarios, most populated regions of the United States coastline is not anticipated to reach this threshold until the middle of the 21st century.

In contrast, another chronic threat to the world repeated long-lasting droughts that lead to a comprehensive dearth of water in a region. As reservoirs and aquifers deplete, the lack of water for human consumption and industrial use could rapidly cause longer-term economic impacts. The current multi-year drought across much of the Western US is increasing in concern for water usage in coming decades. Most studies suggest that if this chronic threat were to materialize, it would be at least 20 years in the future.

An accumulation of severe acute risks of increasing frequency can also give rise to concern for market viability of insurance. In regions experiencing statistically significant increases in rainfall (due to rainfall covering larger areas or being heavier and more severe in nature), floods could be more frequent in the future. These events could increase the degree of economic disruption and potential insurability. A lack of timely investments in rainwater removal systems may result in an increased frequency of flooding, which could depreciate home values across a metropolitan region.

Figure 6: Climate Events of GSE Concern Relative to Risk Type and Scope



Longer heatwaves and higher humidity for longer periods of the year are a concern across the southern United States. If high humidity prevents bodies from cooling properly, outdoor activities may no longer be possible, hurting economies that require outdoor activity. While this is likely not a direct impact to property insurance coverage, it could have impacts on agriculture, workers compensation and plausibly liability and health insurance coverages.

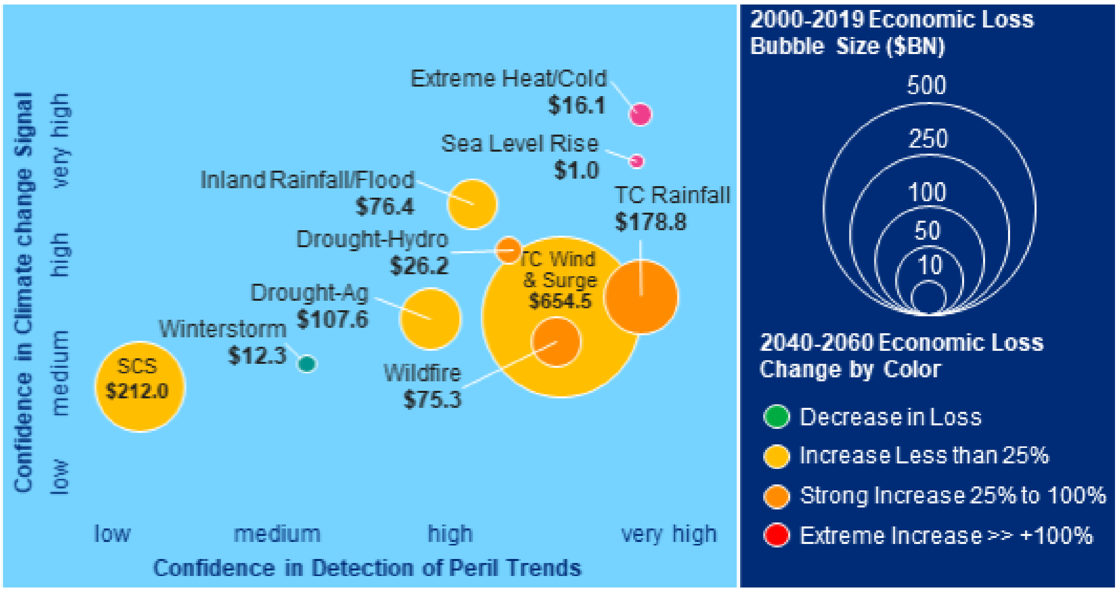
Among the less likely ways markets could be affected are cascading impacts on the heels of a natural disaster. Wildfires, earthquakes and Category 4 and 5 hurricanes with accompanying storm surges are not, in and of themselves, conventionally regarded as events large enough to influence widespread economic damage for a prolonged time. However, cascading events after such a natural disaster can increase the threat of indirect and, potentially, economic impacts. Will the increased frequency, duration and severity of wildfires make pre-emptive power outages commonplace—and will populations begin to move due to a lack of reliable power? Will storm surge inundation from a major hurricane combine with excessive rainfall to cause a large-scale environmental disaster that renders certain regions uninhabitable? These questions indicate areas ripe for further investigation, and much hinges on mitigation and resiliency measures to possibly lessen these impacts. From a modeling perspective, cascading serial catastrophes are very challenging to quantify, because they involve more than one systemic failure(s) across multiple aspects of society.

