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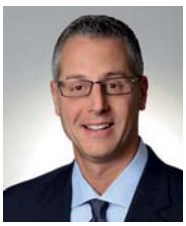
ASPEN RE

CLIMATE CHANGE AND THE (RE)INSURANCE IMPLICATIONS

WELCOME



The issue of Climate Change (sometimes referred to as "global warming") is increasingly permeating virtually every topic of discussion and we do not believe the concern is going to dissipate anytime soon. Rightly so, as many of the scientific models present ongoing catastrophic damage scenarios affecting persons, property, businesses, governments, economies, ecosystems and natural resources, to name but a few. The scope and scale of estimated damage from Climate Change is unprecedented and the costs to mitigate the risk no less daunting. Insurers and their policyholders face high exposure risk from Climate Change on many fronts, including general liability claims for third-party bodily injury and property damage, D&O claims for a Company's failure to properly disclose climate-related risk to its business and/or failure to "align its business model with a low-carbon future" and first-party loss, including business interruption. While, to date, there have been minimal coverage actions relating to Climate Change, we expect that to change, given the increasing number of underlying lawsuits and related activity, coupled with the staggering liability that is at stake.

This paper undertakes a comprehensive examination of Climate Change, with particular focus on the downstream consequences to the insurance industry. Accordingly, we believe this paper is unique and we trust it will provide a valuable resource for all readers seeking to command an understanding of this important, active and evolving subject.

We look forward to continuing this critical dialogue and welcome the opportunity assist the insurance industry in all matters of risk surrounding Climate Change.

Thank you,

Adam D. Krauss
Senior Counsel, Traub Lieberman Straus & Shrewsberry LLP

This white paper has been co-authored by Traub Lieberman Straus & Shrewsberry LLP and Aspen Re. It takes a comprehensive look at the issues surrounding climate change, including the science, data, litigation, cost and examples of international and national action and insurance implications. The litigation landscape has been changing and this in turn has implications for the (re)insurance industry especially those transacting commercial general liability, D&O and property business. Alternative capital is increasingly playing a role in risk management of the latter. Climate change is not only about the liability side of the balance sheet. (Re)insurers, as investors, need to appraise existing investment strategy including fossil fuel and renewable energy companies to help mitigate the projected impact of climate change.

EXECUTIVE SUMMARY/HIGHLIGHTS

- Climate impacts every facet of daily life – of this there is no debate.
- Although the subject of climate change and the need for immediate mitigative action still has its shrinking group of naysayers[1], New York Times columnist David Leonhardt declared in his last article of the year, that "[t]he story of 2018 was climate change" and "future generations may ask why we were distracted by lesser matters."[2]
- Indeed, the 2018 Nobel Prize in Economics was awarded to William D. Nordhaus, Ph.D of Yale University, for his work on integrating climate change into long-run macroeconomics analysis.[3]
- Sunday talk show, NBC's Meet the Press, devoted the entirety of its last show of 2018 to discussing climate change. In setting the tone, host Chuck Todd said "We're not going to debate climate change, the existence of it…The Earth is getting hotter. And human activity is a major cause, period. We're not going to give time to climate deniers. The science is settled, even if political opinion is not."[4] Former NYC Mayor Michael Bloomberg, a guest on the Meet the Press episode, put pressure on whoever may challenge Donald Trump in the 2020 presidential race, stating that climate change needed to be a major campaign issue:

  Any candidate for federal office better darn well have a plan to deal with the problem that the Trump science advisers say could, basically, end this world… I can tell you one thing, I don't know whether I'm going to run or not, but I will be out there demanding that anybody that's running has a [climate change] plan.[5]

- Sounding additional alarm bells regarding climate related risk, Zurich chief risk officer, Alison Martin recently stated that "[o]ur analysis suggests that the current level of efforts to keep global temperatures from rising over 2°C above pre-industrial levels will likely fail, so businesses should prepare for the physical consequences of a warming planet. Companies must know the magnitude of their climate risk, so that they can prioritize actions based on their particular circumstances."[6]
- After paying first-party property claim amounts in 2017 at a rate more than double the prior year, Lloyd's CEO, Inga Beale advised the London Market that "[w]e are seeing the impact of climate change - particularly on these weather losses, with rising sea level that impacts and increases the amount of loss and rising sea temperatures that increases the frequency and likelihood of some of these hurricane's hitting land."[7]
- Due to the lengthy atmospheric residency time of Greenhouse Gases ("GHGs"), anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as sea level rise, with associated impacts, even if all emissions were ceased today. (Page 3)

- Although climate change is a highly politicized subject, even major fossil fuel companies have publically acknowledged that climate change is real and presents significant risk, and that the "climate system is warming in part due to increased concentration of GHGs in the atmosphere", which in turn were emitted by human activities, including the combustion of coal, oil and natural gas.[8] (Page 3-4)
- Natural gases, alternatively known as GHGs, in the Earth's atmosphere impact the levels of radiation from the Sun. Human activity, most notably the burning of fossil fuels, has increased the quantum of these natural gases and has caused changes in climate. These GHGs vary in life span and global warming potential (GWP) but are universal since they are well mixed and do not respect national boundaries. (Page 3-4)
- Measures of climate change include global surface temperatures and carbon dioxide ("C02") levels which have increased at an unprecedented pace. Since 1993, average sea levels have increased at twice the rate of the long term trend. The Intergovernmental Panel on Climate Change has concluded that limiting global warming to 1.5°C above pre industrial levels would require rapid and far reaching societal changes. (Page 3-4)
- The 2018 Fourth National Climate Assessment Report warns that climate change could cost the United States hundreds of billions of dollars annually by century's end and the 2018 IPCC Special Report cautions that global climate change damages are projected to climb into the tens of trillions of dollars without rapid de-carbonization.[9] (Page 7)
- The signatories of the 2016 Paris Agreement, representing more than 88% of global GHG emissions, agreed to take action in an effort to limit global temperature rise to well below 2°C above pre industrialized levels. Although the U.S. has indicated intent to withdraw from this, attendees of the 2018 UN Climate summit made further progress on the Agreement and a UN meeting scheduled in 2019 aims to increase and accelerate climate action and ambition. (Page 9)
- As things stand now, even if every country met the commitment it made in the Paris Agreement, many in the scientific community believe that the temperature would likely still increase to 3° C (5.4° F) above pre-industrial levels by the end of the century.[10] If the world continues burning fossil fuels and emitting GHGs at the current rate, it could rise by 4° C (7.2° F). Those temperature rise scenarios are expected to result in catastrophic human, biologic, ecologic and economic loss on a global scale. (Page 9)
- During the period 2030 to 2050, the World Health Organization ("WHO") expects 250,000 additional deaths per year due to climate change.[11]
- China is the world largest emitter of GHGs but is keen to assert itself as a global climate leader and is on target by certain measures to meet or exceed its pledges to curb GHG emissions by or before its 2030 Nationally Determined Contribution ("NDC"). However, several significant concerns have been raised, including a possible ramping up of new fossil fuel plants in China. India ranks by many studies as the most vulnerable to the impact of climate change, but has also taken a number of initiatives and is on target to meet or exceed its 2030 NDC. (Page 10)
- The escalating barrage of reports warn that there is no avoiding the costs of climate change - we either invest now to curtail GHG, or we pay down the line through increased property damage and lost lives. (Page 12)
- According to a United Nations Report, 654 climate change cases have been filed in the United States as of March 2017, with more than 230 cases being filed in all other countries combined.[12]
- The costs of climate change are increasing and are substantial. 2017 was the costliest year on record for natural catastrophe events, with US$344 billion in global economic loss, of which 97% was due to weather-related events. Insured loss estimates from natural catastrophes totaled $140 billion in 2017 and at $80 billion in 2018, remained significantly higher than the long-term average. The 2018 IPCC Special Report estimated that global economic damages by 2100 would reach $54 trillion with 1.5°C (2.7°F) of warming, $69 trillion with 2°C (3.7°F) warming and $551 trillion with 3.7°C (6.7°F) of warming above preindustrial levels. (Page 13)
- Climate litigation is increasing and reflects advancements in science and economic modelling, discovery of corporations climate knowledge, public involvement and a more collaborative approach of cities, experts and the legal community. *Massachusetts v. EPA* (2007) ruled that USEPA should regulate GHGs – not the courts – and the Clean Air Act supplants any private cause of action for common law. Nevertheless a number of recent climate change suits filed by municipalities are being closely watched. There has been a dearth of coverage actions and decisional law relating to insurance for climate change liability is virtually non-existent - but that will likely change soon, given the rising prominence of the issue, the substantial costs involved and the increased litigation activity by municipalities and private parties against fossil fuel companies and other target defendants. Commercial General Liability, D&O, and Property insurance are all in the sight line of climate change litigation. Choice of law is important for the coverage action litigant, but coverage issues including: amount and type of damage, occurrence, trigger, allocation and pollutant exclusions are all topics for consideration. (Page 15)
- The world's leading insurance companies have made some progress in setting climate strategy, targets and risk management in place, although those in the U.S. are lagging those in Europe and Japan. Both the asset and the liability side of the balance sheet are vulnerable and insurers have played a part in divestment from the fossil fuel industry and this is expected to continue. (Page 21)
- Climate change implications include potential credit rating downgrades for coastal municipalities given sea level projections and possible rapid escalation of flood insurance premiums, given the current indebtedness of National Flood Insurance Program and the strong push for significant legislative reform, including accounting for specific flood risks associated with the location and structural characteristics of the property, rather than much more general underwriting criteria currently in use. Third party capital has entered the (re)insurance market to help address climate change risk and the cat bond market totals some US$100 billion to date. The climate aligned bond universe is much larger, although it has been estimated that some $90 trillion of investment is needed in climate projects by 2030 to mitigate the anticipated effects of climate change. Carbon taxation is being considered as a potential mechanism to reduce GHG emissions. The "Economists' Statement on Carbon Dividends," published in 2019, and signed by 3,508 U.S. based economists, concludes that a yearly increasing carbon tax, with the revenues returned to U.S. citizens, offers the most cost-effective lever to reduce carbon emissions at the scale and speed that is necessary to curb GHG emissions. (Page 21-22)

CLIMATE CHANGE SCIENCE – THE BASICS

Natural gases, alternatively known as greenhouse gases ("GHGs"), in the Earth's atmosphere impact the levels of radiation from the Sun. Human activity, most notably the burning of fossil fuels, has increased the quantum of these natural gases and has caused changes in climate. These GHGs vary in life span and global warming potential ("GWP") but are universal since they are well mixed and do not respect national boundaries.

What is "Climate Change"?

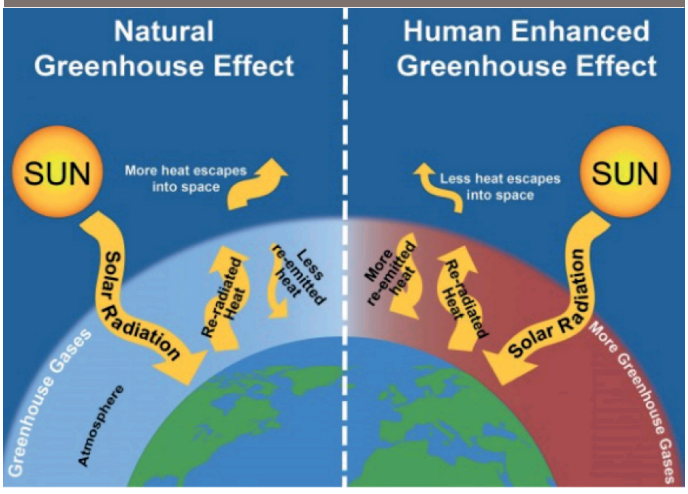
"Climate" is how the atmosphere behaves over relatively long periods of time, whereas "weather" refers to conditions of the atmosphere over a short period of time. Climate is the aggregated patterns over time of weather, meaning averages, extremes, timing, and spatial distribution of weather events. It is often stated that relatively small temperature changes will result in big changes in weather patterns.[13]

According to the Intergovernmental Panel on Climate Change ("IPCC"), "climate change" refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.[14]

The "Greenhouse Effect"

As depicted in Figure 1[15], the Greenhouse Effect describes how natural gases in the Earth's atmosphere reduce the amount of heat escaping from the Earth and how increased levels of these GHGs from human activities can amplify global warming through an "enhanced" greenhouse effect:

FIGURE 1 – THE GREENHOUSE EFFECT

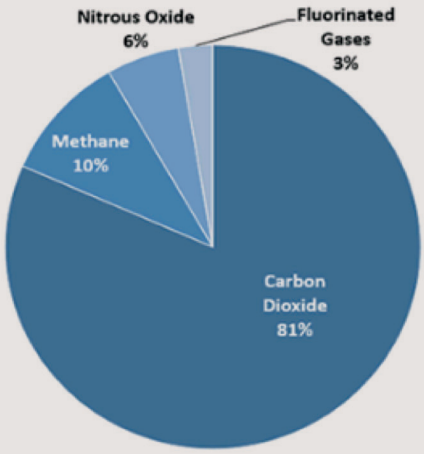


The Greenhouse Effect is not all bad. Radiation from our Sun drives the Earth's climate. Our distance from the Sun and reflectivity of the Earth determines how much radiation is absorbed. The Earth's atmosphere traps outgoing radiation (the Greenhouse Effect). It's this equilibrium of incoming and outgoing radiation that makes the Earth habitable. Thus, while global warming is often called the "Greenhouse Effect"[16], it is more properly termed the "Enhanced Greenhouse Effect." The atmosphere of Venus is nearly all carbon dioxide. But Venus has about 154,000 times as much carbon dioxide in its atmosphere as Earth, producing a runaway greenhouse effect and a surface temperature hot enough to melt lead.[17]

The GHGs are: water vapor (H2o), carbon dioxide (Co2), nitrous oxide (N2O), chlorofluorocarbons ("CFCs "), methane (CH4) and ozone.[18] Various human activities release gases and contribute to the Greenhouse Effect. Some of the largest sources of these GHGs include: the burning of fossil fuels (carbon dioxide);[19] aerosol sprays and refrigerants (CFCs); agricultural and industrial activities (nitrous oxide); livestock and other agricultural practices and decay of organic waste (methane).[20]

As shown in Figure 2, carbon dioxide accounted for 81% of total 2016 United States GHG emissions:[21]

FIGURE 2 – U.S. GREENHOUSE GAS EMISSIONS IN 2016



Total Emissions in 2016 = 6,511 Million Metric Tons of CO_2 equivalent

Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years. Importantly, "[a]ll of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions."[22]

Some gases are more effective than others at making the planet warmer. For each GHG, a Global Warming Potential ("GWP") has been determined to reflect how long it remains in the atmosphere, on average, and how strongly it absorbs energy. Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP, and thus contribute more to warming the Earth.

Specifically, GWP is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide ("CO2"). The larger the GWP, the more that a given gas warms the Earth compared to CO2 over that time period. The time period typically used for GWPs is 100 years. CO2, by definition, has a GWP of 1 regardless of the time period used, because it is the gas being used as the reference. CO2 emissions cause increases in atmospheric concentrations of CO2 that will last thousands of years. With CO2 as the reference, the other GHGs have been found to have the following GWP:[23]

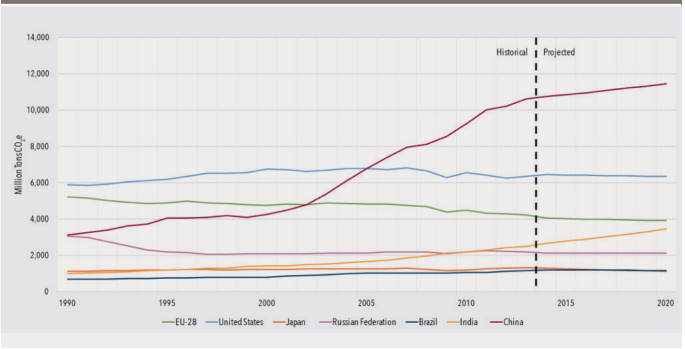
- Methane (CH4) is estimated to have a GWP of 28–36 over 100 years. CH4 emitted today lasts about a decade on average, which is much less time than CO2. However, CH4 also absorbs much more energy than CO2. The net effect of the shorter lifetime and higher energy absorption is reflected in its increased GWP.
- Nitrous Oxide (N2O) has a GWP 265–298 times that of CO2 for a 100-year timescale. N2O emitted today remains in the atmosphere for more than 100 years, on average.
- Chlorofluorocarbons (CFCs) trap substantially more heat than CO2. The GWPs for these gases can be in the thousands or tens of thousands.

CLIMATE CHANGE DATA & ACCOUNTABILITY

Measures of climate change include global surface temperatures and C02 levels which have increased at an unprecedented pace. Since 1993 average sea levels have risen at twice the rate of the long term trend. The IPCC has concluded that limiting global warming to 1.5°C above pre industrial levels would require rapid and far reaching societal change. In its recent report, the U.S. Global Change Research Program presented a wealth of scientific evidence of climate change and the impact on human welfare and environment. The 2018 Lancet report provided critical findings and recommendations on the relationship between public health and climate change.

As of 2016, the United States accounted for approximately 28% of global carbon emissions for major economies, although making up only 5% of the global population. As reflected in Figure 3, China surpassed the United States in carbon emissions in 2006 and has and is projected to be the global "leader" through at least 2020:[24]

FIGURE 3 – U.S. GREENHOUSE GAS EMISSIONS FOR MAJOR ECONOMIES, 1990-2020

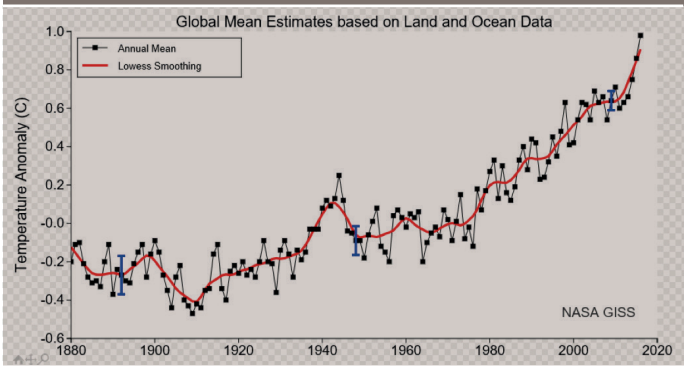


But GHGs do not obey political boundaries and as noted, all of these gases become "well mixed" in the Earth's atmosphere.

