Catastrophe and Climate

Climate Change and Environmental Risks

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A Primer on Environmental Risks to the Insurance Industry

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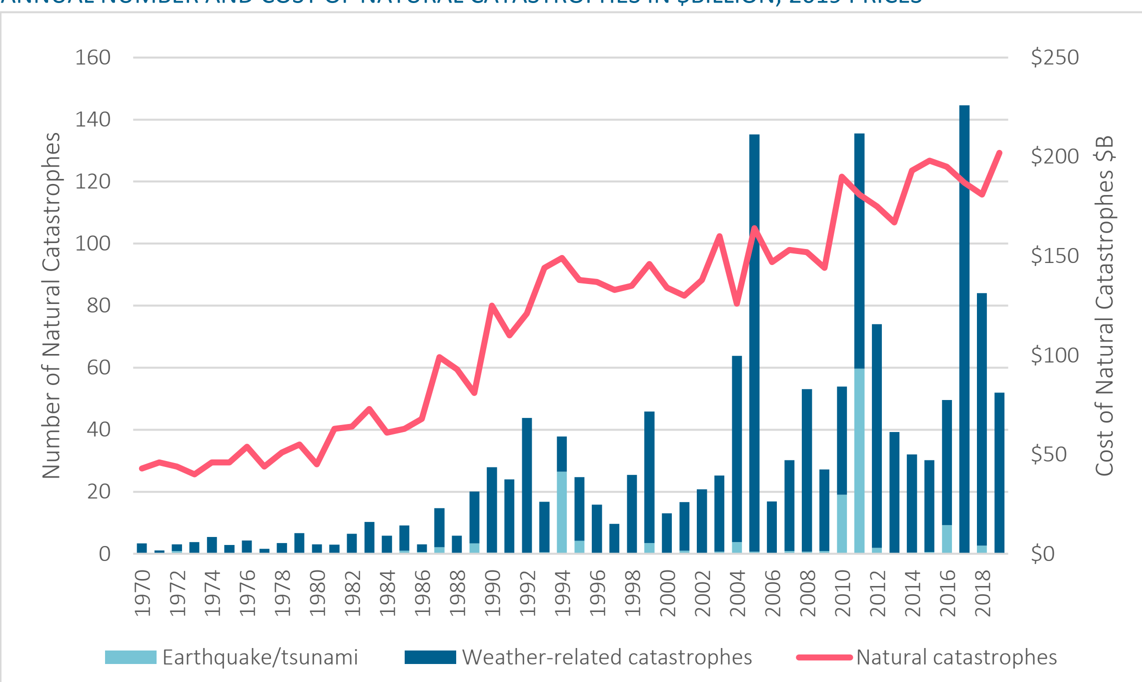
Introduction

Climate change is occurring. As a result, insured and uninsured losses are increasing. Billion-dollar (CPI adjusted) disaster events have increased in each decade in which they have been tracked since 1980, starting with 29 in the 1980s and followed by 53, 62, and 119 in the following decades. Deaths related to those disasters have increased from 2,870 in the 1980s to 5,217 in the 2010s, and the associated dollar amounts have increased as well from $177.2 billion in the 1980s to $273.4 billion, $517.1 billion, and $807.3 billion in subsequent decades (NOAA Billion, 2020). Munich Re (2020) notes that all sizes of natural catastrophes are on the rise. By one measure the total number of natural catastrophes per year in the 1980s was approximately 250. By 2019, the number had risen to over 800. All types of catastrophic events (including hydrological, meteorological, climatological, and geophysical) increased with hydrological events experiencing the largest increase, followed closely by meteorological. Global economic and insured losses resulting from weather-related catastrophes have been rising. Swiss Re Institute (2020) notes that global economic losses resulting from weather-related catastrophes have risen from $214 in the 1980s ($US billion 2019 prices), to $879, $1030, and $1618 in the subsequent decades (Figure 1).

Figure 1

ANNUAL NUMBER AND COST OF NATURAL CATASTROPHES IN $BILLION, 2019 PRICES



Cost broken into earthquake/tsunami and weather-related (Chart data from Swiss Re Institute 2020)