The confidence in projections and expectations of future impacts of climate change are illustrated in Figure 7. Two key attributes summarize the scientific literature to provide a comparative assessment of confidence across perils:

Confidence in Climate Change Signal: How likely is the discernable trend of an individual peril attributable to human induced climate change?

Confidence in Detection of Peril Trends: Does the body of published scientific research conclude that recent trends in peril risk have a meaningful trend due to a changing climate?

Figure 7: Confidence in climate change signals and direction of peril trends.



Each US catastrophe peril is ranked on a four-category confidence scale (low, medium, high, very high) based on the scientific consensus of the Intergovernmental Panel on Climate Change, the US Fourth National Climate Assessment and an extreme weather assessment of climate change from the National Academy of Sciences in 2016. The size of the bubble represents the economic loss level as measured by NOAA's billion dollar database from 2000-2019. For projections 20-40 years into the future (2040-2060), the color of the bubble indicates the projected percentage change in economic loss due to climate change influences alone.

14. How should FIO assess the availability and affordability of insurance coverage in U.S. markets that are particularly vulnerable to climate change impacts? In your response, please discuss how to balance maintaining insurer solvency with the need to address the availability and affordability of insurance products responsive to perils associated with climate-related risks, particularly for traditionally underserved communities and consumers, minorities, and low- and moderate-income persons.

Marsh McLennan: As climate change leads to increases in the frequency and severity of perils such as wildfire and flood, the risk-based premiums in private insurance markets will increase. These increases will be uneven, concentrated in hotspot regions most exposed to the perils in question. As Marsh McLennan's report "Sunk costs: The socioeconomic impacts of flooding" argues, this may lead to a cycle of more frequent disasters and rising inequality because socioeconomically disadvantaged groups are more likely to live in at risk areas, more likely to remain in at risk areas and more likely to move into at risk areas as properties devalue.

Extending insurance cover among vulnerable communities can break this sequence and enable people to recover. Government can consider a number of approaches for how to do so. These range from targeting vulnerable groups with *Community-Based Catastrophe Insurance*, to state or national-level public-private partnerships to establish risk pools and public disaster insurance programs. In these models, government must work with private insurers to share risks efficiently (so as not to imperil insurer solvency and/or create too large a fiscal burden) and utilize reinsurance to transfer risks appropriately. Such interventions need to be designed carefully to ensure they are administered efficiently, are fiscally sustainable and do not create perverse incentives for insureds or crowd out private insurance from markets it could otherwise serve.

In the most extreme cases, it may become economically unfeasible to continue to provide insurance in the worst affected areas, regardless of the model. In these circumstances, a strategy of managed retreat may be necessary. The Marsh McLennan report discusses these approaches in more detail and sets out five principles for policymakers to consider in designing interventions to extend insurance cover to vulnerable communities in high-risk areas.

15. In what areas have public-private partnerships or collaborations among state or local governments been effective in developing responses to climate change that may be taken by the insurance sector or insurance regulators? How can FIO evaluate the potential long-term or permanent effects on the insurance sector of such public-private partnerships or state and local collaborations to address climate-related risks? How should FIO consider state insurance regulatory efforts on consumer education related to climate risks?

Marsh McLennan: An active example is a product we are helping develop in New York City to make traditional insurance products more affordable and responsive. In low-income communities in the city, many find flood coverage to be much too expensive, leading the city to look for alternative options to either lower costs or determine a mechanism for funding. Thanks to a grant from the NYC Mayor's Office, Guy Carpenter and several partners are creating a more inclusive flood product.

The aim of this project and others like it is to increase awareness and understanding of the risks certain communities face. The overall mission is to find a way for everyone to have some level of protection over their most valuable asset, whether it is their home or their business.