Temperature Change

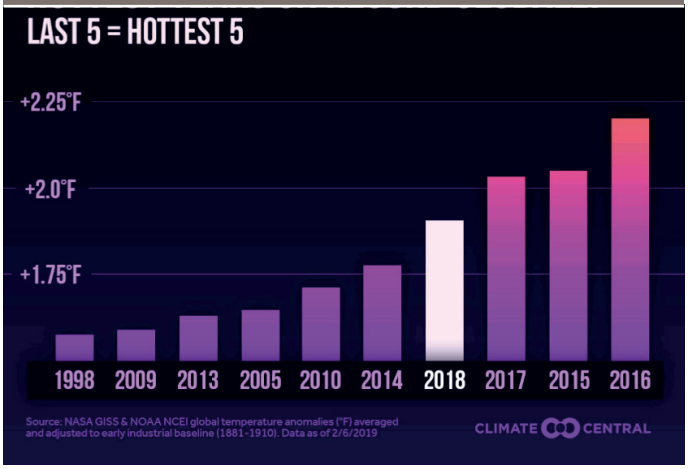
Figure 4 shows increasing global surface temperatures, as measured from 1880:[25]

FIGURE 4 – INCREASING GLOBAL SURFACE TEMPERATURES, AS MEASURED FROM 1980



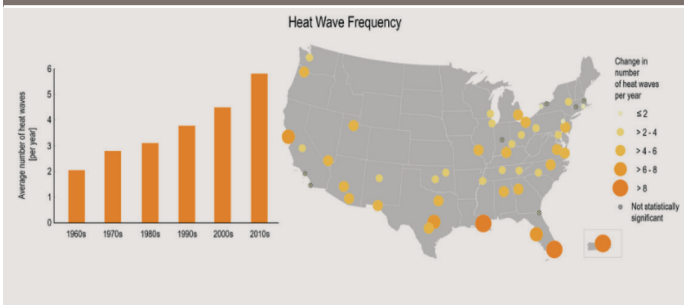
Indeed, as shown in Figure 5, with the exception of 1998, seventeen of the eighteen warmest years in the 136-year record all have occurred since 2001[26] and the year 2016 ranks as the warmest on record:[27]

FIGURE 5 – HOTTEST YEARS ON RECORD GLOBALLY



As shown in Figure 6, according to the U.S. Global Change Research Program ("USGCRP"), heat waves[28] are occurring more often in major cities across the United States, from an average of two heat waves per year during the 1960s to nearly six per year during the 2010s:[29]

FIGURE 6 – HEAT WAVE CHARACTERISTICS IN 50 LARGE U.S. CITIES, 1961-2017



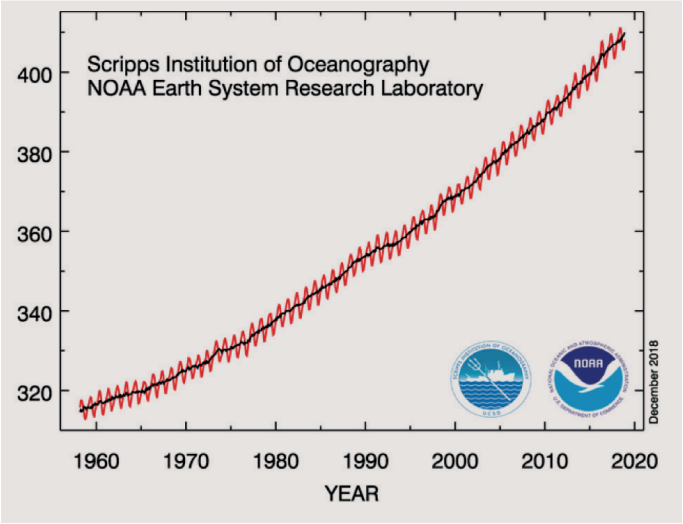
The latest reports are finding that 2018 was the fourth hottest year on record, with average global temperatures nearly 1°C above the pre-industrial average. According to the World Meteorological Organization ("WMO"), the 20 warmest years on record have been in the past 22 years, with the top four in the past four years.[30]

But surface temperature is only one measure of climate change. Other focal points include: atmospheric CO2 levels, sea ice cover, glacial melt,[31] sea level, ocean heat content, patterns of rain and snow, droughts and storms, as well as plant and animal distributions.[32]

Atmospheric Carbon Dioxide

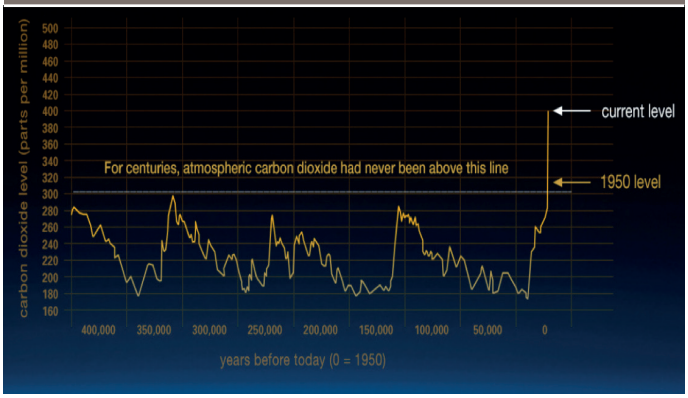
According to measurements taken since 1960 by the NOAA Earth System Research Laboratory at the Mauna Loa Observatory in Hawaii, atmospheric carbon dioxide has been steadily increasing with recent readings in February 2019 approaching 412 parts per million ("ppm"), as shown in Figure 7:[33]

FIGURE 7 – ATMOSPHERIC CO_2 AT MAUNA LOA OBSERVATORY



Scientists are also able to measure carbon dioxide levels going back centuries by sampling air bubbles trapped in glacial ice cores. Figure 8 shows that current atmospheric carbon dioxide is at levels which have never been reached over the last hundreds of thousands of years:[34]

FIGURE 8 – ATMOSPHERIC CO_2 LEVEL 1950-2019



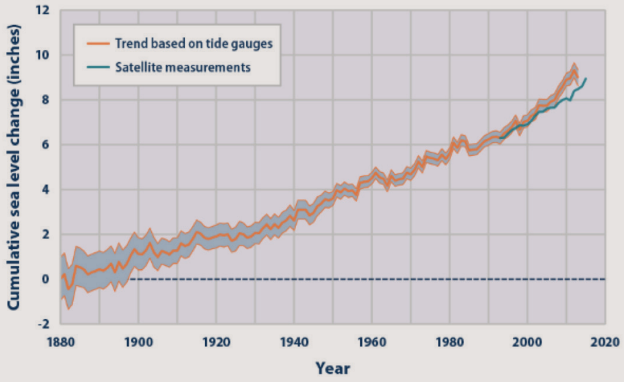
Sea Level Change

After a period of approximately 2,000 years of little change, global average sea level rose throughout the 20th century, and the rate of change has been found to have accelerated in recent years. When averaged over all of the world's oceans, *absolute* sea level is estimated to have risen at an average rate of 0.06 inches per year from 1880 to 2013.[35] Since 1993, however, average sea level has risen at a rate of 0.11 to 0.14 inches per year – roughly twice as fast as the long-term trend.[36]

Relative sea level rose along much of the U.S. coastline between 1960 and 2015, particularly the Mid-Atlantic coast and parts of the Gulf coast, where some stations registered increases of more than 8 inches.[37] However, relative sea level fell at some locations in Alaska and the Pacific Northwest, even though absolute sea level has risen, because land elevation in that region has risen more rapidly.[38]

Figure 9 depicts global average absolute sea level change from 1880-2015, which indicates an over eight inch rise:[39]

FIGURE 9 – GLOBAL AVERAGE ABSOLUTE SEA LEVEL CHANGE, 1880-2015



In our Section on Climate Change Damages and Associated Costs, we discuss some of the models which estimate further sea level rise over the next several decades.

The Intergovernmental Panel on Climate Change Reports

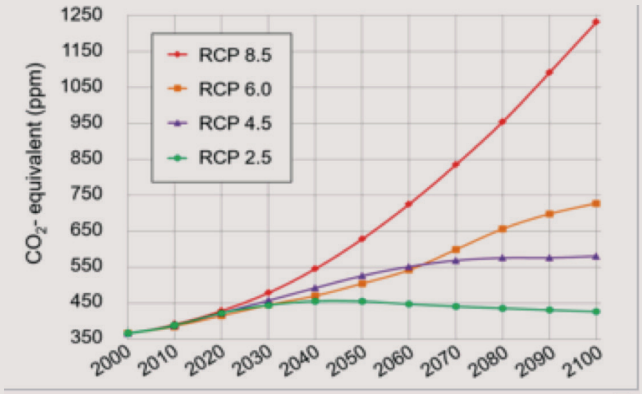
The Intergovernmental Panel on Climate Change ("IPCC") was established in 1988 by the World Meteorological Organization ("WMO") and the United Nations Environmental Programme. The IPCC is made up of voluntary representatives from 195 member states from around the world. It does not conduct independent research, but rather assesses available climate change information based on published sources, with a priority to those that are peer reviewed.[40] As of this writing, IPCC has prepared five assessment reports regarding the state of climate change knowledge, with the sixth expected in 2022. In addition, it has prepared several publications and special reports. The goal of the assessment reports are to convey the scientific basis of climate change, its impacts and future risks, as well as options for adaptation and mitigation.

Over the course of its five assessment reports, the IPCC's tone has gotten increasingly alarmist and its "confidence level" concerning climate change conclusions has gone from "about as likely as not" it is occurring (33%-66% probability) in year 1990 to "very likely" it is occurring (90%-100% probability) in year 2013.[41]

The IPCC's Fifth Assessment Report (2014) developed four Representative Concentration Pathway ("RCP") scenarios for use in climate modeling – namely: RCP8.5, RCP6, RCP4.5, and RCP2.6. The numbers refer to radiative forcings (global energy imbalances), measured in watts per square meter, by the year 2100.[42] The four RCP also establish different CO2 emission and atmospheric concentration scenarios running through the year 2100, with corresponding temperature and sea level rise calculations. Figure 10 summarizes the RCP scenarios for atmospheric CO2 concentrations, with RCP 2.5 and RCP 4.5 assuming concentrations will reach peak several decades in advance of 2100:[43]

FIGURE 10 – IPCC AR5 GREENHOUSE GAS CONCENTRATION PATHWAYS

Representative Concentration Pathways (RCPs) from the fifth Assessment Report by the International Panel on Climate Change



All forcing agents' atmospheric CO_2-equivalent concentrations (in parts-per-million-by-volume (ppmv)) according to the four RCPs used by the fifth IPCC Assessment Report to make predictions.

Figure 11 sets forth the global sea level and temperature rise corresponding to each of the four IPCC RCP scenarios, relative to the reference period 1986-2005:[44]

FIGURE 11 – IPCC RCP SCENARIOS, 1986-2005

		2046–2065		2081–2100	
	Scenario	Mean	*Likely* range[c]	Mean	*Likely* range[c]
Global Mean Surface Temperature Change (°C)[a]	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	1.4	0.9 to 2.0	1.8	1.1 to 2.6
	RCP6.0	1.3	0.8 to 1.8	2.2	1.4 to 3.1
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8
	Scenario	Mean	*Likely* range[d]	Mean	*Likely* range[d]
Global Mean Sea Level Rise (m)[b]	RCP2.6	0.24	0.17 to 0.32	0.40	0.26 to 0.55
	RCP4.5	0.26	0.19 to 0.33	0.47	0.32 to 0.63
	RCP6.0	0.25	0.18 to 0.32	0.48	0.33 to 0.63
	RCP8.5	0.30	0.22 to 0.38	0.63	0.45 to 0.82

IPCC Special Report (2018)

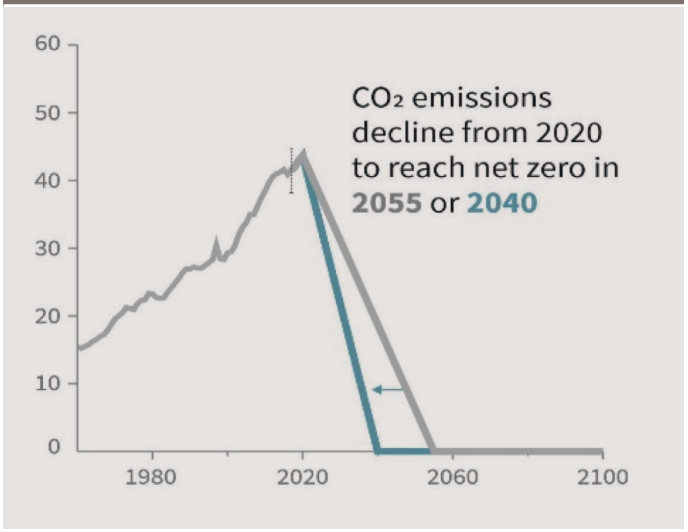
In 2018, the IPCC issued a Special Report on the Impacts of Global Warming of 1.5°C (2.7°F) above pre-industrial levels ("2018 Special Report"[45]). The primary catalysts for this 2018 Special Report were the Paris Agreement and its goal of limiting global warming to "well below" 2°C (3.6°F) above pre-industrial levels, coupled with mounting scientific evidence that such a two degree average temperature increase contemplated by the Agreement presents potentially catastrophic consequences for the earth, its inhabitants and ecosystems. Accordingly, the 2018 Special Report sought to determine whether limiting the global temperature increase to 1.5 versus 2°C would provide a significant benefit, by reducing the adverse consequences predicted by otherwise adhering to the Paris Agreement's goal of "well below" 2°C.[46]

The 2018 Special Report details numerous climate change impacts that could be avoided or significantly mitigated by limiting global warming to 1.5°C – a threshold its states the world will reach sometime between 2030 and 2052, if current trends continue. It is important to recognize that the world has already surpassed one degree C of warming, as carbon emissions have ballooned since the 1850s.

A comparison to the last major ice age provides some context on the impact of a few degrees in temperature swing. During that transition, the Earth's average surface temperature warmed about 4°C, but that temperature rise occurred over a period of about 10,000 years.[47] In contrast, over the past 150 years the Earth has warmed nearly 1°C, and studies suggest we could trigger anywhere from another 1 to 4°C warming over the next 85 years, depending on how much more carbon is discharged into the atmosphere. Thus, the Earth is estimated to be warming about 20 times faster than during the ice age transition.[48]

The IPCC 2018 Special Report stresses that limiting global warming to 1.5°C would require "rapid and far-reaching" changes in all aspects of society including: land, energy, industry, buildings, transport, and cities. As shown in Figure 12[49], this would also entail reducing "global net human-caused" emissions of carbon dioxide by 45 percent from 2010 levels by 2030 and reaching "net zero" levels around 2050. While Jim Skea, Co-Chair of the IPCC Working Group III, recognizes that limiting global warming to 1.5°C is "possible within the laws of chemistry and physics" he is mindful that "doing so would require unprecedented changes":[50]

FIGURE 12 – BILLION TONNES CO_2 PER YEAR ($GtCO_2$/YR)



According to the IPCC Special Report, staying at or below 1.5°C (2.7°F) requires slashing global greenhouse gas emissions 45 percent below 2010 levels by 2030 and reaching net zero by 2050. "We have not identified any pathways that get to 1.5°C without carbon dioxide removal," said Jim Skea, co-chair of IPCC Working Group III, at the Incheon press conference. The 1.5°C goal will require sucking carbon dioxide out of the air, even if the planet doesn't overshoot its carbon budget. In the worst-case scenario, its calculated that we may have to drawdown upward 1,000 gigatons of carbon dioxide from the atmosphere by 2100, a massive international undertaking with vexing scientific hurdles utilizing fledgling and unproven technology.[51]

Some of the climate change impacts that could be avoided or significantly mitigated by limiting global warming to 1.5°C discussed in the 2018 Special Report include the following:

- By 2100 global sea level rise would be 10 centimeters lower with global warming of 1.5°C compared with 2°C, placing 10 million fewer people at related-risk.
- The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C compared with at least once per decade with 2°C.
- Coral reefs would decline by 70-90 percent with global warming of 1.5°C, whereas virtually all would be lost with 2°C.[52]

- Of 105,000 species studied, 6% of insects, 8% of plants and 4% of vertebrates are projected to lose over half of their "climatically determined geographic range" for global warming of 1.5°C, compared with 18% of insects, 16% of plants and 8% on invertebrates for global warming of 2°C.
- The percent of global population exposed to extreme heat at least once every five years is reduced to 14% for global warming of 1.5°C, compared to 37% for global warming of 2°C.

The 2018 Special Report is the first in a series of Special Reports to be produced in the IPCC's Sixth Assessment cycle. In 2019, the IPCC will be releasing Special Reports on the "Ocean and Cryosphere in a Changing Climate" and "Climate Change and Land".

Fourth National Climate Assessment (2018)

In November 2018, the United States Global Change Research Program ("USGCRP") published their Fourth National Climate Assessment Report ("NCA4").[53] The USGCRP is comprised of many governmental agencies, with the lead agencies being NOAA and the Department of Commerce.[54] The purpose of the National Climate Assessment, is to provide the U.S. public and "decision-makers" with the state of the science on climate change, the impacts that it is currently having on the country, and those that are likely to manifest.

The NCA4 is comprised of two volumes, with the first volume being titled "The Climate Science Special Report" ("CSSR"), published in 2017.[55] The CSSR provides a detailed analysis of how climate change is affecting the physical earth system across the United States and provides the foundational physical science upon which much of the assessment of impacts in the NCA4 is based. Volume II focuses on the human welfare, societal, and environmental elements of climate change. As the report is a scientific assessment, it does not provide policy recommendations.