The International Panel on Climate Change (IPCC) is a United Nations entity, tasked with compiling thorough assessments of the most recent science related to climate change to inform governments worldwide in preparing climate policy. The panel provides global perspective and projects future climate change. The IPCC has found average temperatures to be rising slowly while extreme high temperatures are becoming more common; the IPCC (2019) predictions include, on average 1.3°C–4.6°C increase over 1850-1900 averages for near future, depending on greenhouse gas (GHG) emissions scenario. In general, extreme cold is lessening, but some specific areas are experiencing an increase in either extreme cold or cold snaps that are coming at unusual times of year. The atmospheric water cycle is also intensifying. Higher temperatures raise the saturation point of air (by c.7% per degree-°C) and accelerate evaporation (by c.10% per degree-°C) (IPCC 2019). As atmospheric layers warm and expand, thunderclouds may grow in height and strength, leading to heavier rainfall, more variability in rainfall, and also extreme droughts. Scientists are not all in agreement on how climate change is affecting hurricanes, but there is evidence that, although the number of tropical cyclones will decline, more of those that occur will be category 4-5, which are the most damaging (IPCC 2019). Sadowski and Sutter (2005) find that the category of a storm and the fatalities caused by the storm are highly correlated. Fatalities triple with each increase in category. Their model also estimates that a one-category increase in the strength of a land-falling hurricane increases expected damages by about $1.4 billion (2005). In addition, hurricanes may survive longer over land, carry greater amounts of rain, and be slower moving leading to higher damages. Hurricane storm paths may also extend to higher latitudes.

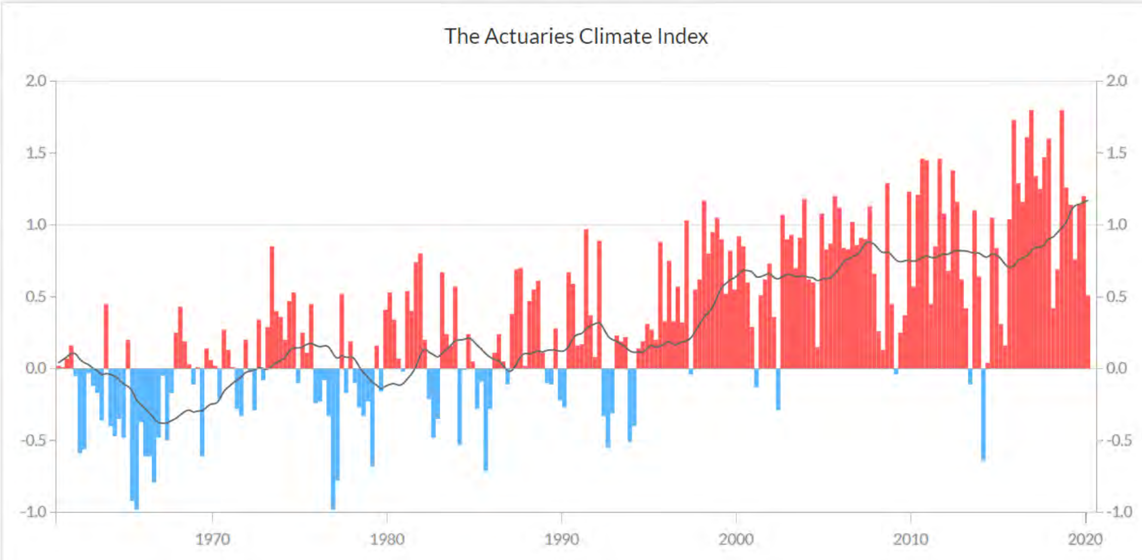
The IPCC predicts sea level rise of 0.43 to 0.84 meters (depending on greenhouse gas emissions scenario) by 2100, with increasing rates of sea level rise over the centuries that follow (IPCC 2019); this combined with the increasing storm frequency/intensity, suggests that coastal areas may experience severe climate change effects.

The panel has also found that ocean acidity is rising. Ocean surface pH has declined by a range of 0.017 to 0.027 pH units per decade since the late-1980s due to CO2 emission absorption. As a result, organisms are struggling to form calcium-based shells or skeletons (IPCC 2019). Coral dissolution may lead to decreased coastal protection from storm surge, increasing insured losses. Scientists have also observed decreasing oxygen levels in the planet's oceans. When catalyzed by fertilizer run-off from agriculture, oxygen levels fall further and faster in warmer water. Hypoxia and acidification interact to synergistically reduce growth and survival of early-life stage finfish and molluscs (Griffith and Gobler, 2019) which could increase aquaculture insurance claims. In addition, warming water increases the risk of harmful algal blooms. Many algal species involved produce potent biotoxins that concentrate in the tissues of bivalve shellfish resulting in severe, even fatal, shellfish poisoning if consumed by humans (Griffith and Gobler).

Increasing ice sheet loss in Greenland and the Antarctic has slowed the Atlantic Ocean's circulation by about 15 percent since the mid-20th century (Berwyn, 2018). This slowing increases extreme temperatures in Europe, changes rainfall patterns in the tropics, and builds warmer water along the U.S. coast that can fuel sea level rise and destructive storms (ibid), and in general contributes to more prolonged weather anomalies in adjacent areas including Canada, the USA, and Europe (IPCC 2019).These and other changes are expected to be associated with some irreversible ecosystem transitions in marine communities and ocean circulation, (IPCC 2019). If the system passes tipping points, National Research Council points out that there could be abrupt changes in risk profile over a period of decades or years (NRC 2013); for example, changes in ocean circulation could lead to changes in the climates of important agricultural areas and population centers, and serious economic transitions in fisheries. These changes occur more quickly than expected, planned, or budgeted for (NRC 2013) wreaking havoc on insurance industry catastrophe models.