Using incentives, Marsh McLennan has recently started a program to provide improved terms on directors & officers policies for clients deemed to be proactive in advancing ESG principles. Marsh, along with international law firms and the carrier community, are working to recognize corporate clients for strong efforts in their commitment to climate-change disclosures and representations. Eligible participants will have their practices reviewed by attorneys and participating carriers will provide coverage perks, such as lower deductibles, potential higher limits and favorable terms and conditions—but not lower insurance rates.

Underwriters should recognize clients who are truly working to enhance their commitment to ESG, to implement resiliency into their core principles and who are seeking forward-looking practices when it comes to an evolving climate as a better risk when underwriting.

Insurance Sector Engagement

18. What role or actions might states take to encourage the insurance sector's transition to a low emissions environment and an adaptive and resilient economy? In your response, please discuss whether efforts by states to encourage the development of new insurance products, to promote sustainable investment and underwriting activities, and to address protection gaps created by climate-related financial risks might facilitate this transition.

Marsh McLennan: States need to come to a consensus of a shared commitment to resilience. Without a level of accountability, we will have some actors that are progressive at advancing this agenda, and others that are not. Those who are not engaged will drag down the insurance marketplace.

As mentioned above, implementing programs that include incentives in the form of lower deductibles and higher limits are a way the insurance industry can encourage the transition to a low emissions environment. The same could be done with certain natural catastrophes, like wildfire. We have seen a resistance to write cover for the peril in certain states, notably California. Coverage then becomes unavailable or unaffordable.

While working to reduce the impact of climate change, we realize there is an element of evaluating returns. Mercer has worked with the state of California to assess insurance company investment portfolios and incentivize socially-beneficial investments. We feel capabilities in this space in assessing insurer investment portfolios could be of great interest to other states as well as FIO.

If the goal is to help proactively combat climate change, the insurance industry's incentives should focus on the components that humans and businesses can control. For example, clearance of dead brush on public and private lands, adding emergency sprinkler systems and inspection and correction of possible issues with transmission lines are mitigation measures for wildfire risk. These actions equate to less risk of large fires spreading along with entities taking responsibility for their own lands. This then should equate to a financial incentive as these measures are expenses in the name of the greater good. Marsh McLennan and Guy Carpenter have a strong partnership with the Institute for Business and Home Safety (IBHS). Their mission is to reduce unnecessary losses under extreme weather, and to support safer homes and businesses. They advance this effort through original research at their full-scale lab facility in Richburg, SC, by advancing consumer and public policy to prevent unnecessary loss and by providing action points for insurance companies and their policyholders towards more resilient homes and businesses.

These IBHS action points, informed by research at their facility, can offset damage from hazards including wildfire, wind, and hail, for both commercial and residential structures. Wind resilience is best supported by a properly attached, sealed and covered roof, with a continuous load path from the roof through the walls to the foundation. Wildfire resilience improves by maintaining a defensible space around a property that is free of combustible materials, with noncombustible building materials and screens on intake vents. The IBHS has also developed new industry test protocols for shingle resilience to hail, informed by original field research into hail characteristics. Such action points are increasingly used by insurance companies and policyholders toward improved resilience, and recognition of reduced losses from these resilience measures.

The IBHS is also actively involved in advancing building code measures at both the national and state level, supported by their *Rating the States* publication on building code adaptation and enforcement. The IBHS has also developed a set of resilience measures to surpass the minimum design thresholds of building codes—called the *FORTIFIED standard*, supported by extensive research at their facility. Over recent years, the State of Alabama Department of Insurance has offered wind mitigation credits to homeowners that adapt their homes to the FORTIFIED standard, both for new construction as well as retrofit. This “Strengthen Alabama Homes” program has met with considerable success, with over 3,000 homes funded under the program thus far. Other success stories are also growing in the Carolinas. IBHS field surveys following Hurricanes Michael (2018) and Harvey (2017) clearly demonstrate reduced damage for those homes meeting the FORTIFIED standard.

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