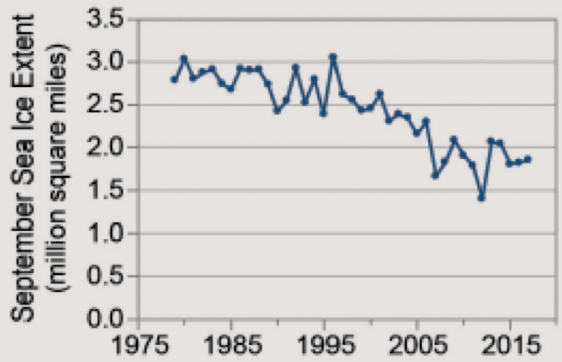
The NCA4 broadcasts several warning calls upfront including the following in its Introduction:

> *The assumption that current and future climate conditions will resemble the recent past is no longer valid. Observations collected around the world provide significant, clear, and compelling evidence that global average temperature is much higher, and is rising more rapidly, than anything modern civilization has experienced, with widespread and growing impacts. The warming trend observed over the past century can only be explained by the effects that human activities, especially emissions of greenhouse gases, have had on the climate.*
>
> *Greenhouse gas emissions from human activities will continue to affect Earth's climate for decades and even centuries. Humans are adding carbon dioxide to the atmosphere at a rate far greater than it is removed by natural processes, creating a long-lived reservoir of the gas in the atmosphere and oceans that is driving the climate to a warmer and warmer state.*
>
> *Today, the largest uncertainty in projecting future climate conditions is the level of greenhouse gas emissions going forward.*
>
> *The effects of different future greenhouse gas emissions levels on global climate become most evident around 2050, when temperature, precipitation and sea level rise projections based on each scenario begin to diverge significantly.*

Some of the key findings in the NCA4 include the following:[56]

- Carbon dioxide levels are now higher than any time in the last 3 million years, when temperatures and sea levels were much higher. The current emissions rate of nearly 10 gigatons of carbon per year is unprecedented in at least the last 50 million years. Put another way, we're emitting at a rate unseen in at least 50 million years, and continued growth in emissions would create conditions not seen on this planet for tens to hundreds of millions of years.
- The potential need for millions of people and billions of dollars of coastal infrastructure to be relocated in the future creates challenging legal, financial, and equity issues that have not yet been addressed.
- Annual average temperatures across the contiguous U.S. have risen by 1.8°F since the beginning of the 20th century.
- Annual medial sea level along U.S. coasts (with land movement removed) has increased about 9 inches since the early 20th century.
- Each year, some U.S. sectors are likely to see more than $100 billion of losses by the end of this century as a result of climate change (which, for context, is higher than the GDP of many states).
- Annual average near-surface air temperature in Alaska and across the Arctic has increased over the last 50 years at a rate more than twice as fast as the global average temperature.
- As shown in Figure 13, since the early 1980s, Arctic sea ice extent has decreased between 3.5 percent and 4.1 percent per decade, has become thinner by between 4.3 and 7.5 feet, and on average the season of melting lasts 15 more days per year:[57]

FIGURE 13 – ARTIC SEA ICE EXTENT



United Nations Climate Change Annual Report (2017)

In the Report's opening remarks, U.N. Secretary-General Antonio Guterres called climate change the "defining challenge of our time."[58] Mr. Guterres went on to caution that the Paris Agreement was a beginning and not an end and the "world is currently not on track to achieve the Paris targets." He urged all Parties to implement decisive, immediate climate action if we are to safeguard the future of this and future generations.

United Nations Emissions Gap Report (2018)

In November 2018, the U.N. released the ninth edition of its Emissions Gap Report.[59] The purpose of the Report is to assess the latest scientific studies on current and estimated future greenhouse gas emissions and compare those with the emission levels permissible for the world to progress on a "least-cost pathway" to achieve the goals of the Paris Agreement. This difference between "where we are likely to be and where we need to be" is considered the "emissions gap."

In her opening remarks, Acting Exec. Dir. of the U.N. Environment Programme, Ms. Joyce Msuya, stated fatalistically:

> *Even if the nations of the world live up to their current commitments [under the Paris Agreement], that will likely result*

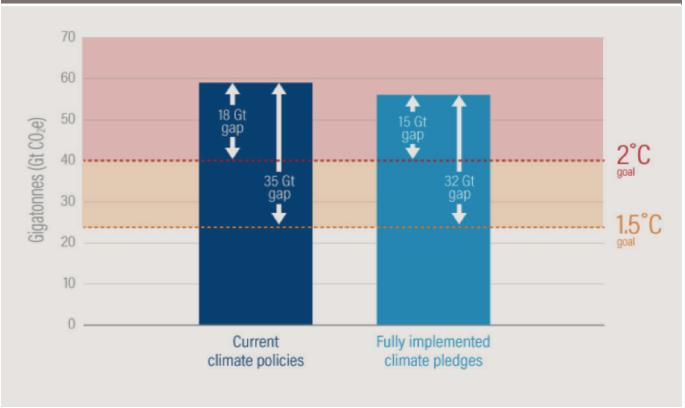
in global warming of around 3°C by the end of the century. That's a number that would be catastrophic – and fatal for many small island states and coastal areas.

Some additional takeaways from the U.N. Gap Report include:

- **As shown in Figure 14[60], the global emissions gap is larger than previously estimated.** While the nationally determined contributions ("NDCs") under the Paris Agreement will limit total global carbon dioxide emissions in 2030 to 53-56 gigatonnes ("GtCO2e"), keeping warming below 2˚C is believed to require reducing them to 40 GtCO2e on average. And to limit warming to 1.5˚C, we'd need to reduce emissions to 24 GtCO2e:
- **Emissions will not peak by 2030 even if countries fully implement their climate commitments under the Paris Agreement.** Although global GHG emissions from fossil fuels and industrial sources remained constant from 2014 to 2016, they increased again in 2017, reaching a record high of 54 GtCO2e.
- **Only six of the world's twenty largest economies are on track to meet their Paris Agreement commitments by 2030.**[61]

Lancet Countdown Report on Health and Climate

FIGURE 14 – EMISSIONS GAP IN 2030



Change (2018)

The Lancet Countdown Report Tracking Health and Climate Change was released in November 2018. The Report is a product of an independent collaboration between 27 leading academic institutions, the United Nations and intergovernmental agencies from every continent. It provides critical findings and recommendations on the relationship between public health and climate change.[62]

The Report looks at 41 separate indicators across five domains: climate change impacts, exposures, and vulnerability; adaptation, planning, and resilience for health; mitigation actions and health co-benefits; finance and economics; and public and political engagement.

The Report warns that urgent steps are needed to protect people now from the impacts of climate change. More specifically, stronger labor regulations are needed to protect workers from extremes of heat and hospitals and the health systems we rely on need to be better equipped for extreme heat so they are able to cope. But the Report also emphasizes that if left unabated, climate change and heat will overwhelm even the strongest of systems, so the need for reducing greenhouse gas emissions is critical.

Anthony Costello, co-chair of The Lancet Countdown, states: "Following current trends we exhaust our carbon budget required to keep warming below 2°C, by 2032. The health impacts of climate change above this level threaten to overwhelm our emergency and health services."

Key findings of the Lancet Report include:

- A lack of progress in reducing emissions and building adaptive capacity threatens human lives and the health systems on which they depend.
- The nature and scale of the response to climate change will determine the health of nations for centuries to come.
- 157 million more vulnerable people were subjected to a heatwave in 2017 than in 2000, and 18 million more than in 2016.
- 153 billion hours of work were lost in 2017 due to extreme heat as a result of climate change. China alone lost 21 billion hours, the equivalent of a year's work for 1.4% of their working population. India lost 75 billion hours, equivalent to 7% of their total working population.
- Heat stress, an early and severe effect of climate change, is commonplace and we, and the health systems we rely on, are ill equipped to cope.
- Rising temperatures and unseasonable warmth is responsible for cholera and dengue fever spreading, with vectorial capacity for their transmission increasing across many endemic areas.
- The mean global temperature change to which humans are exposed is more than double the global average change, with temperatures rising 0.8°C versus 0.3°C.

2013 and 2017 Climate Change Accountability Studies

In 2013, the Climate Accountability Institute Study quantified total historical carbon dioxide and methane emissions of the top 90 fossil fuel companies and other carbon producers for the period 1854-2010.[63] A 2017 Study builds upon the 2013 Climate Accountability Study to conclude that since 1880, 90 companies are responsible for up to 50% of global temperature rise, 57% of the increase in atmospheric CO2, and between 26% and 32% of sea level rise.[64] As depicted in Figure 15[65], the 2017 Study rankings include both individual companies and sovereign nations:

FIGURE 15 – CLIMATE IMPACTS OF THE BIGGEST CARBON PRODUCERS

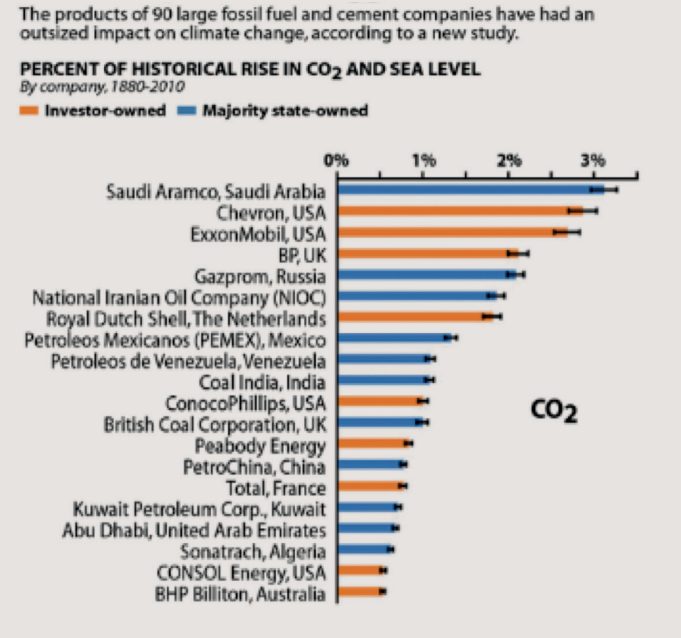


FIGURE 15 – CLIMATE IMPACTS OF THE BIGGEST CARBON PRODUCERS - CONTINUED

INTERNATIONAL TREATIES & OTHER CLIMATE CHANGE INITIATIVES

The signatories of the 2016 Paris Agreement representing more than 88% of global greenhouse gas emissions, agreed to take action in an effort to limit global temperature rise to well below 2°C above pre industrialized levels. Although the U.S. has indicated intent to withdraw from this, attendees of the 2018 UN Climate Summit made further progress on the Agreement and the intent to increase and accelerate climate action and ambition should continue to be realized in 2019. While China is the world largest emitter of GHGs, it is keen to assert itself as a global climate leader and, by certain measures, is on target to meet or exceed its pledges to curb GHG emissions by or before its 2030 Nationally Determined Contribution (NDC). However, several significant concerns have been raised, including a possible ramping up of new fossil fuel plants in China. India ranks by many studies as the most vulnerable to the impact of climate change but has also taken a number of initiatives and is similarly on target to meet or exceed its 2030 NDC. There are more than 1500 climate laws and policies world-wide, at least 106 of which have been introduced since the Paris Agreement.

THE PARIS AGREEMENT

At the 2015 United Nations Climate Change Conference in Paris, parties to the United Nations Framework Convention on Climate Change ("UNFCCC") reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future.

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century to "well below" 2°C (3.6°F) above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C (2.7°F).

The Paris Agreement requires that all parties report regularly on their GHG emissions and on their implementation efforts. There will also be an assessment every 5 years to determine the collective progress made towards achieving the purpose of the Agreement.

The Paris Agreement opened for signature on April 22, 2016 (Earth Day) and entered into force on November 4, 2016, 30 days after the so-called "double threshold" (ratification by 55 countries that account for at least 55% of global emissions) had been met. As of April 2019, 195 states and the European Union have signed the Agreement.[66] 185 states and the EU, representing more than 88% of global greenhouse gas emissions, have ratified or acceded to the Agreement.[67]

On June 1, 2017, U.S. President Donald Trump announced that the United States would withdraw from the Paris Agreement. In accordance with Article 28 of the Agreement, the earliest possible effective withdrawal date for the United States is November 4, 2020. Importantly, that is the day *after* the next presidential election.[68]

In President Trump's statement of withdrawal, he criticized the Paris Accord and the "draconian financial and economic burdens the agreement imposes on... [the United States, including]… the Green Climate Fund which is costing the United States a vast fortune."[69] President Trump went on to state that compliance with the terms of the Paris Accord and the onerous energy restrictions it has placed on the United States could cost America as much as 2.7 million lost jobs by 2025.[70] President Trump also explained that he could not support a deal that "punishes the United States..., while imposing no meaningful obligations on the world's leading polluters."[71] By way of example, President Trump stated that under the Agreement, China will be able to increase its emissions for a period of thirteen years and "India makes its participation contingent on receiving billions and billions and billions of dollars in foreign aid from developed countries."[72]

However, despite President Trump's intent to withdraw the United States, over 400 U.S. mayors have separately committed to uphold the Paris Agreement.[73]

COP24 U.N. Climate Summit (Poland - 2018)

In December 2018, nearly 200 countries attended the 12-day climate talks in Katowice, Poland to, among other things, finalize regulations arising from the 2015 Paris Agreement.

Hoesung Lee, chairman of the IPCC, told attendees that "urgent action is needed" to tackle global warming, and further cautioned that "[w]e are moving in the right direction in many areas, but we need to do more and faster."

In the end, more than 190 countries agreed to adoption of the rules. However, consensus was not reached on a critical but complicated issue involving how countries "trade" and account for certain pollution. That issue is expected to be taken up again at a later date in 2019.

Moreover, certain nation representatives did not agree to unequivocally accept the latest climate science. Instead, those countries reached a "compromise" statement in which they welcomed the recent 2018 IPCC Special Report, but not necessarily its actual findings. U.N. Secretary-General António Guterres said it would be "suicidal" and "immoral" to fail at COP24.[74]

In September 2019, the U.N. will convene a Climate Summit to bring together governmental world leaders and the private sector and civil society together to increase and accelerate climate action and ambition.[75] The Summit will focus on heavy industry, nature-based solutions, cities, energy, resilience, and climate finance.

Global Climate Change Spotlight

Trends in Climate Change Legislation

According to the Grantham Research Institute on Climate Change and the Environment, as of May 2018, all 197 Paris Agreement signatories or ratifiers have at least one law or policy addressing

climate change or the transition to a low-carbon economy.[76] Moreover, there are over 1,500 climate laws and policies world-wide (up from 72 in 1997) and at least 106 have been introduced since the Paris Agreement. However, the pace of passing legislation has slowed, with 64 new laws in 2016 and only 36 in 2017.

The European Commission recently announced a new long-term strategy for the EU to be carbon-neutral by 2050. Miguel Arias Cañete, Commissioner for Climate Action and Energy, said: "The EU has already started the modernization and transformation towards a climate neutral economy. And today, we are stepping up our efforts as we propose a strategy for Europe to become the world's first major economy to go climate neutral by 2050. Going climate neutral is necessary, possible and in Europe's interest. It is necessary to meet the long-term temperature goals of the Paris Agreement."[77]

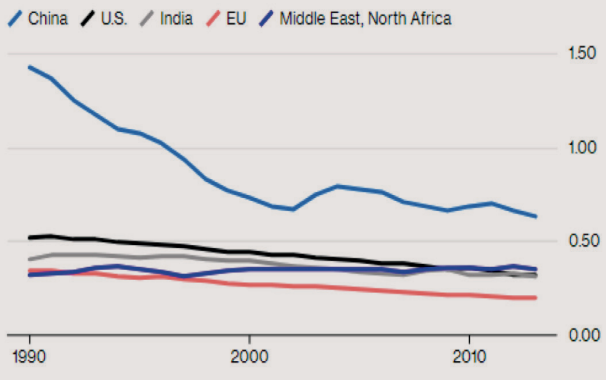
U.S. cities and states are assessing their vulnerability to climate change and making investments to increase infrastructure resilience. As part of such efforts, many states have released extensive reports assessing, on a more local level, the present and future anticipated impacts of climate change.[78]

Most recently, in November 2018, New York City introduced a landmark bill (Intro. 1253) to slash fossil fuel pollution from City buildings of more than 25,000 square feet ("Big Buildings").[79] Starting in 2022 the bill requires Big Building owners to reduce carbon emissions by 40 percent by 2030. Thereafter, the legislation gives landlords until 2050 to double those cuts. However, the bill is facing significant opposition, particularly from the real estate industry, due to a loophole for buildings housing even one rent-regulated apartment – which could exempt up to a third of the city's big residential emitters. Moreover, The Greater New York Hospital Association insists that the 2022 start date represents an "extremely problematic" and "arbitrary timeline" for facilities that stay open 24/7 and require constant lighting and power.[80]

China's Pivotal Role in Mitigating Climate Change

China, a country of 1.3 billion people, is now the world's second largest economy and the world's largest emitter of GHGs, contributing approximately twenty-five percent of global emissions.[81] China now releases almost as much carbon dioxide as the U.S. and Europe combined.[82] Moreover, as shown in Figure 16,[83] China is also severely lagging behind other developing and developed nations when measuring kilograms of carbon dioxide emissions against each dollar of GDP:

FIGURE 16 – CO2 EMISSIONS IN KILOGRAMS PER DOLLAR OF GROSS DOMESTIC PRODUCT



Source: World Bank

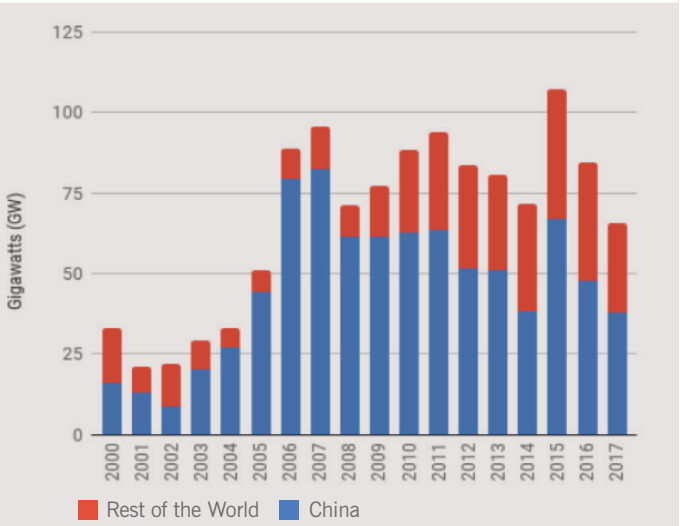
Although China's 6.6% GDP growth in 2018 ranks as its slowest pace in twenty-eight years, it is still considered a "developing nation" with a growth rate exponentially greater than the 2.27% exhibited by the United States in 2017.[84] As such, China's energy demands are likewise expected to continue on a steep upward trajectory for some time. For example, China's electrical consumption is expected to double by 2040.[85] With increased energy demands, comes increased challenges to reduce GHG emissions. Indeed, China is seen as an indispensable party in an effort to combat climate change.[86]