Aspects of climate change can be measured, and actuaries have begun quantifying the measurements. The Actuaries Climate Index, which is updated quarterly, tracks high and low temperature extremes, heavy rainfall, drought, high wind, and sea level in Canada and the United States, expressed in units of difference (standard deviations) from the mean of the 30-year reference period of 1961 to 1990 (ACI 2020). These major components of climate change affect insurance liability in North America. The index indicates a clear change in climate between the reference period and the current time with the changes accelerating (Figure 2).

Figure 2
COMPOSITE INDEX FOR CANADA AND US COMBINED



Line is five-year average. (ACI 2020)

The Actuaries Climate Risk Index, currently in the developmental stage, is intended to connect loss-dollar risk to climate change. It measures the change in damages resulting from environmental conditions in excess of those observed in the reference period. After controlling for inflation, exposure, region, and seasonality, preliminary indications show a portion of the increase of losses due to extreme weather events are from climate change while the larger amount of increase is from changing exposure (increased human and physical assets) in natural disaster-prone areas (Jackson, 2020).

This paper will discuss the risks of climate change that are or will be relevant to actuaries' work of pricing, creating, or modifying coverage and determining reserves. In the short-term, there may be some increasing risks due to climate change that are partially offset by a decrease in other risks. Changes in risk may be gradual until they reach a tipping point. Without intentional consideration, the gradual changes in climate will produce unintended changes in baseline statistics. As a result, the full extent of the changes will be undermeasured or underreported, insurance products will be mispriced, insurers and insureds will argue over the limitations of coverage, Insurance companies may be faced with unsustainable claims and insureds may find themselves with insufficient compensation. In the long term, climate change is likely to impact the insurability and affordability of insurance.

It is crucial that actuaries educate themselves about the current and potential future impact of climate change on the design and pricing of products as well as the reserve requirements for all lines of insurance. Thistlethwaite and Wood (2018) analyzed responses to the 2012 (2015) U.S. National Association of Insurance Commissioners Climate Risk Disclosure Survey and found that most companies do not integrate climate change into their risk management practices. Reinsurers include climate change in their risk management more than primary insurers. Thistlethwaite and Wood feel that the spatial and temporal scale in the insurance industry create resistance to climate change risk management.

Conversely, when actuaries are properly educated to consider risks that have either increased or newly emerged due to climate change in the design and price of products, their work can define and quantify objectively the cost of climate change. "Non-governmental organizations, policy-makers and thought-leaders seeking to strengthen global climate change governance have engaged the insurance industry as a potential market-based system for pricing risks associated with climate change throughout the economy." (Thistlethwaite and Wood, 2018)

This paper focuses on life, health, accident, liability, and property insurance risks. The direct effects of climate change, such as environmental degradation or species loss will not be addressed unless it is related in some way to insured or insurable loss. For a risk to be insurable, the insurer must be able to identify and quantify the frequency and severity of potential hazards and the resulting losses. As such, we will lay out aspects of risk that actuaries may want to consider in their analysis, when designing, pricing, and setting reserves for insurance lines that could be subject to claims stemming from these risks. Climate change may also pose a risk to insurer's assets if severe weather events cause a decline in industry-specific investments or general financial markets. However, this paper concentrates on how actuarial pricing and reserving concerns are impacted by climate change and thus deals mainly with liability risk.

Direct Weather-Related Losses

Some consequences of climate change include increased high-temperature extremes, decreased low-temperature extremes, changes in precipitation patterns (leading to more extreme events), increased wind variability (including increased high-wind extremes), rising sea level and increased ocean temperature (leading to decreased oxygenation and increased acidity), and the general increased variability and change in weather patterns. We expect these changes to directly increase weather-related risks that affect multiple lines of insurance.

Extreme Weather Events

Observers have clearly documented an increase in the volatility of weather patterns and the frequency of extreme-weather events, such as heavy rain, thunderstorms, tornados, and hurricanes. Catastrophe losses are projected to continue to increase. Peter Sousounis of AIR notes that a hurricane like Harvey in 2017 would, in the 20th century, have been classed as a 2000-year storm; but by 2017, it was classed as a 300-year storm; and by 2100, it will be a 100-year storm. Similarly, tidal surges that were once-a-millennium events are expected to increase in frequency until they occur once in 30 years (Blown Cover 2019). Increased extreme wind losses do not grow linearly. Above-100km-per-hour winds, a 10% increase in wind speed, results in 50-60% more damage, according to Pete Dailey of RMS (Blown Cover 2019). Injuries and sickness from extreme weather and the related shutdowns in services, during or after extreme weather events, are likely to increase. The excess deaths, associated with Hurricane Maria in Puerto Rico, reveal the myriad ways that medical pipelines can be disrupted in the wake of severe storms, from disruption of supply chains for needed medicines, to lack of electricity to run life-support equipment (Kishore et al. 2018). Health and life insurance in addition to property and casualty insurance could both be heavily affected if the risk is not properly recognized in pricing.

The increasingly volatile storms coming with climate change are creating further risk for Superfund sites that were assumed to be cleaned up to the required extent. For example, Hurricane Harvey caused such heavy flooding that a concrete cap covering the cleaned-up San Jacinto Superfund site waste pit was undermined, causing toxic dioxins to wash downriver. The river sediment after the flood contained human carcinogen 2,300 times the EPA standard for cleanup (Hasemyer and Olsen, 2020). Companies, who cleaned up the original site, could be liable for another round of cleanup. The Government Accountability Office warned in a 2019 report that there are 945 Superfund sites across the United States vulnerable to hurricanes, flooding, sea-level rise, increased precipitation, or wildfires—all of which are intensifying with climate change (Hasemyer and Olsen, 2020).

The increases in severe storms and the disruptions they cause, such as power loss, flow through the supply chain, causing loss far afield of the geographic area of loss. Both contingent business interruption (CBI) and supply chain insurance reimburse for lost profits and related costs caused by disruptions in the insured's supply chain, even if the insured itself has not suffered any damage. In CBI, the suppliers must suffer physical property damage. Supply chain insurance is broader coverage. One can buy multi-tier coverage, covering more than just the first-level suppliers. Those actuaries who price CBI and Supply Chain insurance need to be particularly cognizant of the insured's supply chains. Transport hubs can have an outsized impact if affected by a climate disaster. Similarly, clusters of suppliers in specialized regions (think China) can affect insureds throughout the world. Because power is necessary for so much of production and worker's transportation, the effects of power outages can ripple through society as well, causing increased business interruption claims. If there is any coverage for interruption due to evacuations, these are projected to rise as well as the probability of storms rises.

Extreme Temperatures

DIRECT IMPACT ON HUMAN LIFE AND HEALTH

Gasparrini (2017) found that heat-related deaths have increased, while cold-related deaths have decreased in North America. The total fraction of deaths, caused by temperature, was 7.71%. Though there are more deaths in North America from cold than from heat, most of the cold-temperature-related mortality was from milder but non-optimum temperatures with a lesser effect on mortality from extreme-cold-temperature days. Mortality risk increases slowly and linearly for cold temperatures below the minimum mortality temperature but escalates quickly and non-linearly for excessively high temperatures (Gasparrini, 2017). In certain localities, cold related deaths could decrease in climate change scenarios, but as modeled for Manhattan by Li et al. (2013), the decreased mortality during cold times of year would not compensate for the increased mortality during the warm times of year and climate change would lead to a net annual increase in mortality. A study of temperature effect on mortality in Detroit noted sharp increases in mortality and hospitalizations with extreme heat, while having more gradual increases in mortality in cold temperatures with no clear threshold (Gronlund et al. 2018). Because of the swift non-linear increase in mortality at high temperatures, it seems that an increase in high temperatures could have a large effect on heat-mortality risk, which could translate into higher health and life insurance costs.

Workers' compensation coverage may be more severely affected than life or health insurance by extreme heat and cold snaps because, unlike the general public, workers may be required by their jobs to accept exposure to extreme temperatures and may be limited in their capacity to mitigate or avoid the associated risk. Therefore, workers may see impacts of climate change before the general public. Workers are not only exposed to temperature extremes and severe-weather events, but also, to air pollution, weather-dependent infectious and zoonotic diseases, and wildfires—all of which are exacerbated by climate change. As they work during and rebuild after catastrophic events, workers face increasing safety hazards from working at heights, with machinery, with live power, and in confined spaces, destroyed buildings and landscapes (Roelofs and Wegman, 2014). Extreme heat will also exacerbate the hazards of working at elevations and in situations where the work is physically demanding and requires long hours (Roelofs and Wegman, 2014). Warming temperatures may make some chemicals toxic at lower concentration levels (Roelofs and Wegman, 2014). Personal protective equipment may be less comfortable or even unbearable at higher temperatures (Roelofs and Wegman, 2014). In a review of workers compensation claims in Melborne, McInnes et al. (2017) found that high heat led to increased claims. Specifically, males, young workers, and workers engaged in the most physically demanding occupations were most at risk on days with high maximum temperature. On days that followed nights with high minimum overnight temperatures, there were more WC claims, not just from higher risk workers but also from female workers and workers in climate-controlled environments (McInnes et al. 2017). Man's efforts to reverse climate change with new energy resources is expected to increase employment in hazardous occupations such as during weather-related disasters. Jobs in green energy may add new risks with little historical data for pricing, such as installing and servicing Wind Farms (Transportation Research Board, 2013). This would also increase workers compensation losses.