A recent study conducted to determine how daily temperature changes influenced electricity consumption in the region, obtained household electricity data for more than 800,000 residential customers residing in Shanghai, China for the period 2014-2016. The study concluded that for daily temperatures above 77°F, every 1.8°F (1°C) increase resulted in a 14.5 percent increase in daily household electricity consumption. The researchers then analyzed global climate models and determined that for every 1.8°F increase in global surface temperature, residential electricity use would increase by 9 percent and peak electrical demand would mushroom by more than 36 percent by the end of this century.[87]

China has been positioning itself as a global climate leader and is on track to meet or exceed its 2030 Nationally Determined Contribution ("NDC") – a voluntary pledge made pursuant to the Paris Treaty, to reduce carbon emissions by a certain amount. However, a rise in coal consumption drove Chinese carbon emissions to a new high in 2017, which will likely be exceeded again in 2018.[88] Despite the return to increasing emissions in 2017, China has reportedly met its 2020 "carbon intensity target" in 2017, three years ahead of schedule.[89] Nevertheless, China's NDC is not believed to be ambitious enough to limit global warming to "well below" 2°C, as called for under the Paris Agreement, unless other countries make much greater GHG reductions.[90]

China is in the paradoxical position of being both the largest consumer of coal and the largest solar technology manufacturer.[91] It is also one of the top producers of electric cars.[92] Skeptics lay concern that China's prime motivation for being a leader in climate change had been its desire to secure sizable funding that was to be made available to developing nations under the Green Climate Fund ("GCF"), established by the 194 countries who are parties to the United Nations Framework Convention on Climate Change ("UNFCCC"). The GCF was also given an important role in helping to reach the goals of the Paris Agreement.[93] The Paris Agreement urges developed nations to provide voluntary annual contributions of $100 billion to the GCF to assist developing nations with climate change mitigation and adaption. However, with U.S. President Trump's decision to withdraw the U.S. from the Paris Agreement, only a small fraction of the $100 billion in funding has been secured from developed nations.[94] As of February 2019, $4.6 billion in funding has been committed.[95] Accordingly, pundits worry that with a significantly underfunded GCF, China's prime motivations to be a climate change mitigation leader will be curtailed. Indeed, a recent report from CoalSwarm indicates through satellite imagery that many coal-fired power projects that had been halted by the Chinese government have been restarted.[96] The CoalSwarm Report states that hundreds of new coal-fired power plants - comparable in size to the entire U.S. fleet, are in the works to be added to China's inventory.[97] As shown in Figure 17,[98] since 2000, China is estimated to be responsible for over 70% of all coal-fired plants added worldwide:[99]

FIGURE 17 – NEW COAL-FIRED POWER CAPACITY ADDED IN CHINA AND REST OF THE WORLD, 2000-2017



(Source: CoalSwarm, Global Coal Plant Tracker, July 2018)

In the recent COP24 United Nations Climate Change Conference in Poland, much debate took place as to whether large rapidly developing economies like China should be treated as a "developing nation" for the purpose of transparency in accounting for their GHG emissions under the Paris Agreement.[100]

China's coastline spans approximately 11,184 miles (18,000 km) and is central to the global shipping and seafood market. China is estimated to account for approximately half of the growth of global seafood consumption in the coming decades.[101] Moreover, many of China's thriving industrial cities are built on the banks of rivers and estuarine river deltas. According to Worldshipping.org, China possesses seven of the top ten container shipping ports in the world.[102] A 2013 World Bank report, concludes that economically, the Chinese port city of Guangzhou has more at stake from climate change than any other city on the planet.[103] Nearby Shenzhen, ranked 10th on the World Bank list, which measured risk as a percentage of GDP.[104]

HSBC recently commissioned a study specifically focused on climate change costs to Asia Pacific Ports. The Report prepared by Asia Research & Engagement ("ARE") was presented in March 2018.[105] The stated purpose of the Report was to "raise awareness of climate change risks to port infrastructure in Asia, quantifying the potential costs to rebuild and adapt ports to climate change."[106] The Report notes the extreme importance of Asia ports to the global economy, occupying nine of the top ten spots in terms of capacity. It goes on to stress that financial backers for new infrastructure, should insure that projects have included climate projections into asset development and long-term capital plans to avoid facing such costs in the future.[107] Importantly, the Report concludes that, in general, it will be "considerably cheaper" to build a port with a greater height above sea level, than to elevate it at a later date.[108]

The ARE Report estimates that the cost to adapt eleven of the highest capacity ports in China to sea level rise and increased storm intensity, ranges from a low of $4.3 billion to a high of $7.453 billion.[109] The low cost scenario is based on a sea level rise of 1.6 meters (5.3 feet) and the high on a rise of 2.3 meters (7.5 feet). As a foundation for these estimates, the ARE Report utilized the IPCC RCP scenarios 4.5 and 8.5.[110] RCP 4.5, assumes that atmospheric CO2 will peak in 2040, resulting in, among other things, a sea level rise between 0.3 meters (1 foot) and 0.6 meters (2 feet), whereas the Report's use of RCP 8.5, assumes CO2 levels continue to increase throughout the century, resulting in sea level rise between 0.45 meters (1.5 feet) and 0.8 meters (2.6 feet). However, the ARE Report included additional sea level rise amounts to account for the highest expected storm surge, thereby arriving at the aforementioned figures of 1.6 and 2.3 meters.[111]

It is reported that about 70 percent of Shenzhen's thousands of acres of mangrove forests have been destroyed due to development.[112] Mangroves provide a natural buffer from the sea, filter out salt that can infiltrate freshwater and can also serve as a carbon "sink", while aiding in lowering ambient temperatures.[113]

Nonetheless, as depicted in Figure 18[114], a February 2019 Report found that China and India lead the world in the reintroduction of trees, plants and crops, in what the study called a "strikingly prominent" greening through land-use management, with a goal to mitigate air pollution and climate change.[115] Satellite data for the period 2000-2017 shows that China accounts for 25% of the global net increase in vegetative "leaf area," with 42% coming from increased forests and 32% from croplands:[116]

FIGURE 18 – RANKING OF THE 11 LARGEST COUNTRIES BY LEAF AREA AND ITS CHANGE DURING 2000-2017

Rank	Annual average leaf area in 2000 (million km^2)	Net change in leaf area (10^{-1} million km^2)	Net change in leaf area (%)
1	Brazil (29.68)	China (13.51)	China (17.80)
2	Russia (12.36)	Russia (7.57)	India (11.10)
3	United States (8.93)	EU (4.02)	EU (7.78)
4	Indonesia (8.69)	India (3.65)	Canada (7.13)
5	DRC (8.50)	United States (3.59)	Russia (6.62)
6	China (7.64)	Canada (3.35)	Australia (5.62)
7	Canada (5.41)	Australia (2.83)	United States (4.55)
8	EU (5.23)	Brazil (1.12)	Mexico (4.07)
9	Australia (5.19)	Mexico (0.96)	Argentina (1.70)
10	India (3.33)	DRC (0.96)	Brazil (1.54)
11	Mexico (2.66)	Indonesia (0.51)	DRC (1.34)
12	Argentina (2.16)	Argentina (0.13)	Indonesia (0.83)

In summary, China is a crucial player in the concerted effort to curb global warming and the world's attempt to limit warming to 1.5°C. Moreover, negative impacts to its economy could have a significant trickledown impact to the rest of the world, especially given the outsourcing of manufacturing to China and the dependency on the region's factories and supply chain.

INDIA: CHAMPION AND VICTIM OF CLIMATE CHANGE

According to a 2018 HSBC Report, India ranks as the most vulnerable country in the world to the impacts of climate change.[117] The HSBC Report looked at 67 developed, emerging and "frontier market" countries and assigned scores based on the following factors: (1) Physical Impacts; (2) Sensitivity to Extreme Events; (3) Energy Transition Risks; and (4) Potential to Respond to Climate Risks.[118] After India, the remaining top ten most vulnerable countries are identified as: Pakistan, Philippines, Bangladesh, Oman, Sri Lanka, Colombia, Mexico, Kenya and South Africa.[119] China and the U.S. ranked 26 and 39, respectively.[120]

A 2019 Germanwatch Global Climate Risk Index Report which studied the period between 1998 and 2017, ranked India as the fourteenth most vulnerable nation to the impacts of climate change and found that on average, there were 3,660 deaths annually due to extreme weather events.[121] In 2017, the Report notes that there were 2,726 deaths in India directly related to extreme weather events such as heatwaves, storms, floods, and drought – ranking India second for fatalities.[122]

The World Bank ranks India at the top of the poverty scale, with approximately 270 million Indians living below the poverty line of $1.90 (U.S.) a day.[123] For the poor, the difficulty to escape the harsh elements of weather is escalating as climate change and extreme weather becomes more pronounced. There is concern that many rural Indians may migrate into urban cities, as rising temperatures and erratic rainfall continue to threaten their livelihoods and already reduced living standards.[124] However, the author notes that India's cities are already severely overcrowded and adding millions of "climate refugees" to underdeveloped slums would be catastrophic.[125]

Sixty percent of India's agriculture is estimated to be rain-fed.[126] Studies show that many agricultural areas in India have succumb to a significant fall in crop yield due to increased frequency of droughts.[127] Six hundred million people in India presently face an acute potable water shortage.[128] At the same time, widespread extreme rains are estimated to have increased three-fold during the period 1950-2017, due to the "overheating of landmass" causing intensification of monsoon rainfalls in central and southern India.[129] According to Kira Vinke, a scientist at the Potsdam Institute for Climate Impact Research, the wet season in India is going to get wetter and the dry season drier.[130]

India's NDC established targets for 2030 to lower the emissions intensity of GDP by between 33%–35% below 2005 levels, increase the share of non-fossil based power generation capacity to 40%, and to create a further (cumulative) "carbon sink" of 2.5–3 GtCO2e through additional forest and tree cover.[131]

As part of meeting its NDC targets, the Indian government has announced, that no diesel or petrol-powered vehicle should be sold in India by 2030.[132] And as discussed above, India and China lead the world in the reintroduction of trees, plants and crops, which create "carbon sinks" to help absorb carbon dioxide.[133] However, recent reports indicate that Indian policymakers are finding it increasingly difficult to continue this "greening" process, as much of the targeted land has been encroached upon by people with "political connections" and is being sought by agencies implementing infrastructure projects such as roads, dams and canals.[134]

It is expected that India's current climate policies will see it reaching its 2030 non-fossil capacity target, and overachieving its emissions intensity target submitted under the Paris Agreement. Moreover, if its "Draft Electricity Plan" is fully implemented it is believed that India could achieve its NDC target more than eight years ahead of the 2030 timeframe pledged and would be ranked by climateactiontracker.org ("CAT") as a global climate leader, with an upgraded rating of "1.5°C Paris Agreement Compatible."[135]

India's Draft Electricity Plan confirms that no new coal capacity is needed after 2022, apart from the 50 GW that was already under construction in 2016 and is likely to be ready by 2022. The Draft Electricity Plan further assumes that no gas-fired capacity will be deployed after 2022, as the availability of natural gas is uncertain in India due to increasing dependency on imports.[136]

CAT acknowledges two 2017 publications by a "government think tank" which have raised concerns about India's commitment to low carbon economic growth, citing: the government's Draft National Energy Policy and the Three Year Action Agenda (2017–18 to 2019–20), both of which include recommendations to increase domestic production and distribution of coal, oil and gas.[137] There is also concern that India's growing demand for transport is causing a transition from bicycles and rickshaws to motorcycles and scooters – which require fossil fuels. Instead, critics suggest that India introduce electric vehicles and strengthen its public transportation infrastructure.[138]

A recent report by the Cement Sustainability Initiative ("CSI") shows that the local cement sector in India is on track to meet its 2030 emission targets set out in the low carbon technology roadmap ("LCTR"), allaying certain concerns that increased cement demands to support development would cause carbon emissions to spike.[139] Direct CO2 emission intensity is estimated to have fallen by 5% in 2017 in the Indian cement sector compared to the 2010 baseline. The alternative fuels thermal substitution rate ("TSR") increased by 5 times from 2010 to 2017.[140]

In an unsettling paradox, studies have found that dust particles high in the atmosphere from air pollution largely emanating from India and China, have assisted in cooling the earth, by reflecting sunlight back to space.[141] Accordingly, question is raised as to whether India and China's efforts to clean up their air pollution, will have a measurable negative impact on rising global temperatures?

UNITED STATES CONGRESSIONAL HEARING: THE STATE OF CLIMATE SCIENCE AND WHY IT MATTERS

On February 13, 2019, the House of Representatives Committee on Science, Space, and Technology held a two hour hearing to deepen understanding as to why the climate is changing and to help develop mitigation and adaption strategies.[142] This was to be the first in a series of Congressional hearings on climate change.

Several climate scientists testified, including Dr. Jennifer Francis, Senior Scientist, Woods Hole Research Center who stressed that extreme weather events have tripled since the 1980's, citing data from insurer Munich Re and explained that "we know that our atmosphere is warmer and wetter now" and that "alters every weather event that happens now..."[143] Dr. Joseph Majkut, Director of Climate Policy for the Niskanen Center, highlighted three primary areas of focus:

1) The Committee should continue its research to manage this "chronic condition" and to support local and private sector efforts.
2) The Committee should support research and development of "carbon-capture" technologies, emphasizing that a "world aiming for [limiting warming to] 2 degree C, will require a portfolio of low carbon energy sources, including carbon capture and storage of fossil fuels." Dr. Majkut added that a world aiming for limiting warming to 1.5°C will require deployment of processes to remove carbon from the atmosphere at a scale capturing up to one-quarter of today's emissions – "a mindboggling [task] for an infant technology."
3) The Committee should also support early research into alternative "geo-engineering" technologies.[144]

When asked by Representative McNerney whether the Earth could avoid a 1.5°C temperature increase solely by reducing carbon emissions, Rutgers University professor Dr. Robert Kopp stated that it is physically possible "but may be challenging" and would require getting GHG emissions to net zero "very quickly."[145]

Similarly, Cornell University professor Dr. Natalie Mahowald, a lead author of the IPCC 2018 Special Report, testified that keeping global warming below 1.5°C will require "extremely ambitious emissions cuts" of forty-five percent in global CO2 by 2030, which is significantly more than pledged in the Paris Agreement. In that regard, she noted that adhering to the lesser Paris Agreement emission cuts would likely result in warming of 3°C.[146]

CLIMATE CHANGE DAMAGES AND ASSOCIATED COSTS

The costs of climate change are increasing and are substantial. 2017 was the costliest year on record for natural catastrophe events, with US$344 billion in global economic loss, of which 97% was due to weather-related events. Insured loss estimates from natural catastrophes totaled $140 billion in 2017 and at $80 billion in 2018, remained significantly higher than the long-term average. The 2018 IPCC Special Report estimated that global economic damages by 2100 would reach $54 trillion with 1.5°C (2.7°F) of warming, $69 trillion with 2°C (3.7°F) warming and $551 trillion with 3.7°C (6.7°F) of warming above preindustrial levels.