INDIRECT IMPACT ON HUMAN LIFE AND HEALTH

Lack of extreme cold poses risks by preventing the winter die-off while increasing the reproduction of pests, especially insectan pests. With changes in weather patterns, it is likely that these pests will migrate to higher latitudes enlarging the areas in North America prone to damage. These pests can cause direct damage to crops in particular, affecting crop insurance. They can also be disease vectors, impacting health and life coverages by facilitating disease epidemics. Waits et al.'s (2018) metanalysis results suggested that many diseases, including Echinococcus sp., tularemia, West Nile virus, hantavirus, tick-borne encephalitis, Lyme disease, and sindbis fever, are predicted to increase in the Arctic as climate change leads to range shifts in vector populations (Waits et al. 2018). Mosquito-borne diseases (MBDs) have increased 10% in Canada over the last 20 years due in large part to climate change; it is anticipated that climate change will continue to drive range expansion and increase the duration of transmission seasons leading to MBD-related epidemics.(Ludwig et al. 2019). Semenza et al. (2018) predict that, due to climate change, Europe will see increased occurrence of mosquitoes and their associated diseases (Zika, dengue, and chikungunya) and sandflies, which may transmit Leishmaiasis, while Khan et al. (2020) predict analogously that main mosquito species will expand northward into larger areas of Canada and the United States increasing the risk of the transmitted diseases.

Temperate areas are projected to have a lengthened growing season with increases and changes in pollen. Shea et al. (2008) suggest changes in the distribution and population density of pollen-producing plants, and the lengthening of pollen seasons will generate increases in the number and severity of pollen-related allergies. They also point out that other changes attributable to climate change, including the increased severity and frequency of storms and increased air pollution, could exacerbate asthma and allergic disease (Shea et al. 2008). An increase in diseases, associated with urban areas (i.e. asthma), may also be associated with increased urbanization due to climate refugees (Booth, 2018).

Flooding, drought, and wildfires may be part of altered precipitation regimes associated with climate change. Besides direct deaths from flooding, flood may interact with other factors to increase the spread of leptospirosis (Lau et al. 2010) and mold-related health maladies. Fires associated with drought may lead to direct health problems, including both acute injury and death, as well as longer term negative impacts on respiratory health (Smith et al. 2014; Fann et al. 2018). Drought associated with climate change also may indirectly reduce health by impacting food security (Schmidhuber et al. 2007).

Psychological or emotional distress, including anxiety, depression, PTSD, and suicide may increase as climate-change drives increases in extreme-weather events, which cause trauma (Manning and Clayton 2018). Women, children, people from marginalized communities, and indigenous people are likely to be exceptionally vulnerable to these increases (Manning and Clayton, 2018).

EFFECT ON HABITABLE AND CULTIVATABLE HUMAN ENVIRONMENT AND INFRASTRUCTURE

The lack of cold poses additional risks for Arctic areas. Transportation can be limited as ice roads melt. Thermokarst lakes, which are bodies of freshwater that collect in depressions formed by thawing permafrost, cover 20% of Arctic lowlands and are prone to causing catastrophic flooding, sometimes annually. Many of these floods exceed river-flood events with implications for downstream human infrastructure as development pushes into Arctic lowlands (Arp et al. 2020).

Heavy precipitation extremes are problematic because they cause flooding. However, inadequate precipitation causes its own problems. Certain infrastructure and supply chain structures require sufficient amounts of precipitation. As precipitation in some areas falls, the reduction may increase business interruption risk for both these structures and any in the supply chains that rely on these structures. Hydropower dams are one example; as the precipitation levels vary, the generated power is not stable and at times is not available. Another example is the

Panama and Suez Canals, where prolonged dry seasons have decreased the water levels. Decreased water levels mean many ships, if they can transit at all, must transit the canal with less than their maximum load of cargo (Beyond seasonable drought, Economist 9/21/2019), which can lead to supply-chain issues.

Crops can also be damaged if the synchrony between insect emergence and flowering of crop plants becomes asynchronous. Temperature changes due to climate change lead to species-specific shifts in phenology. If the crop varieties and their pollinators have different phenological shifts, they may end up mismatched to the detriment of one or both of the species. (Settele et al. 2016) Heat and drought together can lead to increased crop losses and increased wildfire risk. Wildfire causes direct property, health, and life insurance losses as well as business interruption. The tactics taken to decrease wildfire risk, such as shutting down power flow during the riskiest times, also contribute to losses.

As ocean acidity rises due to CO2 emission absorption, organisms struggle to form calcium-based shells or skeletons. Low oxygen levels, caused by fertilizer run-off, may be exacerbated by warming. Various USDA crop insurance offerings cover reduced production losses due to both the reduced ability to produce shells and oxygen depletion. For example, clam insurance covers the decrease in inventory due to the following named perils: "oxygen depletion (due to vegetation, microbial activity, harmful algae bloom, or high water temperature), disease, freeze, hurricane, increase or decrease in salinity, tidal wave, storm surge or ice floe" (USDA 2020) (https://www.rma.usda.gov/en/Fact-Sheets/National-Fact-Sheets/Aquaculture-Oysters-Clams-WFRP). The oyster insurance is not as specific but covers decreased landings due to "drought, flood, hurricane, and other natural disasters" (ibid), which would seem to cover climate-change-related losses, since climate change in general can be considered a natural disaster. Whole-Farm Revenue Protection covers all commodities on the farm including aquaculture (excluding timber, forest, and forest products as well as animals for sport, show, or pets). Farm revenue is thus insured against loss due to an unavoidable natural cause. Private insurers cover aquaculture as well, and many cover changes in water, including deoxygenation and increased salinity (https://axaxl.com/insurance/products/aquaculture-insurance, https://insurance.indianafarmers.com/products/farm-insurance/aquaculture). The changing ocean circulation may also affect aquaculture policies. Actuaries, pricing such policies, will need to trend for these changes, brought about by climate change.

Potential Liability Risk for Those Considered Responsible for Climate Change

There is precedent that retroactive liability can be forced on insureds and through the insureds on the insurance industry with courts enforcing retroactive liability and coverage, where none was contemplated. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Asbestos liability are both examples of this. CERCLA, passed in 1979, requires any person who knows of a release of a reportable quantity of hazardous waste to notify the EPA. The Act gives the government power to compel parties to clean up releases of hazardous substances and gives government and private parties the authority to recover the costs of cleanup (Salzman and Thompson, 2014). Once CERCLA was in place, potentially responsible parties suddenly incurred enormous amounts of liability, oftentimes stemming from activities that occurred prior (sometimes long prior) to the passage of the law. Tweedale and Warren (2004) explain that prior to the 1973 suit, launched by mesothelioma sufferer Clarence Borel against Fibreboard (and several other defendants), plaintiffs usually had to prove negligence, but Borel won his suit under product liability law, according to which the companies were liable for their "failure to warn." This new precedent widened the field of potential claimants and defendants. The largest wave of litigation in history occurred as American plaintiffs and their lawyers launched thousands of suits against the asbestos industry. Since the latency of asbestos-related diseases is around 30 to 50 years (in the case of mesothelioma), companies were suddenly liable for products, produced decades earlier (Tweedale and Warren 2004). Liable companies attempted to collect from their insurers. There is every possibility that when attribution science matures, something similar could happen with climate change. Companies, whose practices or products contribute to climate change, may be held responsible for the damages.

The IPCC has noted that although the attribution of individual extreme-weather events to warming is difficult, ongoing research is focused on how climate change affects the likelihood and intensity of extreme-weather events occurring (IPCC 2019). The Actuaries Climate Risk Index, as an example of attributional science, estimates the portion of the increase in losses, associated with extreme-weather events that stems from climate change (ACI 2020). According to the National Academies of Science, this rapidly advancing scientific capability now makes it possible to “make and defend quantitative statements about the extent to which human-induced climate change has influenced either the magnitude or the probability of specific types of events or event classes” (Stott, 2016). This science is not yet to the level of being able to attribute a specific event to climate change, but work continues towards making such specific attribution possible. In an example of attributional science, Schaller et al. found no evidence that human-induced climate change had made the extreme precipitation seen in Spring 2013 in the Upper Danube and Elbe River basin more likely (Stott, 2016).

Some researchers have begun studying attribution of damages to specific companies. Richard Heede started by analyzing and modeling Standard Oil/ExxonMobil’s contribution to temperature change and sea level rise (Heede 2017). Ekwurzel et al. (2017) have traced emissions, related to temperature rise, to the 90 largest carbon producers; while Licker et al. (2018) identify the contribution of the largest carbon producers to ocean acidification and related risks.