2017 was the costliest year on record for natural catastrophe events, with $344 billion in global economic loss, of which 97% was due to weather-related events.[147] 2017 was also noteworthy as being a record year for insured losses from natural catastrophe at $140 billion.[148] Natural catastrophe losses remained high for 2018 at $160 billion (total loss)/$80 billion (insured) – correlating to a loss burden for insurers substantially higher than the long-term average.[149]

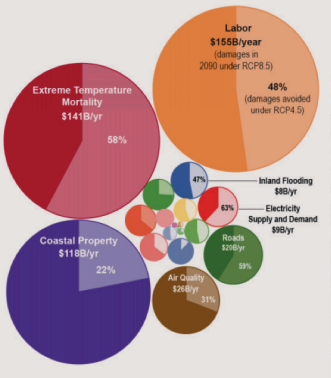
The full extent of damages and associated costs from climate change are far-reaching and seemingly unquantifiable – although many impacts have and are being assessed. Impacts generally include, but are certainly not limited to:

- Direct damage to real and personal property
- Costs to mitigate against sea level rise (dams, levees, raising/strengthening buildings and structures, relocation, etc.)
- Impacts of climate change on physical systems, such as oceans, lakes and snowpack
- Impacts of climate change on biological systems – humans, vegetation and wildlife
- Loss of natural resources (e.g. forest wildfires, complete submergence of sensitive wetlands, coral reefs, impacts to fish and wildlife)
- Alteration of marine and terrestrial animal indigenous habitat/range
- Bodily injury
- Increased waterborne pests & associated disease (mosquitos, etc.)
- Damage to crops, agricultural productivity, growing season and soil erosion
- Salinization and other contamination of potable of water supply
- Business interruption and loss of income
- Lost worker productivity
- Loss of property value
- Impact to national security
- Loss of cultural identity

As global temperatures continue to rise, so too will the costs and consequences. Scientists maintain that the record setting $330 billion price tag for global natural disasters in 2017 was not an aberration.[150] Indeed, NOAA estimates that the United States has experienced 44 billion-dollar plus weather and climate disasters since 2015 (through April 6, 2018), incurring costs of nearly $400 billion.[151]

As depicted in Figure 19[152], the 2018 NCA4 warned that climate change could cost the U.S. hundreds of billions of dollars annually by century's end[153]:

FIGURE 19 – ANNUAL ECONOMIC DAMAGES IN 2090

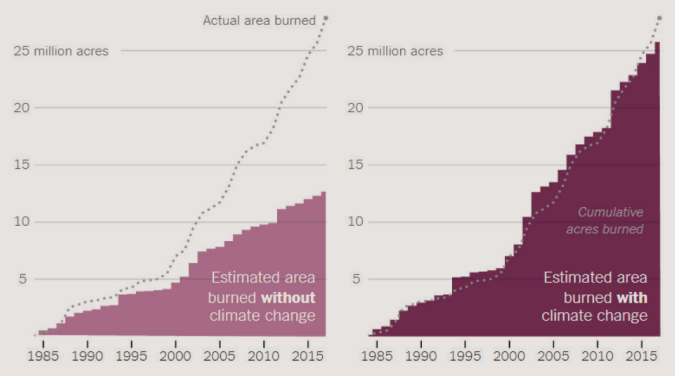


Annual Economic Damages in 2090		
Sector	Annual damages under RCP8.5	Damages avoided under RCP4.5
Labor	$155B	48%
Extreme Temperature Mortality◊	$141B	58%
Coastal Property◊	$118B	22%
Air Quality	$26B	31%
Roads◊	$20B	59%
Electricity Supply and Demand	$9B	63%
Inland Flooding	$8B	47%
Urban Drainage	$6B	26%
Rail◊	$6B	36%
Water Quality	$5B	35%
Coral Reefs	$4B	12%
West Nile Virus	$3B	47%
Freshwater Fish	$3B	44%
Winter Recreation	$2B	107%
Bridges	$1B	48%
Munic. and Industrial Water Supply	$316M	33%
Harmful Algal Blooms	$199M	45%
Alaska Infrastructure◊	$174M	53%
Shellfish*	$23M	57%
Agriculture*	$12M	11%
Aeroallergens*	$1M	57%
Wildfire	−$106M	−134%

Global damage costs are projected to climb into the tens of trillions of dollars without rapid de-carbonization. The 2018 IPCC Special Report[154] estimated that global economic damages by 2100 would reach $54 trillion with 1.5°C (2.7°F) of warming, and $69 trillion with 2°C (3.7°F) warming above preindustrial levels.[155] The IPCC Special Report further concludes that a 3.7°C (6.7°F) increase above preindustrial levels will cause a staggering $551 trillion in global damage. To put these figures in perspective, $551 trillion in damage is almost double all the wealth currently existing on Earth and widely eclipses the collective GDP of the world several times over.[156]

According to the 2018 NCA4, human-caused warming has increased the area burned by wildfire in the Western United States, "particularly by drying forests and making them more susceptible to burning."[157] By 2050, according to the NCA4, the area that burns yearly in the West could be two to six times larger than today. The NCA4 estimated the total acres burned in western forests under current climate conditions and in a model without human-caused warming. As shown in Figure 20[158], it found that half as much forest area would have burned between 1984 and 2015 in a world not warmed by climate change:

FIGURE 20 – CLIMATE CHANGE COMPARISON, ESTIMATED AREAS BURNED



Source: Proceedings of the National Academy of Sciences; data updated through 2017 by A. Park Williams

According to the NCA4, coral reefs in the U.S. Caribbean, Hawaii, Florida and the U.S. Pacific islands are already affected by bleaching and disease caused in part by climate change. The NCA4 concludes that loss of recreational benefits alone from coral reefs in the U.S. could reach $140 billion by 2100.[159]

The NCA4 determined that as of 2013, U.S. coastal shoreline counties were home to 133.2 million people, or 42% of the population. A recent study by the Union of Concerned Scientists found that high-tide flooding could put over 300,000 coastal homes and commercial properties in the lower 48 states with a collective market value of about $136 billion in today's dollars at risk within the next 30 years. By the end of the century, over 2.5 million homes and commercial properties currently worth more than $1 trillion altogether could be at risk.[160]

A 2017 Report from Zillow determined[161]:

- By 2050, more than 386,000 existing homes on the U.S. coastal areas, worth $209.6 billion (2018 dollars), are likely to be at risk of permanent inundation from sea level rise alone.
- If sea levels rise as predicted by the year 2100, almost 300 U.S. cities would lose at least half their homes, and 36 U.S. cities would be completely lost.
- One in eight Florida homes would be under water, accounting for nearly half of the lost housing value nationwide.
- Nationwide, almost 2.5 million homes – worth a combined $1.3 trillion – are at risk of being underwater by 2100.

A 2018 NOAA Report states Miami streets could flood every single day by 2070 under many climate models.[162]

The NCA4 Report states that inland flooding is anticipated to result in average annual damages to bridges of $1.2 to $1.4 billion each year by 2050. Nationally, the total annual damages from temperature and precipitation to paved roads could be as high at $20 billion in 2090 under a high carbon emissions scenario.

Indeed, more intense rain and higher sea levels are prompting Galveston, Texas officials to deviate from a drainage master plan written in 2003 by rethinking their approach to system improvements and requiring developers to meet more stringent drainage requirements.[163] The city plans call for investing almost $600 million in drainage-related projects from 2013-2023, a figure that includes federal and state grants.[164] In late-2018, federal officials changed the definition of a 100-year flood in Galveston from 13.5 inches in a 24-hour period to 17 inches.[165] According to a 2017 study by MIT professor Kerry Emanuel, the probability of a Texas storm dropping about 20 inches of rain was about 1% per year between 1981 and 2000, but will likely increase to 18% per year by 2100.[166]

According to a recent study, by 2040, more than 67,000 (64%) of the septic tanks in Miami-Dade County, Florida could have yearly issues due to sea level rise – impacting not only the tank owners, but the potable water supply and the health of residents and the ecosystem.[167] The building code has been revised to double the amount of clean fill that needs to be placed under the septic, as groundwater level continues to rise.[168] Officials have considered excavating/abandoning all the septic tanks and connecting homes to the county's sewer lines, at an estimated cost of $3.3 billion.[169]

The City of Rotterdam, ninety percent of which lies below sea level, has decentralized many aspects of water management, with flood protection now the responsibility of regional water management boards. They have also bolstered defenses, including a 3,700km network of dikes, dams and seawalls, to protect against worst case sea level rise scenarios.[170]

Estimates in the NCA4 Report of the likely climate-related hit to the nation's economy by the end of this century under the highest-emission IPCC scenario (RCP8.5)[171], in 2015 dollars, include:

- 203 to $507 billion of cumulative loss in real estate expected to be below sea level by 2100.
- $140 billion in cumulative tourism loss as a result of damage to U.S. coral reefs.
- $32 to $87 billion per year in energy expenses, as greater demand for air conditioning overwhelms more modest savings in heating costs.
- Up to $20 billion per year in temperature- and moisture-related damage to paved roads.

A Look Back at 2018 Severe Weather Events

Several reports were released analyzing 2018 weather events, including a Report by Christian Aid which focused on the top 10 most destructive, each of which caused damage of over US$1 billion. Four of the events are estimated to have cost more than US$7 billion each. All told, the Report estimates damages upwards of US$100 billion and notes that these figures are likely to be underestimates, as in some cases they show only insured losses and do not take into account the costs of lost productivity and uninsured losses.[172]

Two of the most destructive hurricanes in U.S. history, Florence and Michael fill the top spots, respectively, at $17 and $15 billion in damages. Hurricane Florence brought record rainfall in the Carolinas, with some places receiving more than 30 inches of rain.[173] This made Florence the third-wettest storm on record in the U.S. (all of the top three have happened since 2016).[174] At least 51 people were killed by the storm. Hurricane Michael was the strongest storm ever to hit the Florida Panhandle, with winds reaching about 155 mph and was the fourth strongest storm on record in the U.S. The storm killed 60 in the U.S., Honduras, Nicaragua and El Salvador.[175]

California wildfires also top the 2018 list. The Camp Fire, in November 2018, was the deadliest and most destructive in California's history, and the deadliest in the entire country for nearly 90 years. It killed at least 85 people and destroyed about 14,000 homes. The fire is estimated to have caused $11-$13 billion worth of property damage. The Woolsey Fire, caused further property damage estimated at $4-$6 billion.[176]

In 2017 approximately $100 billion in economic damages were wrought by Hurricane Maria, with over 2,000 dead, hundreds of thousands of homes damaged or destroyed, and the island of Puerto Rico left without power for up to eleven months – making it the largest blackout in U.S. history.[177] Hurricane Maria was also the costliest recorded hurricane to track across the Caribbean. Maria was also the first Category 5 storm on record to make landfall in the island of Dominica, with 98 percent of buildings on that island sustaining damage.[178] Moreover, Maria was the eighth-costliest global event in terms of economic loss and the sixth in terms of insured loss.[179]

CLIMATE CHANGE LITIGATION

Climate litigation is increasing and reflects advancements in science and economic modelling, discovery of corporations climate knowledge, public involvement and a more collaborative approach of cities, experts and the legal community. *Massachusetts v. EPA* (2007) ruled that it was for USEPA to regulate GHGs – not the courts – and the Clean Air Act supplants any private cause of action for nuisance under common law. Nevertheless, there are a number of recent climate change suits filed by municipalities that are being closely watched.

Climate litigation has been on a steady increase for the past decade across jurisdictions. In early 2017, there were over 1,200 laws and policies related to climate change in 164 countries, while in 1997 there were only 60.[180] Outside the U.S., approximately 64 climate cases have been filed in the past 15 years, at least 21 of which have been filed since 2015.[181] Traditionally, these cases have been brought against governments, but there is now a steep rise in climate lawsuits brought directly against companies: in the USA seven climate lawsuits were filed against fossil fuel companies in 2017, and six in 2018.[182] This rise can be attributed to advancements in science and economics modeling, discovery of companies' climate knowledge, increased public involvement, and collaboration between cities, lawyers, scientists and activists.

In the landmark case of *Massachusetts v. EPA*, 549 U.S. 497 (2007), the United States Supreme Court determined that carbon dioxide was a "pollutant" under the Clean Air Act ("CAA") and that the USEPA was remiss in failing to promulgate regulations governing GHG emissions.

Since that time, there have been a handful of climate change suits alleging public nuisance, all of which were dismissed on justiciability, displacement, preemption and/or standing grounds, citing to the precedent of *Massachusetts v. EPA* and its progeny and holding that the CAA supplants any private cause of action for common law nuisance and it is for the USEPA to regulate GHG's, not the courts.[183]

However, in the last two years, there have been a proliferation of new climate change suits by municipalities across the U.S., seeking to hold the fossil fuel companies accountable for the past and future costs arising from climate change. There have been no substantive rulings in any of these cases on the merits raised by the plaintiffs. All of these cases were filed in state court and removed to federal court by the defendants to take advantage of *Massachusetts v. EPA* and similar federal precedent.

The "big ten" pending climate change suits filed by municipalities are:[184]

- *County of San Mateo v. Chevron, et al.*[185]
- *County of Marin v. Chevron, et al.*[186]
- *City of Santa Cruz v. Chevron, et al.*[187]
- *City of Richmond v. Chevron, et al.*[188]
- *City and County of San Francisco & City of Oakland v. BP, et al.*[189]
- *City of New York v. BP, et al.*[190]
- *City of Boulder v. Suncor Energy (U.S.A.), et al.*[191]
- *King County v. BP p.l.c, et al.*[192]
- *Rhode Island v. Chevron, et al.*[193]
- *Mayor & City Council of Baltimore BP p.l.c, et al.*[194]

The *New York City* and *San Francisco/Oakland* cases were dismissed on the pleadings and appeals are pending.[195] The remaining "big ten" cases are in various stages of motions to dismiss or other "procedural" battles and appeals related to same.[196] These suits all contain one or more of the following causes of action and prayers for relief[197]:

- Damage to the municipality's property, as well as to the public at large.
- Nuisance due to sea level rise, increased flooding and intensified storms.
- Trespass due to sea level rise and increased flooding onto property.
- Defendants' historical knowledge of global warming, sea level rise and other climate change.
- Strict liability (failure to warn and design defect), and negligent failure to warn.
- Unjust enrichment, and deceptive trade practices.
- Climate change "data" regarding impact of sea level rise particular to Plaintiff's geographic location.
- Compensatory damages, abatement of the alleged nuisance, punitive/treble damages, and disgorgement of profits.
- Order requiring the defendants to abate the nuisance by funding a "climate adaptation program" to build sea walls and other infrastructure necessary to protect public and private property from sea level rise and other climate impacts.
- Loss of income from reduced agricultural productivity.

A number of commentators have suggested that these climate change plaintiffs are pursuing a "tobacco litigation strategy," with critics suggesting that such an approach will surely fail. Among other things, critics argue that while both involve products, tobacco is always hazardous to human health when consumed and fossil fuel is a "staple of the modern world."[198] Indeed, in granting defendants' Motion to Dismiss the Complaint of San Francisco and Oakland (one of the "Big Ten" cases), the federal court remarked that while it is true that fossil fuels have caused (and will continue to cause) global warming:

> *[O]ur industrial revolution and the development of our modern world has literally been fueled by oil and coal. Without those fuels, virtually all of our monumental progress would have been impossible. All of us have benefitted. Having reaped the benefit of that historic progress, would it really be fair to now ignore our own responsibility in the use of fossil fuels and place the blame for global warming on those who supplied what we demanded?*[199]

Given the mounting scientific evidence of climate change impacts and the magnitude of potential damages at stake, it is expected that numerous other states and cities will continue to bring suit against the fossil fuel industry.[200]

Pacific Coast Federation of Fishermen's Associations, Inc. v. Chevron Corp., et al.

In November 2018, as the first of its kind, an action was filed in California state court by a commercial fishing industry trade group to hold fossil fuel companies liable for adverse climate 'change impacts to the ocean off the coasts of California and Oregon, asserting that it resulted in "prolonged closures" of Dungeness crab fisheries'.[201]

Juliana v. United States

A case that is being watched closely by all climate change litigants, is a landmark climate-change lawsuit brought in Oregon federal court by 21 young people (ages 11 to 22) against the United States, styled *Juliana v. United States*.[202] The case had been scheduled to begin trial in October 2018, but has been stayed on numerous occasions, pending the United States various motions and attempts at Writ of Mandamus. Recently, the United States Supreme Court declined to intervene and dismiss the case. However, in its Ruling, the Supreme Court suggested that a federal appeals court should consider interlocutory appeals on other grounds before the case heads to trial in the district court.[203] In June 2019, the Ninth Circuit Court of Appeals is scheduled to hear argument regarding the United States' interlocutory appeal.

The plaintiffs allege that the government has violated their constitutional rights to life, liberty and property by failing to prevent dangerous climate change. They are asking the district court to order the federal government to prepare a plan that will ensure the level of carbon dioxide in the atmosphere falls below 350 ppm by 2100, down from an average of 405 ppm in 2017.[204]

WildEarth Guardians v. Zinke

In *WildEarth Guardians v. Zinke*, a recent noteworthy decision by a federal judge invalidated drilling leases for more than 300,000 acres of federal land, ruling that the Department of Interior ("DOI") and the Bureau of Land Management's ("BLM") authorization of oil and gas leasing in Wyoming failed to adequately consider climate change in its environmental impact statement ("EIS") under the National Environmental Policy Act ("NEPA").[205]

BLM stated in the EIS that the leases would not have a "measurable effect" on national or global emissions. The court disagreed, emphasizing that "[t]he leasing stage... is the point of no return with respect to emissions." The court went on to hold that BLM must provide documents backing its claim that the leases would not affect emissions and after such documentation is provided, the plaintiffs may again challenge the EIS. Until such time, the leases in question were declared invalid.

The court urged BLM to take the responsibility to assess the leases' impact on the environment seriously, stating "[c]ompliance with NEPA cannot be reduced to a bureaucratic formality, and the court expects [BLM] not to treat remand as an exercise in filling out the proper paperwork."

While the ruling applies to Wyoming, it has implications for public lands across the country. A DOI study found that for the period 2005-2014, GHG emissions from public lands accounted for 25 percent of overall U.S. emissions.[206]

Milieudefensie v. Royal Dutch Shell

In April 2019, seven environmental and human rights groups in the Netherlands filed suit against Royal Dutch Shell for failing to align its business model with the goals of the Paris Climate Agreement.[207] Plaintiffs are not seeking monetary compensation, but are demanding that Shell adjust its business model in order to keep global temperature rise below 1.5°C (2.7°F), as recommended by the IPCC.

New York & Massachusetts Attorney-General Fraud Investigations

New York and Massachusetts AG's have been investigating ExxonMobil for some time with respect to potential investor "climate fraud." New York argues that ExxonMobil allegedly used two different accounting methods – one for communicating climate change to the public and another kept private for internal projections. Massachusetts asserts that ExxonMobil allegedly deceived investors by failing to divulge potential climate change related risks to their investments and violated Massachusetts consumer protection laws by misleading consumers on the impact of its products on climate change.

After repeated admonitions by ExxonMobil over a three-year period, that the AG should either "put up or shut up," New York AG concluded its "investigation" and brought suit in October 2018.[208] The suit was brought under several anti-fraud statutes, including New York's Martin Act, one of the toughest such laws in the country. New York seeks an order prohibiting ExxonMobil from continuing to make misrepresentations and forcing the company to correct its past claims. The state also seeks unspecified money damages and a disgorgement of all profit derived from the alleged fraud. In a press statement, New York AG Underwood stated:

> *Exxon built a facade to deceive investors into believing that the company was managing the risks of climate-change regulation to its business when, in fact, it was intentionally and systematically underestimating or ignoring them, contrary to its public representations.*[209]

ExxonMobil's counter-suit alleging political motivations and constitutional First Amendment violations was dismissed, and its appeal to the Second Circuit unsuccessful.

On January 7, 2019, the United States Supreme Court declined to take up ExxonMobil's latest attempt to block Massachusetts' investigation into whether the oil giant misled the public and investors about climate change.[210] ExxonMobil crafted a failed argument to stop the Massachusetts investigation: It maintained that the state's attorney general had no jurisdiction over the Texas based company, because Exxon simply franchised service stations in Massachusetts but did not have an actual business operation there. Moreover, Exxon's argued that it does not control advertisements aired by its franchisees and the court wrongly relied on those ads to establish personal jurisdiction. Exxon also asserted that since the ads don't discuss climate change, they can't provide the requisite connection for the AG to seek decades worth of documents regarding climate change. The trial court denied Exxon's Motion to Stay the investigation and the Massachusetts Supreme Court affirmed, allowing the investigation to proceed.[211]

The decision clears the way for Massachusetts AG Healey to compel Exxon to produce records as her office probes whether Exxon concealed its knowledge of the role fossil fuels play in global warming.