The oil and gas industry has faced many legal attempts to hold it liable for its part in causing climate change (Hasemyer, 2020). Lawsuits increased after information from internal Exxon documents emerged in 2015, showing that the oil company understood the science of global warming, predicted its consequences, and spent millions to promote disinformation. The attorneys general of New York and Massachusetts sued Exxon over climate change, alleging that Exxon engaged in “a longstanding fraudulent scheme” to deceive investors that it was effectively managing the economic risks, posed by the policies and regulations it anticipated being adopted to address climate change and over alleged violations of the Massachusetts Consumer Protection Act. Directors and officers were also charged. Climate litigation is a growing risk. The 1990s had a few cases, the 2000s had about 20, and since 2010, there have been over 110 cases. There are cases brought by American states and cities against major fossil fuel companies, alleging that the companies made a profit on extracting and selling fossil fuels, that the combustion of the fuels made weather events more likely, and that the added damage should be paid for by the fossil fuel companies. The Economist (9/19/2020) projects that if cases follow a similar route as those against Big Tobacco, the fossil fuel companies could be hit by enormous liabilities. One think tank estimates liabilities of $58 billion to $107 billion annually. This is on the average of 5% to 20% of the companies’ pre-tax earnings (Economist 9/19/2020). Other cases are brought on human-rights grounds. Lastly, there are cases against individual executives under a duty-of-care theory (Economist Guilt by Emission 9/19/2020) which could increase D&O claims.

Venue has a large impact on the success of climate-change-related lawsuits. In the federal court, most lawsuits to date have been won by fossil fuel companies. Many state courts have common law provisions that support avenues of prosecution, favorable to climate-change plaintiffs. For example, plaintiffs can pursue a claim of public nuisance, arguing that the state’s residents cannot enjoy a stable climate due to the actions of the defendant, and that those actions force additional costs on the residents. Plaintiffs can also pursue a claim of product liability, which argue that a company pushed products into the market, while knowing the products would probably cause damage. Plaintiffs, therefore, tend to sue in state court. In the NY Exxon case, the New York judge cleared Exxon of investor fraud allegations but noted “nothing in this opinion is intended to absolve Exxon from responsibility for contributing to climate change,” (Hasemyer 2020). Several other states and more than 10 cities and counties have sued fossil fuel companies seeking compensation for climate-change damages. Some of the suits rely on a public nuisance claim and some on a claim of negligence. The plaintiffs seek billions to pay for mitigation measures. The companies seek to move the cases to federal court, where nuisance claims are less likely to succeed (Hasemyer 2020, Frazin 2020).

Delaware recently (September 2020) sued Exxon Mobil, Chevron, BP, Shell, and the American Petroleum Institute (a lobbying group) on the grounds of product liability, alleging that the defendants had "actual knowledge that their products were and are causing and contributing to the injuries complained of, and acted with conscious indifference to the probable dangerous consequences of their conduct's and products' foreseeable impact upon the rights of others, including the State and its residents, motivated primarily by unreasonable financial gain." (Frazin 2020). Our Children's Trust is supporting ten children's lawsuits in various state courts. These lawsuits rely on the public trust doctrine, which asserts that some resources are public commons–belonging to all and without private ownership—and that the government is the trustee and must care for these resources. The lawsuits demand change in federal programs and laws. One case has been dismissed, saying the youth had no standing to sue and would have to work through the executive and legislative branches of government, not the courts (Hasemyer 2020). Though the lawsuits have not yet succeeded (one was dismissed by a federal court of appeals in 2020), they have brought the issue to the fore. Nobel economist Joseph Stiglitz wrote an expert court report, supporting the children's case in 2018 (ibid). Fossil fuel companies may soon start asking their insurers to defend them in such suits and if they are found guilty, the insurers could face enormous indemnity payments. One federal judge said the dangers of climate change are "very real", but they should be handled by Congress (Hasemyer 2020), perhaps implying a CERCLA-type law for climate change.

There is a risk that liability suits will extend beyond the fossil fuel industry similar to what we saw with Asbestos. In Australia there will be a trial in November determining whether a pension fund ought to do more to protect savers' money from climate risks (Economist Guilt by Emission 2020). If lawsuits against other industries increase, these could also flow through to their insurers with general liability and directors and officers policies affected.

Risks Related to Transition, Mitigation, and Adaptation

Transition from traditional energy resources to green energy will cause upheaval in the energy and related property markets. The highly accelerated devaluation of carbon intensive assets does pose a potential risk for property insurers. There is a moral hazard risk as owners may be incentivized to find or cause reasons to collect insurance on some hard-to-insulate properties that are losing value. The payout may be higher than the worth of the property if the insured values are not monitored frequently. Additionally, insureds may try to claim for equipment requiring modification or early decommissioning to meet target emission standards. Similarly, there is increased risk to extraction-related real estate and drilling rights. Researchers estimate that 70-80% of proven fossil fuel reserves must be stranded to stay below the carbon budget for <2°C. The industries most at risk are those that extract and produce fossil fuels and those that emit large volumes of GHGs (IPCC 2019).