The documents produced by Exxon as part of the AG investigation will undoubtedly be scrutinized by the plaintiffs in the Big Ten climate change cases and other potential litigants.

THE INSURANCE COVERAGE IMPLICATIONS OF CLIMATE CHANGE – A NEW FRONTIER

There has been a dearth of coverage actions and decisional law relating to insurance for climate change liability. However, this will likely change soon, given the rising prominence of the issue, the substantial costs involved and the increased litigation activity by municipalities and private parties against fossil fuel companies and other target defendants. Commercial General Liability, D&O, and Property insurance are all in the sight line of climate change litigation. Choice of law is important for the litigant but coverage issues including, damage, type of damage, occurrence, trigger, allocation and pollutant exclusions are all topics for consideration.

AES Corp. v. Steadfast Ins. Co., 725 S.E. 2d 532 (Va. 2012), is the only reported decision involving coverage for climate change liabilities, where the Virginia Supreme Court held that the insurer had no obligation to provide a defense or coverage for the insured's potential climate change-related liabilities arising from the *Native Village of Kivalina* suit.[212] However, the case was summarily disposed solely on the lack of an "occurrence" issue.

More specifically, the Supreme Court of Virginia found that the underlying allegations asserting that the insured intentionally released tons of carbon dioxide and GHGs into the atmosphere as part of its business operations did not constitute an "occurrence" within the terms of the policies.

Notably, even though the underlying Complaint alleged both negligent and intentional conduct of the insured, the Court held that "whether or not AES's [insured] intentional act constitutes negligence, the natural or probable consequence of that intentional act is not covered."

Choice of Law

Choice of law is the first step in resolving any substantive legal issue. State courts must choose when a conflict exists between substantive law of two or more states relevant to the insurance coverage issues. Federal courts sitting in diversity must, pursuant to the Erie doctrine, go through same analysis and apply applicable state law.[213] Which State's law is chosen can often be dispositive in the coverage action, as a number of States have diametrically conflicting views on a certain of the coverage issues and policy language.

To the extent the underlying climate change suit by a particular municipality is for alleged injury to property and persons solely within its geographic borders, the coverage court could simply apply that state's law, particularly if it is also the forum state. However, given the transient nature of GHGs and the global impact of climate change, a choice of law analysis could likely become exceedingly complex.

The CGL Policy

Commercial general liability (CGL) insurance policies generally provide defense and indemnity coverage when a third-party sues the insured for money damages due to bodily injury and/or property damage that took place during the policy period, which arose from an "occurrence."

Below are some of the likely coverage issues to be addressed in the climate change context under a CGL policy:

Do the Climate Change Suits Against the Insureds Seek "Damages"?

The term "damages" is not defined under most CGL policies. Insurers argue the term is limited to "legal" damages and does not include equitable relief. The majority of states have ruled that environmental response costs are "damages" and are covered under the CGL policy.

Monetary relief as compensatory damages sought in the climate change suits should qualify. However, insurers will likely argue that the injunctive relief to abate the nuisance does not qualify as "damages." Certain of the plaintiffs seek an order requiring the companies to pay monies into a "Climate Change Abatement Fund" for future perceived harm, which raises additional issues, particularly if there has been no present finding of "property damage" or "bodily injury." Declaratory and various types of equitable relief sought may also create coverage disputes.

Do the Climate Change Suits Against the Insureds Involve "Property Damage"?

"Property damage" is generally defined in most CGL policies as: "Physical injury to tangible property, or loss of use of that same physically injured tangible property." Some CGL policies also include within the "property damage" definition, the "loss of use of tangible property that is not physically injured."

To determine "physical injury," courts often look at whether the tangible property was altered in appearance, shape, color, or in another material dimension. Generally environmental damage to property has been found by courts to constitute physical injury to tangible property.

To the extent the climate suits allege water damage to real property, buildings and structures from sea level rise, they may qualify as "property damage." However, mitigative and preventative efforts to curtail or avert "property damage" (e.g. dams, dikes and raising or relocating buildings) may raise disputes. Courts have found coverage for mitigative and prophylactic costs, especially where "property damage" is present and the mitigation is to avoid further damage.[214]

Economic loss alone, without any accompanying damage to or loss of use of tangible property, is not covered property damage. Accordingly, insurers would likely argue that coastal property which has decreased in value due to rising sea level is not covered, unless there is an accompanying damage or loss of use. If seas rise and start to cause actual "property damage," is all future damage covered?

Alleged damages in these climate change suits resulting from a decrease in crop yields may not be covered. Courts have sometimes found coverage in other contexts if there was physical damage to the crops. However, coverage denials have been upheld for costs arising from crop failures due to the seeds failing to germinate.[215]

What if the climate change plaintiffs seek damages against the insured to abate the mere presence of excess GHG's in the atmosphere? In *Concord Gen Mut. Ins. Co. v. Green & Co. Bldg. & Dev. Corp.*[216], the Supreme Court of New Hampshire held that there was no requisite physical injury to tangible property, where CO2 was leaking from insured's chimney, as the gases did not physically alter the property and the homeowners were able to continue living in their house, although they could not use their chimney.

Is There "Property Damage" During the Policy Period?

This will undoubtedly be a disputed issue in a climate suit context and often involve a "battle of the experts." If "property damage" has happened, in which year(s) did it take place? Most large target companies have "legacy" liability insurance policies stretching back to the 1940s or earlier. Accordingly, nearly every major insurance company will be implicated if the "property damage" is deemed to have occurred from the 1940s through present.

Not until approximately 2011, did the EPA promulgate "certain" regulations under the CAA to regulate GHG emissions.[217] Additional regulations were promulgated in 2015. Accordingly, there was no emission standard to measure before then.

However, the scientific community and even the fossil fuel companies admit GHGs have been and are causing detrimental physical changes in the earth's climate. But are physical changes to the earth's climate "property damage"?

In certain of the pending climate change suits the plaintiffs are seeking recovery of past costs, although the basis is not entirely clear. If the past costs relate to building a sea wall to mitigate against future erosion of beaches and damage to structures due to rising sea level and more intense weather events, insurers will likely argue no "property damage" during the policy period.

Do the Climate Change suits against the insureds involve "Property Damage" arising from an "Occurrence"?

"Occurrence" is generally defined as:

> *An accident, including continuous or repeated exposure to substantially the same general harmful conditions which results in injury or damage which is neither expected nor intended from the standpoint of the insured.*

"Occurrence" is *not* the trigger of coverage. Rather, it is the act of the insured (the accident, event or conditions) that results in injury – the cause. It is the resulting injury/damage during the policy period that triggers coverage – the effect.

There are generally four legal issues with respect to an "occurrence" analysis:

1) Whether the "neither expected nor intended" requirement concerns the offending act or resulting injury;

2) Whether there should be an objective or subjective standard applied in determining "expected or intended" (subjective standard is majority approach);

3) How to define "expected" (e.g. whether the insured knew the damage would result, or whether the insured should have known damage would result.); and

4) Who bears the burden of proof on the "expected or intended" issue. (This question turns on whether the court will interpret the occurrence requirement as an exclusion or as part of the definition of coverage).

All of the pending U.S. climate change suits allege intentional and knowing conduct on the part of the fossil fuel defendants dating back to at least the 1960s. Such allegations may support a finding of no "occurrence".[218]

How Many Occurrences Are There?

The answer to this question could have huge monetary implications on available policy limits and exhaustion of coverage. The analysis could be exceedingly complex in these climate change suits, where the alleged damages involve both traditional concepts of property damage and bodily injury, as well as injury to ecosystems, marine life, and natural resources separated by time and place.

Typical limits of liability language states "[f]or the purpose of determining the limits of the Company's liability, all injury or damage arising out of continuous or repeated exposure to substantially the same general harmful conditions shall be considered as arising out of one occurrence."

The courts generally apply either the "cause test" or the "effects test" in determining the number of occurrences. Under the "cause" test, the inquiry is whether the diverse injuries or claims share a common, uninterrupted proximate cause? This often results in a one occurrence finding. In contrast, under the "effects test" the focus is on the point at which people or property are damaged by insured's act or omission, which militates in favor of a multiple occurrence finding, should the facts permit.

Two possible outcomes in a climate change coverage action would be: one "occurrence" – the insured's decision to manufacture and supply a "defective" product (fossil fuels which, when burned, release persistent GHGs), or multiple "occurrences" – any isolated discrete injuries separated in place and time.

We raise caution, as the case law addressing number of occurrences is often extremely fact specific, result- oriented, often affected by SIRs/deductibles, and even inconsistent within particular jurisdictions.

Operation of the Products/Completed Operations Hazards

Many CGL policies only contain aggregate policy limits for products/completed operations hazards (as defined). The assertion of strict liability and other "defective product" allegations in the climate change Complaints could implicate this aggregate limitation. Depending on the number of occurrences outcome, the applicability of the products hazard definition could have a significant impact on available policy limits.

Trigger of Coverage

Trigger of coverage refers to what must occur during the policy period to give rise to potential coverage under the specific terms of the policy. There are four main GL trigger theories which could be applied to these climate change suits, the selection of which could have a significant impact on the number of policy years implicated:[219]

1) **Injury in fact** (All policies are triggered if they are in effect during the time the injury or damage is shown to have actually taken place, even if the injury or damage continues over time).

2) **Exposure** (All policies are triggered if they are in effect during exposure to injurious or harmful conditions) – (Applied more often in bodily injury cases).

3) **Manifestation** (The policy is triggered when the injury or damage is discovered or manifests itself – or in some cases is capable of being discovered – during the policy period) – (Applied more often in first-party property cases).

4) **Continuous** (All policies are triggered if they are in effect during any of the following times: exposure to harmful conditions; actual injury or damage; and upon manifestation of the injury or damage).

Application of Pollution Exclusions

The three main types of pollution exclusions likely to be encountered in climate change coverage actions are: (1) Sudden and Accidental (1973-1985); (2) Absolute (1986 -); and Total (1988-).

All three of these variants, exclude coverage for, *inter alia*, "property damage" arising out of the discharge of "pollutants..." The term "pollutant" is most commonly defined in a CGL policy as: "Any solid, liquid, gaseous or thermal irritant or contaminant, including smoke, vapor, soot, fumes, acids, alkalis, chemicals and waste. Waste includes materials to be recycled, reconditioned or reclaimed."

All three types of pollution exclusions require a discharge and a finding that the offending substance (e.g. GHGs, carbon dioxide, methane) falls within the definition of "Pollutant." Courts generally apply either a "traditional environmental pollution" approach or a broader, literal interpretation to the exclusions.

Under the "traditional" approach, courts interpret the exclusion to preclude coverage only for those claims that are commonly considered to arise from "traditional" environmental pollution (e.g. dumping waste at a landfill).

Under the "literal" approach, courts focus on the plain language of the policies and apply the exclusion to all claims arising from contaminants or irritants that cause damage, regardless of whether the claims involve traditionally understood contamination.

Importantly, the U.S. Supreme Court has on multiple occasions held that greenhouse gases (including carbon dioxide and methane) fall within the CAA's definition of "air pollutant."[220] Insurers should therefore, have a reasonably strong argument that the "pollutant" prong of the exclusion has been met in a climate change coverage action, especially in "traditional" states.

But insured's may argue that carbon dioxide is emitted by every human being as part of normal bodily respiration and thus, should not be considered a "pollutant" under the exclusion.[221]

We believe a strong argument will also be raised by policyholders in most of the climate change cases that the "discharge" requirement of the pollution exclusion has been met, given, among other things, the offending "pollutant" (GHGs, carbon dioxide, etc.) can be shown to have originated from numerous point sources and were dispersed within the outdoor atmosphere.

Is Climate Change Liability a D&O Issue?

According to the recent Zurich Quarterly Claim Journal (Spring 2018)[222], climate change liability presents significant D&O exposure:

> *From a D&O perspective it is more than likely that the industry will see an increase in claims in the future as a result of companies failing to adequately manage the risk of climate change on their business and to disclose these risks to investors. With respect to Financial Lines, it is most likely that D&O insurance will take the brunt of the Impact.*
>
> *It is speculated that we may shortly arrive at a time where the use of fossil fuels is severely restricted. There is therefore an argument that the fossil fuel reserves that currently exist will never be used. The concern is that energy companies and their directors are aware of this risk, however have not taken this into account when stating their reserves, thus massively overstating the value of their business and leaving them open to the risk of actions against them. This may also have a 'carry-over' effect to their advisors, (e.g. actions against their auditors and investment banks).*

A Report issued last year by the Grantham Research Institute on Climate Change and the Environment, remarked that it expects to see an increase in suits asserting liability for "injuries arising

from an alleged failure to anticipate and address [the] foreseeable consequences of climate change," given investors and insurers mounting attention to the "growing gap between scientific understanding of climate change and sluggish adaption efforts."[223]

In 2010, the S.E.C. issued a twenty-nine page "interpretive guidance" (not a new rule) on *existing* disclosure requirements regarding how companies are to address the risks posed by climate change in their securities filings.[224]

The "Guidance" stressed that "[t]his interpretive release is intended to remind companies of their obligations under existing federal securities laws and regulations to consider climate change and its consequences as they prepare disclosure documents to be filed with us and provided to investors."

The SEC Guidance states:

> *For some companies, the regulatory, legislative and other developments noted above could have a significant effect on operating and financial decisions, including those involving capital expenditures to reduce emissions...*
>
> *Companies that may not be directly affected by such developments could nonetheless be indirectly affected by changing prices for goods or services provided by companies that are directly affected...*
>
> *There have been increasing calls for climate-related disclosures by shareholders of public companies. This is reflected in the several petitions for interpretive advice submitted by large institutional investors and other investor groups...*
>
> *Among the factors companies should address are: legislation and regulation related to climate change, international treaties on the issue, the physical impacts of climate change... and indirect consequences of regulation or business trends.*
>
> *We reiterate that climate change regulation is a rapidly developing area. Registrants need to regularly assess their potential disclosure obligations given new developments.*

In the two years after the Interpretive Guidance, the S.E.C. issued 49 comment letters to companies addressing the adequacy of their climate change disclosures. However, in 2012 it issued only three such letters and none in 2013.[225]

In 2014, three prominent environmental groups sent a series of letters to individual board members of various major energy companies, to several D&O insurers, and others, pertaining to the companies' contribution to GHG emissions. The letters specifically discussed "climate change-related risk" of the companies' directors and officers and the fact that there may be no insurance coverage under their D&O policies.[226]

In April 2015, an alliance of 62 institutional investors and New York City wrote letters to the S.E.C. calling for greater scrutiny of climate-related disclosures from energy companies in particular.[227]

In October 2015, thirty-five Democratic Congressional lawmakers wrote the SEC requesting an update on the 2010 Interpretive Guidance and asking numerous pointed questions, including:

- What actions has the SEC taken to ensure that all companies understand their obligations under the Climate Change Guidance?
- How does the SEC ensure that companies are in compliance with the Climate Change Guidance?
- For each year since the issuance of the Climate Change Guidance, how many comment letters has the SEC sent to companies concerning the sufficiency of their disclosure concerning climate change?
- For each year since the issuance of the Climate Change Guidance, how many companies have not been in conformance with the Climate Change Guidance?
- What steps will the SEC take to ensure greater compliance with the Climate Change Guidance going forward?
- What has the SEC done to assess the effectiveness of the Climate Change Guidance in providing meaningful disclosures to investors?

The S.E.C. responded with a less than illuminating message, by simply stating that since the S.E.C. issued its Interpretive Guidance, "incrementally" more companies are making disclosures related to climate change.[228]

In February 2018, the GAO issued a 44-page Report entitled "Climate Related Risks – SEC Has Taken Steps to Clarify Disclosure Requirements."[229] The GAO Report pointedly concluded, without elaboration, that the SEC's disclosure requirements concerning risks associated with climate change are clear and "the SEC currently has no plans to revise the guidance."

The SEC recently responded to shareholder resolutions sent to Chevron and ExxonMobil requesting disclosure regarding how they plan to "align their business models with a low-carbon economy" – commonly heard buzz words. (In 2017, 62 percent of Exxon shareholders voted to require the company to disclose more about climate risks.). The SEC determined that Exxon had met it disclosure requirements and could "dismiss" the proposal.[230] However, the SEC ruled that Chevron must submit a compliant disclosure for consideration at its upcoming shareholder meeting.[231]

In 2017, shareholders of the Commonwealth Bank of Australia ("CBA") brought suit asserting that CBA failed to address climate risk in its financial disclosures and did not include reference to funding for a coal mine in Queensland, Australia. However, less than a week after the claim was filed, CBA published its Annual Report advising shareholders that climate change posed a significant risk to the bank's operations and it considers climate change as a "significant long-term driver of both financial (credit, market, insurance) and non-financial (operational, compliance, reputation) risks."[232] Had the case proceeded, it would have been the first of its kind to determine how companies are required to disclose climate change-related risks.