There may be other real estate market effects as well. For example, Sadasivam (2020) found that homes at risk of flooding are currently overvalued by $34 billion and in Florida coastal homes could lose 15 to 35 percent of their value by 2050. Bernstein et al, (2019) show that under the scenario of a one-foot rise in sea levels, properties in the flood zone sell for 15% less than comparable properties outside the zone (Bernstein et al, 2019). As property values fall below insured values, insurance fraud may rise. Properties in high-hazard flood zones may sell for less, and this could lead to "blue-lining" where banks would avoid lending in those areas. This could cause hiccups in the financial and real estate markets as the new sustainable development models take hold. There are recommendations that regulators penalize banks that lend money in areas that have been hit by disasters but have not taken steps to mitigate or avoid similar future disasters (FedReserveBank 2019). Insureds may seek to collect insurance in some underhanded way rather than hold devaluing assets.

Mortgage insurance could be affected by the potential development of a common risk standard, used for setting mortgage rates. Regulations could force insurers to insure property at inadequate rates in areas negatively affected by climate change, such as coastal zones, flood zones, and fire zones. Historical data may not indicate the increase in rates, necessary for insurers to receive adequate premium.

Insurers may be called upon to insure new technology as the world transitions to a low-carbon economy. These may have limited or no loss histories. Insurers have already shown a willingness to take on such projects as they have begun to insure hybrid and electric vehicles, wind farms, and solar farms and panels. In the future, additional new technologies, such as hybrid electric ships or cargo ships, fitted with auxiliary sails, may require insurance and the risk modeling to price it.

If carbon trading, an emerging financial risk, is deemed insurable (iii 2019), this will generate another category of risk with little historical basis for pricing. Insurance policies for carbon trading protect investors in clean technology projects against the failure of the project to deliver the agreed-upon emission rights. A risk associated with purchasing carbon trading rights is that the project or technology will not create the offsets promised either because of a flaw in the project or because the company becomes insolvent before it is able to fulfill its contract.

Rating agencies that evaluate the financial health of property and casualty insurers have raised the threshold for capital adequacy, measuring it compared to the company's exposure from a 250-year event rather than a 100-year event and relative to potential losses from two mega disasters in quick succession (iii 2019).

Opportunities

The Federal Reserve published warnings about climate change risk to the financial system (FedReserve 2019). This is an enormous opportunity for insurers if we, as an industry, can provide coverage for these risks that allows the financial system to continue.

Insurers may also be able to use their influence to increase true resilience and limit ecological damage. If insurance companies can model and charge prices reflective of the increased risk due to climate change, the markets may respond by modifying the areas in which development occurs or the resiliency of new structures. For example, expensive flood or fire insurance may decrease new housing and other development in flood and fire-prone areas to the benefit of society as a whole. This opportunity is tempered by regulation which may not allow adequate pricing in certain lines of business. Sadasivam (2020) notes that private insurers have stopped insuring in risky areas, which might be an incentive to leave those areas. However, states have stepped in with subsidized pools undermining most of the incentive.

There are other opportunities to help increase resilience as we battle through transition and adaptation. Some insureds would like to take loans of the decrease in premium that they would get for an increase in resiliency. A discouragement to this is the annual policies. Insureds can fund capital improvements for increased resilience through discounts in policy premium, but the industry may need to implement multi-year policies to make this economically viable. Otherwise a company could fund an improvement only to have the customer move to another insurer the next year. If, however insurers can influence capital improvements for resilience could they, for example, nudge the property owners or municipalities to use the most effective barriers such as soft barriers to coastline?

There are already some incentives to decrease climate change impacts such as policies for green building construction when rebuilding after a disaster for both homeowners and commercial coverage. The first green commercial policy was introduced in 2006 and allows building owners to replace damaged buildings with green alternatives such as energy efficient electrical equipment, water conserving plumbing, nontoxic and low-odor interiors (paints and carpeting),renewable construction materials, etc. (iii 2019)

Conclusion

Climate change risk is one of the most significant risks facing insurers today, yet it is insufficiently understood. While there is and will likely continue to be significant uncertainty in the severity and geography of the changes, it is imperative that actuaries learn about the risks involved so they can be evaluated in the course of their work. Organizations like the International Panel on Climate Change and metrics such as the Actuaries Climate Index are available to assist with understanding and to quantify changes. As climate change becomes increasingly documented, other resources are likely to emerge. The impact of climate change is felt more and more each year highlighting the urgency to consider its actuarial effects.

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