Indeed, Australia's financial regulator, the Australian Prudential Regulation Authority ("APRA") has stepped-up its warning to banks, lenders and insurers, saying climate change is already impacting the global economy, and flagged the possibility of "regulatory action". APRA revealed that it had begun questioning companies about their actions to assess climate risks, noting it would be demanding more in the future. In 2017, APRA put the financial market on notice, urging them to start adapting to climate change and warning that the regulator would be "on the front foot on climate risk."[233]

Most recently, a 2018 Report by Carbon Tracker discussing concerns as to global regulatory divergence regarding climate risk disclosure, notes pressure by investors and financial organizations on the International Organization of Securities Commissions ("IOSCO") to prompt a global shift on climate risk reporting in effort to insure consistency and assist investors in this "global economy."[234]

In 2015, the international Financial Stability Board established the Task Force on Climate-Related Financial Disclosures ("TCFD") to develop guidance for companies in disclosing clear, comparable and consistent information on the financial risks and opportunities presented by climate change.[235] The final recommendations, released in June 2017, were designed to bring consideration of climate risk into the forefront of business and investment decision-making

to facilitate efficient allocation of capital and to enable a smooth transition to a low-carbon economy. According to the latest TCFD Status Report, as of September 2018, the recommendations of the TCFD had received widespread business support from over 500 organizations, including 457 companies with a combined market capitalization of $7.9 trillion, including 287 financial services firms responsible for assets of nearly $100 trillion, equivalent to more than 50% of the global capital markets. Moreover, according to the 2018 TCFD status report, the World Federation of Exchanges is taking the TCFD recommendations into account in revising its Environmental, Social and Governance ("ESG") Guidance & Metrics.[236]

In general terms, the TCFD recommendations categorize climate risks into: (1) Transition Risks (risks that arise from the transition to a low carbon economy such as policy shifts); and (2) Physical Risks (risks that arise from the physical impacts of a changing climate such as increased extreme weather events).[237]

As part of TCFD's efforts to promote adoption of its recommendations, the 2018 Status Report provides an overview of current disclosure practices related to core elements of the recommendations. In sum, TCFD found that the majority of companies reviewed disclosed some information aligned with at least one recommended disclosure, usually in sustainability reports. However, TCFD found that financial implications are often not disclosed. Moreover, information on "strategy resilience" under different climate-related scenarios was found to be limited. More specifically, TCFD found that few companies describe the resilience of their strategies under different climate-related scenarios, including a 2°C or lower scenario, which is a key area of focus for TCFD. Disclosures were also found to vary across industries and regions. For example, a higher percentage of non-financial companies reported information on their climate-related metrics and targets compared to financial companies; but a higher percentage of financial companies indicated their enterprise risk management processes included climate-related risks. In terms of regional differences, a higher percentage of companies in Europe disclosed information aligned with the recommendations compared to companies in other regions.[238]

The TCFD 2018 Status Report cautions that the expected transition to a lower-carbon economy is estimated to require around $3.5 trillion, on average, in energy sector investments *per year* for the foreseeable future, generating new investment opportunities. However, the risk-return profile of companies exposed to climate-related risks may change significantly because of physical impacts of climate change, climate policy, or new technologies. TCFD points to one study which estimated the value at risk to the total global stock of manageable assets because of climate change ranges from $4.2 trillion to $43 trillion between now and the end of the century. The study highlights that much of the impact on future assets will come through weaker growth and lower asset returns across the board. Accordingly, the TCFD warns that investors may not be able to avoid climate-related risks by moving out of certain asset classes, as a broad range of asset types could be affected.[239]

The TCFD will continue to promote and monitor adoption of its recommendations and will prepare a second status report for the Financial Stability Board in mid-2019.

In its recent white paper, FM Global focused on why CFO's must initiate natural catastrophe preparedness, noting that "[i]f the CFO doesn't lead the charge to invest in reducing … [threats from natural catastrophe – including climate change], they will be the ones that stakeholders hold accountable for not properly addressing the risks."[240] According to FM Global, of more than 60 institutional investors polled (representing $32 trillion in assets), nearly eight in ten consider climate change to be a "significant risk" which is now a "mainstream" investor concern. The Paper stressed that while risk managers generally have an inward-looking role and are charged with improving currently existing risks, CFO's have a more outward-looking focus and the ability to eliminate some risks completely.[241] Based on its analysis of over 10,000 wind and flood related investments by 1,800 clients, FM Global determined that for every US$1 a company spends to protect structures from hurricane, wind and flood damage, estimated loss exposures decrease by an average US$105, in relation to those companies' associated reductions in property loss and business interruption exposures.[242] FM Global's review of nearly 100 10-K filings of public companies that experienced property damage and/or business interruption from Hurricane's Harvey, Irma or Maria, provides insightful and unsettling information on the breadth and extent of losses across a wide array of business sectors and the impact deep into these companies supply chains.[243]

The U.K.'s largest money manager, Legal and General Investment Management ("LGIM"), recently stated that the world is facing a "climate catastrophe" and businesses around the world must urgently address it.[244] The LGIM report cautioned that if businesses "remain ignorant to this crisis, they face shareholders refusing to back them anymore."[245]

Directors & Officers have been named in securities lawsuits alleging pollution or asbestos-related misrepresentations or omissions. In the resultant coverage actions, the issue of whether the pollution exclusion applied to bar coverage was often addressed.

On at least several occasions, courts have found that the pollution exclusion did not apply where, for example, "the alleged pollution was too attenuated from the damages arising from the alleged misrepresentations..."[246] or where "[a]ny wrongful acts by the insured or its directors or officers in the context of the asbestos personal injury claims did not form a causal link to the class action."[247]

However, in *Nat'l Union Fire Ins. Co. v. U.S. Liquids, Inc.*, a Magistrate held that a pollution exclusion barred coverage to the insured for liabilities arising from an underlying class securities and shareholder derivative action alleging the insured misrepresented and omitted facts related to its acquisition of waste hauler companies. In applying the exclusion, the Magistrate found that the alleged acts of "polluting and misrepresenting were not mutually exclusive but were related and interdependent."[248]

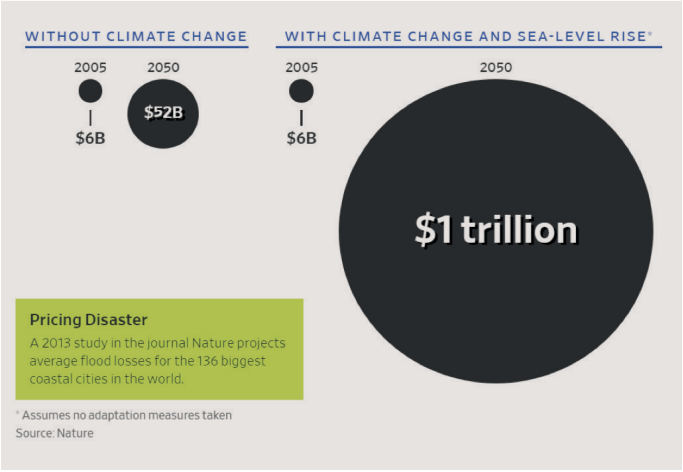
In this age of uncertainty as to potential climate-change liability, Zurich has offered a D&O policy with a coverage extension for "environmental mismanagement" which specifically includes GHG, global warming and climate change.[249]

First-Party Property Insurance

The property insurance market is likewise in the cross-hairs of climate change-related losses.

A 2013 study in the journal Nature projected average flood losses for the world's 136 biggest coastal cities could rise from $6 billion a year in 2005 to $52 billion a year by 2050 due to increased population and development. As shown in Figure 20, when taking climate change and a sea-level rise into account, the study concluded that flood losses could exceed $1 trillion a year by 2050, unless the cities invested about $50 billion annually in adapting:[250]

FIGURE 21 – PROJECTED FLOOD COSTS



A 2017 Zillow Report determined that if sea levels rise as predicted by the year 2100, almost 300 U.S. cities would lose at least half their homes, and 36 U.S. cities would be completely lost.[251]

With the projected increases in the frequency and severity of natural disasters such as hurricanes, floods, snow and hail storms, tornadoes and drought-related forest fires, the expectation is that we will see more homeowner and business owner property claims and more business interruption ("BI") losses, including contingent BI losses.

Coverage issues in the first-party realm will include direct physical loss, flood versus wind coverage disputes, actual loss sustained, as well as BI and contingent BI issues such as business income, period of restoration, claims settlement process disputes and insufficient supply chain coverage.

INSURANCE & FINANCIAL MARKET REACTIONS TO CLIMATE CHANGE

The world's top insurance companies have made some progress in setting climate strategy, targets and risk management in place, although those in the U.S. are lagging those in Europe and Japan. Both the asset and the liability side of the balance sheet are vulnerable and insurers have played a part in divestment from the fossil fuel industry and this is expected to continue. Climate change implications include potential credit rating downgrades for coastal municipalities given sea level projections and possible rapid escalation of flood insurance premiums given the current indebtedness of National Flood Insurance Program and the concern over climate change impacts to insured properties. Third party capital has entered the (re)insurance market to help address the climate change risk and the cat bond market totals some US$100 billion to date. The climate aligned bond universe is much larger, although it has been estimated that some $90 trillion of investment is needed in climate projects by 2030 to mitigate the anticipated effects of climate change. Carbon taxation is being considered as a potential mechanism to reduce GHG emissions. Approximately 40 countries and more than 20 cities, states and provinces already use carbon pricing mechanisms, with more planning to implement them in the future. The "Economists' Statement on Carbon Dividends," published in 2019, and signed by 3,508 U.S. based economists, concludes that a yearly increasing carbon tax, with the revenues returned to U.S. citizens, offers the most cost-effective lever to reduce carbon emissions at the scale and speed that is necessary to curb GHG emissions.

Insurance Industry Preparedness

Marc Grandisson, chief executive of insurer Arch Capital Group Ltd, speaking about potential climate change loss, remarked: "It takes a lot of premium, a lot of margin, to account for this increased uncertainty, and I'm not sure we're doing a good job of reflecting this and charging appropriately for it. We need to incorporate a greater range of possible outcomes into our pricing."[252]

In the 2019 study of "Loss and Damage From Climate Change", the authors raise warning that climate change may make some risks uninsurable and urge insurers to adjust their underwriting practices that are typically based on recent past loss experience.[253]

The Asset Owners Disclosure Project Report (2018), analyzed world's "top" 80 insurance companies in adapting to a "low carbon economy" and looked at whether the insurer had a climate strategy, targets and any risk management policies in place.[254] The Report determined that while some progress is being made in Europe and Japan, the U.S. "seriously lags behind." The Report further found that "taken as a whole, nine out of ten investment strategies in the sector were not aligned to the goals of the Paris Treaty." Strikingly, the Report concluded that less than 0.5 percent of the insurer group's $15 trillion in assets were placed in low carbon investments. Only 3 of the 24 U.S. insurers assessed received a rating above a D or X – the lowest ratings.

Potential Downgrade of Municipalities' Credit Ratings

A May 2018 Report authored by Univ. of Penn. Professor John A. Miller concludes that many U.S. coastal municipalities are unprepared for flooding and other effects of global warming-driven sea level rise and are heading towards an imminent downgrade of their credit, unless proactive mitigative efforts are promptly undertaken.[255] According to Professor Miller: "The ratings companies are really being pushed by the investors to look at the term of a bond. ...If you're issuing a 30 to 40-year bond, your investors are already looking toward... 2050." By that time, more than 300,000 properties in the U.S. worth $136 billion could be rendered unusable by routine flooding.[256]

An April 2019 Report by BlackRock concludes that extreme weather events pose growing risks for the credit worthiness of state and local issuers in the $3.8 trillion U.S. municipal bond market, finding that "some 58% of metropolitan areas face climate-related GDP hits of 1% or more by 2060-2080 under a 'no climate action' scenario."[257]

In 2018, Miami voters overwhelmingly approved issuance of $439 million in general obligation bonds, a quarter of which would be used to directly address the effects of climate change.[258] And when Miami Beach borrowed $162 million from Wall Street in April 2019, it devoted several pages to climate change disclosures, stating city officials are "keenly aware of the risks from hurricanes and sea level rise."[259]

Exxon launched a retaliatory suit, arguing that many of those same cities and counties which are plaintiffs in the pending climate change suits, had failed to disclose climate risks when they sold municipal bonds to investors.[260] Thereafter, two industry-friendly groups stepped forward also requesting that the SEC investigate the cities and counties for possible fraud.[261]

Flood Insurance Premiums Could Skyrocket In the Short Term

On Dec. 21, 2018, President Trump signed legislation passed by Congress that, once again, extends the National Flood Insurance Program's (NFIP's) authorization to May 31, 2019.[262]

The NFIP is the primary source of flood insurance coverage for residential properties in the United States. The NFIP has over 5.1 million flood insurance policies providing over $1.3 trillion in coverage, with approximately 23,000 communities in 56 states and

jurisdictions participating. In 2017, the NFIP took in approximately $3.6 billion in annual premium and paid out $8.7 billion.[263] More than half of the beneficiaries live in Florida and Texas and 3.8% of policyholders have filed for repetitive losses, accounting for a disproportionate 35.5% of flood loss claims and 30.5% of claim payments. Of those serial recipients, FEMA estimates that a 90% pay grandfathered below-market rates.[264] Instead of charging insurance premiums that cover the expected cost of floods, FEMA offers partly subsidized insurance.

The NFIP is over $20 billion in debt.[265] Critics say NFIP needs to be completely overhauled, as, among other issues, the current program gives flood prone property owners the incentive to rebuild time and time again without regard to future risk.

FEMA is considering switching to risk-based pricing in 2020, which would end the subsidies most coastal communities enjoy on their flood insurance premiums and show the true dollar cost of living in areas repeatedly pounded by hurricanes and drenched with floods – like South Florida. Such a paradigm shift could have a significant effect on the fair market value of flood-prone properties.

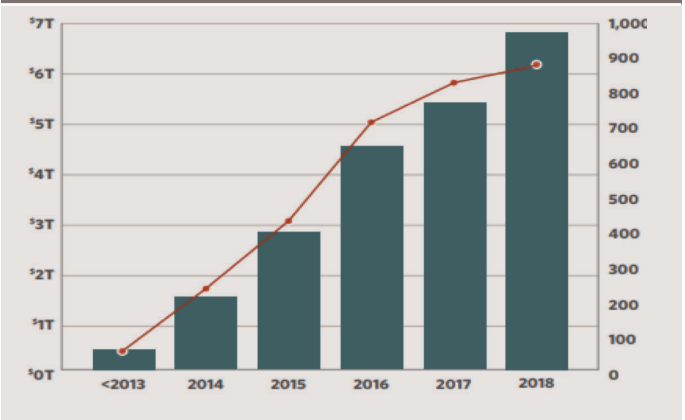
Critics argue that one of the major reasons why the NFIP cannot keep up with the growing number of claims is that it assesses risk based on outdated science, demarcating flood zones using data from the 1980s.[266] Thomas Wahl, a coastal engineer and oceanographer at the University of Central Florida, raises a cautionary flag as to increasing flood risk: "While the particulars of insurance reform are still being determined, one thing that is for certain is that flood risk is going up. I believe we have the science now that we can inform policy makers much better than we could several years ago."[267]

By 2050, according to a recent article in Nature, "some places can expect to see what is currently considered a 100-year-flood event recur as often as every one or five years on average."[268] Global warming and climate change related sea level rise will undoubtedly play a role in reassessing the NFIP.

Divestment From the Coal Industry

In May 2018, Allianz announced that effective immediately, it will no longer insure both single fired coal power plants and all planned and operating coal mines. Allianz will also no longer invest in energy companies that put the two-degree C Paris Treaty temperature reduction target at risk, by extensively building coal-fired power plants.[269] A number of other insurers have followed suit or indicated intent to do so. International insurers Swiss Re, Munich Re, AXA and Zurich have all opted to limit their insurance dealings with coal.[270] According to a 2018 Report by Arabella Advisors, nearly 1,000 institutional investors with $6.2 trillion in assets have committed to divest from fossil fuels, exhibiting a striking upward trend, as shown in Figure 22:[271]

FIGURE 22 – GROWTH IN DIVESTMENT COMMITMENTS



The insurance sector is estimated to account for $3 trillion of the $6.2 trillion in divestitures.[272] However, a recent Report by Insuring Coal No More, reveals that U.S. insurance companies are lagging behind their international peers on climate action, and asserts that U.S. insurers are enabling the construction of new coal-fired power plants, which is undermining international efforts to avoid the dangerous effects of climate change.[273]

Lloyd's Banking Group announced that it will refuse to finance new clients whose revenues "predominately" come from coal power plants and mines.[274]

A February 2019 Report by the Institute for Energy Economics and Financial Analysis ("IEEFA") finds that over 100 "globally significant" financial institutions have divested from thermal coal, including 40% of the top global banks and 20 globally significant insurers, with additional divestiture announcements occurring on an almost weekly basis.[275]

Southeast Asia's second largest lender, Oversea-Chinese Banking Corp., announced in April 2019, that ongoing projects for two Vietnamese coal-fired power plants will be the last it ever finances, as it increases funding for renewable energy projects.[276]

On a related note, Glencore, one of the largest mining and natural resource companies in the world very recently announced that it will "limit its coal production capacity broadly to current levels" – meaning it will not expand production beyond present levels.[277] In 2017, its estimated that Glencore produced more than 129 million tons of coal.[278]

Most recently, fifty-eight public interest nonprofits, including Greenpeace and Sierra Club California, wrote to California's insurance commissioner, asking the regulator to immediately start rulemaking proceedings to require California-licensed insurers to disclose "all their investments in fossil fuel-related entities" and "all the fossil-fuel-related companies and projects that they underwrite or otherwise insure."[279]

The request comes as the National Association of Insurance Commissioners considers abolishing a questionnaire it created in 2010 in which "large insurers" (at least $100 million in direct written premium) are asked about climate-impacting investments. But insurers must respond, only if the states in which they're licensed require it, and only a few, including California do so.[280]

The non-profits' correspondence to the California Insurance Commissioner stressed that there is an "urgent need for insurers to realign their risk management and underwriting strategies, in order to address escalating climate risks" and called on the Insurance Commissioner to provide guidance "to reconcile insurance investments and underwriting strategies for the future." If the non-profits are successful, California would be the first state in the nation to mandate disclosure of insurance companies' fossil fuel underwriting.[281]

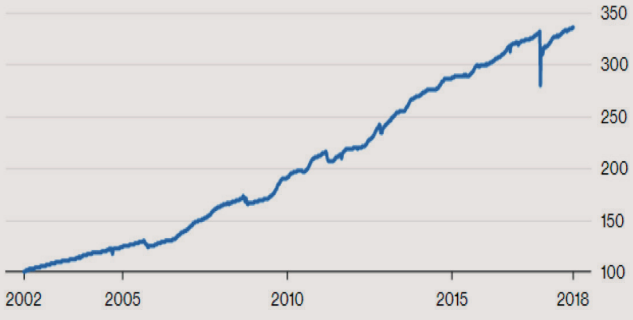
Catastrophe Bonds and Insurance-Linked Securities

Since the early 2000s, much of the commercial insurance industry has experienced a soft market. Prices have remained relatively low despite numerous natural disasters that have been costly for insurers.[282] Why has the insurance market remained soft despite all the costly disasters? The answer lies in part that insurers have easy access to capital from non-traditional sources. After Hurricane Andrew in 1992, insurers needed a new source of capital. Hedge funds, mutual funds, pension funds, and other investors responded by directing money into catastrophe bonds ("Cat Bonds"), and other types of "alternative capital" or "insurance linked securities" ("ILS")."[283] The ILS market has grown significantly since hurricane Katrina in 2005.[284]

Much of the alternative capital has been concentrated in the catastrophe business, protecting insurers from natural disasters.[285] Moody's has recently reported that the role of ILS and alternative reinsurance capital in paying catastrophe claims related to climate change is set to increase, as the insurance and reinsurance sector becomes increasingly aware of the climate risk it faces and turns to efficient capacity to help it offset them.[286]

In fact, the Cat Bond market has been extremely active, with the record issuance of more than $11 billion in 2018 and 2017 and about $100 billion invested to date.[287] The Cat Bond's purpose is to protect insurers from "catastrophic" costs tied to damage from hurricanes, floods or other natural disasters. Despite the recent trend of record natural disasters, as shown in Figure 23[288], Cat Bonds are posting significant positive returns for investors and reportedly haven't posted a negative annual return since the index began:[289]

FIGURE 23 – SWISS RE CAT BOND TOTAL RETURN INDEX VALUE



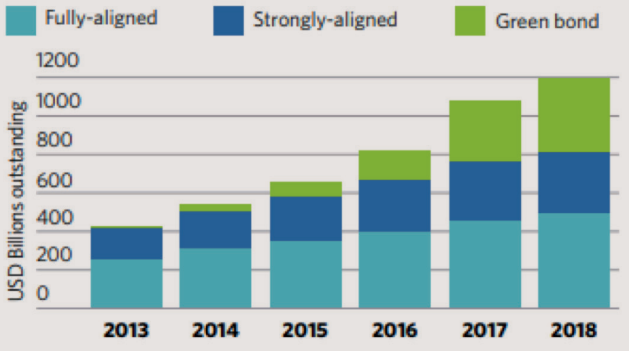
Source: Standard & Poor's

Thus, the use of Cat Bonds to hedge against climate change liabilities may be a wise strategy.[290] This is especially because the typical Cat Bond is "triggered" on very specific terms. For example, a Cat Bond may only cover wind damage for a named Hurricane in a particular geographic area, but not flooding.[291] The Cat Bonds are also not correlated to the stock or other capital market.[292] Moreover, as recognized by Moody, "the majority of the Cat Bonds are effective for only 1-3 years in duration and therefore are priced for the short term, and as a result are not exposed to climate change uncertainty over a longer multi-decade horizon."[293] In fact, in a first of its kind, FEMA recently purchased a $500 million Cat Bond to reinsure a portion of its potential exposure under the ailing National Flood Insurance Program.[294]

Climate Change and "Green" Bonds

A recent Report commissioned by HSBC and prepared by the Climate Bonds Initiative determined that as of 2018, there was $1.45 trillion in "climate-aligned" bonds outstanding, with a significant increase in outstanding amounts year-to-year since 2013, as depicted in Figure 24:[295]

FIGURE 24 – A CLIMATE-ALIGNED BOND UNIVERSE OF USD1.45TN



China tops the list of country rankings, with over $225 billion, followed by the U.S. at approximately $150 billion.[296] Although the upward trend is encouraging, the Report underscores that some $90 trillion of investment is needed in climate projects by 2030 to mitigate anticipated effects of climate change. Accordingly, the Report concludes that "global green finance" must reach $1 trillion in new issuance by the end of 2020 and increase each year of the new decade.[297]

Carbon Taxation

Carbon taxation is being considered as a potential mechanism to reduce GHG emissions. Stated most simply, a carbon tax is a fee that a government generally imposes on any company that burns coal, oil, or gas. Under a carbon tax, the government sets a price that emitters must pay for each ton of GHG emissions they emit.[298] Taxes on greenhouse gases come in two broad forms: an emissions tax, which is based on the quantity an entity produces; and a tax on goods or services that are generally GHG intensive, such as a carbon tax on gasoline or electricity generation.[299]

The carbon tax potentially reduces GHG emissions in several ways. First, increasing the cost of carbon-based fuels will likely motivate companies to switch to clean energy, stimulating innovation. The carbon tax will almost certainly increase the price of gasoline and electricity, with the taxed businesses likely to pass on most or all of the tax in the cost of their product.[300] As a result, it is believed that consumers will then become more energy efficient, further reducing GHG emissions.[301] Moreover, it is suggested that a carbon tax allows industries to find the most cost-effective ways to reduce carbon emissions, which is a better alternative approach for free-market economies than that of government regulation.

According to the most recent information from the World Bank, approximately 40 countries and more than 20 cities, states and provinces already use carbon pricing mechanisms, with more planning to implement them in the future. The carbon pricing schemes now in place are estimated to cover about 13 percent of these entities annual global GHG emissions.[302]

In November 2018, Washington state voters overwhelmingly rejected a proposed carbon fee initiative on the ballot, which would have been the first of its kind in the United States.[303] Carbon tax proposals have been introduced in the United States Congress for several years without success, but the subject continues to be a very active area of debate.

A recent study by MIT and the National Renewable Energy Laboratory, concludes that putting a price on carbon, in the form of a fee or tax on the use of fossil fuels, coupled with returning the generated revenue to the public in one form or another, can be an effective way to curb emissions of GHGs.[304]

On January 19, 2019, the Wall Street Journal published the "Economists' Statement on Carbon Dividends" signed by 3,508 U.S. based economists (including 4 former Federal Reserve chairmen, 27 Nobel Laureate economists and 2 former Secretaries of the U.S. Treasury Dept.).[305] It is being billed as the largest public statement of economists in history.[306] The Statement, which begins by acknowledging that global climate change is a serious problem requiring immediate national action, concludes that a yearly increasing carbon tax, with the revenues returned to U.S. citizens, offers the most cost-effective lever to reduce carbon emissions at the scale and speed that is necessary:[307]

Global climate change is a serious problem calling for immediate national action. Guided by sound economic principles, we are united in the following policy recommendations.

I. A carbon tax offers the most cost-effective lever to reduce carbon emissions at the scale and speed that is necessary. By correcting a well-known market failure, a carbon tax will send a powerful price signal that harnesses the invisible hand of the marketplace to steer economic actors towards a low-carbon future.

II. A carbon tax should increase every year until emissions reductions goals are met and be revenue neutral to avoid debates over the size of government. A consistently rising carbon price will encourage technological innovation and large-scale infrastructure development. It will also accelerate the diffusion of carbon-efficient goods and services.

III. A sufficiently robust and gradually rising carbon tax will replace the need for various carbon regulations that are less efficient. Substituting a price signal for cumbersome regulations will promote economic growth and provide the regulatory certainty companies need for long- term investment in clean-energy alternatives.

IV. To prevent carbon leakage and to protect U.S. competitiveness, a border carbon adjustment system should be established. This system would enhance the competitiveness of American firms that are more energy-efficient than their global competitors. It would also create an incentive for other nations to adopt similar carbon pricing.

V. To maximize the fairness and political viability of a rising carbon tax, all the revenue should be returned directly to U.S. citizens through equal lump-sum rebates. The majority of American families, including the most vulnerable, will benefit financially by receiving more in "carbon dividends" than they pay in increased energy prices.

The Center on Global Energy Policy ("CGEP") at Columbia University published a July 2018 research paper addressing carbon taxation.[308] The study modeled three different carbon taxes: $14 per ton (rising 3 percent a year), $50 per ton (rising 2 percent a year), and $73 per ton (rising 1.5 percent a year). In all scenarios modeled, the tax would be charged "upstream," where carbon enters the economy (e.g. at the wellhead, mine shaft, or import terminal). It was estimated that the tax would ultimately cover more than 80 percent of the economy's total GHG emissions.[309] Under the $50/ton scenario, GHG emissions were found to have fallen 39 to 46 percent below 2005 levels by 2025, putting the U.S. well ahead of its pledged Paris goal of 26 to 28 percent by 2025.[310] However, researchers concluded that none of the taxes considered are likely to achieve the long-term U.S. emission goal of 80 percent below 2005 levels by 2050 "absent complementary GHG policies, significant improvements in technologies that can act as direct substitutes for fossil fuels, and/or significantly faster electrification of the transportation, buildings, and industrial sectors than... considered in this analysis."[311] To get to 80 percent reductions, the CGEP research concludes that carbon prices would likely need to exceed $100/ton by mid-century.[312]

The CGEP research also found that more than 80 percent of the emission reductions achieved by a carbon tax through 2030 would come from the electricity sector – specifically the accelerated decline of coal. In contrast, the research concluded that through 2030, a $50 carbon tax would reduce GHG emissions from the transportation sector by only 2 percent.[313]

In a "companion" paper, CGEP suggests that depending on how the revenue is used, a carbon tax policy can have dramatically different effects on the distribution of tax burdens, including as between low, middle and high-income taxpayers.[314]

Critics of a carbon tax point to, among other things, Australia's failed attempt, where introduction of a national carbon tax in 2012 (repealed in 2014), was found to have resulted in the cost of electricity rising by 15% in the first year and unemployment increasing by more than 10%.[315]

A 2018 white paper jointly prepared by researchers from Yale, Grantham Research Institute and CCCEP, London School of Economics identify the following five general reasons for public resistance to carbon taxes: (1) The personal costs are perceived to be too high; (2) Carbon taxes can be regressive; (3) Carbon taxes could damage the wider economy; (4) Carbon taxes are believed not to discourage high-carbon behavior; and (5) Governments may want to tax carbon to increase their revenues.[316]

There are several carbon tax proposals presently winding their way through Congress. Even ExxonMobil is lobbying for a carbon tax. Under the proposal endorsed by Exxon, the carbon tax would start at $40 per ton of CO2 emissions and then rise. The money would then be sent back to citizens in the form of rebates, starting at $2,000 per year for a family of four.[317] However, the Exxon tax proposal also includes a significant provision that would provide it immunity from future climate change lawsuits.[318]

De-Carbonization Techniques

Many in the scientific community believe that in order to keep global warming within the 1.5-2.0°C thresholds discussed above, some type of carbon-capture technology will be needed. Globally, we currently emit nearly 40 billion metric tons of carbon dioxide annually.[319] Even if we zeroed out all our emissions today, it's estimated that we still have a legacy of two trillion tons of CO2 in the air that will continue to impact the climate for decades, if not centuries to come.[320]

Reforestation and new agricultural practices can trap carbon and help slow warming. A single tree can store an average of about 48 pounds of carbon dioxide in one year.[321] A recent study published in the National Academy of Sciences concludes that "natural climate solutions" can provide thirty-seven percent of cost-effective CO2 mitigation needed through 2030 for a greater than sixty-six percent chance of holding warming to below 2°C.[322] However, direct carbon removal will likely still be necessary, possibly in conjunction with additional mitigative technologies being considered.[323]

There are a few general categories of technology being considered to combat global warming, including[324]:

- "Point Source" Carbon Capture & Sequestration
- Atmospheric or "Direct-Air" Carbon Capture
- Solar Radiation Management (incl. Cloud Seeding, Stratospheric Aerosols, Albedo Enhancement & Space Reflectors).

However, all of these technologies remain unproven on the large scale required to address global warming.[325] Nonetheless, there is a lot of activity in this area and even a consortium of "big oil" companies agreed in late-2016 to invest $1 billion in carbon capture technology.[326] Moreover, various tax credits are providing additional financial incentives to invest in the technology.[327]

"Carbon capture" typically refers to containing the carbon as it is being emitted from a point source, whereas "carbon removal" usually means retrieving carbon dioxide after it has already reached the atmosphere. Once the carbon dioxide is "captured" or "removed," it then has to be put towards a new use or get stored away indefinitely.

"Point Source" Carbon Capture & Sequestration involves capturing and separating the carbon dioxide at the emission source before it enters the atmosphere and transporting it to a storage location (usually deep underground).[328] The oil and gas industries have used carbon capture for decades as a way to enhance oil and gas recovery.[329] Carbon is taken from a power plant source in three basic ways – post-combustion, pre-combustion and oxy-fuel combustion.[330]

With post-combustion carbon capture, the CO2 is grabbed by a "filter" after the fossil fuel is burned. The burning of fossil fuels produces flue gases, which include CO2, water vapor, sulfur dioxides and nitrogen oxides.[331] Post-combustion capture can be used to retrofit existing plants and can prevent 80-90 percent of a power plant's carbon emissions from entering the atmosphere.[332] However, the post-combustion process requires a lot of energy to compress the gas enough for transport.

With pre-combustion carbon capture, CO2 is trapped through a fairly complex process before the fossil fuel is burned and prior to being diluted by other flue gases.[333] Pre-combustion capture is already in use for natural gas, and provides a much higher concentration of CO2 than post-combustion. Although it is lower in cost than post-combustion, it's not a retrofit for older power plant generators. As with post-combustion, pre-combustion capture can prevent 80 to 90 percent of a power plant's emissions from entering the atmosphere.[334]

After CO2 is captured, it is typically transported in a gaseous state to a storage site through a pipeline.[335] There are more than 1,500 miles (2,414 km) of CO2 pipelines in the U.S. today, mostly for enhancing oil production.[336] CO2 is odorless and colorless, so adding an odor to the gas could help to detect leaks.[337]

The two primary places for storing CO2 are: (1) underground (including depleted oil or gas fields); and (2) in the ocean. A 2007 Study estimated that the planet could store up to 10 trillion tons of carbon dioxide – enough for 100 years of storage of all human-created emissions.[338]

However, according to the International Energy Agency's Greenhouse Gas R&D Programme, the world's hydrocarbon reservoirs have a combined storage capacity of roughly 800 gigatonnes of CO2 (GtCO2), while the world's annual CO2 emissions are currently around 36 GtCO2.[339] Accordingly, based on those figures, terrestrial storage could only accommodate about twenty-two years of emissions at current levels. As such, ocean storage is also being considered.

The method in which CO2 is stored in the ocean depends on its phase state and the depth at which it is injected, since pressure increases with depth. Depending on pressure and temperature, carbon dioxide can exist as a gas, liquid, or solid. For example, at depths deeper than 3,000 meters, the weight of the water column compresses the liquid CO2 and it becomes denser than seawater and sinks slowly to the seafloor. Once the carbon dioxide sinks to the seafloor it forms an underwater pool at the bottom of the ocean, trapped in place by its own density.[340] The effectiveness of ocean storage of CO2 depends on how long the stored CO2 remains isolated from the atmosphere. Ocean currents carry surface waters to the deep and vice versa. This mixing effect is more pronounced near the surface and generally decreases with depth. It is estimated that seawater in the deep reaches can take between 300 to 1000 years to go through a complete turnover cycle.[341] If the storage site is below 3,000 meters, the fraction of CO2 that might reach the atmosphere was estimated to be 20 percent over 200 years.[342]

A 2018 Study suggests that large amounts of "properly managed" CO2 could be stored under the ground or sea with only a small risk of surface leakage in the following 10,000 years, with "leakage rates" running from a low of 6% to a high of 33%.[343]

Atmospheric or "Direct-Air" Carbon Capture involves a machine to scrub carbon dioxide straight from the atmosphere and requires moving a huge volume of air through a scrubber, which in turn requires a lot of energy.[344] However, there are companies that have already shown the technology can work, albeit on a much smaller scale.

Carbon Engineering in Canada has built a plant that captures about 1 ton of carbon dioxide per day and Climeworks is running three direct air capture plants – in Iceland, Switzerland, and Italy – together capturing 1,100 tons of carbon dioxide per year.[345]

In Climeworks Switzerland plant, carbon dioxide is captured and fed to a greenhouse, which boosted the growth of the plants inside it. Its Iceland capture plant is being operated near a geothermal power plant, where the captured gas is injected underground along with water, where it reacts with basalt rocks and turns into rock in less than two years.[346]

Although a lot of the "math" is subject to debate, the cost per ton of carbon capture is dropping, as new technology emerges. A recent study by Harvard professor David Keith, investigating a new carbon capture process to make fuel at an industrial plant, is estimated to bring the cost down to between $94 and $232 per ton compared to previous estimates of $600 per ton.[347] According to a 2015 report from the Office of Fossil Energy, the estimated cost of carbon capture was about $60 per metric ton for coal-fired plants and around $70 for natural-gas plants, plus another $11 for transporting and storing the carbon dioxide.[348]

However, others feel that as a source of low-carbon power, carbon capture and sequestration cannot compete economically with wind and solar.[349] Although it is a constantly changing variable, coal plants equipped with carbon capture are estimated to be about three times more expensive than onshore wind power and more than twice as expensive as solar, and the laws of physics supposedly limit its cost-competitiveness, due to the extra energy required to extract, compress, and pump the CO2.[350] But, as discussed above, recent tax incentives may serve to bridge this purported gap. For example, the U.S. federal measure currently in place provides a tax credit of $50 for every metric ton of carbon dioxide buried underground and $35 for every ton put to work in other ways. Companies will have six years to begin qualifying projects, and a dozen from the time they begin operations to claim the credits.[351]

Solar Radiation Management ("SRM") involves a number of highly controversial techniques which seek to bring down temperatures by reflecting a small amount of sunlight back into space, to limit the amount that reaches the Earth's surface. One proposed technique termed "global dimming," is intended to mimic the natural cooling effect caused by major volcanic eruptions by injecting minute particles of sulphur dioxide into the stratosphere.[352]

Another SRM proposal is "marine cloud brightening," where the clouds that cover oceans could be made lighter in color and more reflective (for enhanced albedo effect), by spraying them with droplets of seawater.[353]

The possible unintended consequences of stratospheric engineering include changes to precipitation patterns and damage to the ozone layer, as well as rapid warming of the atmosphere, should any of these methods be abruptly stopped.[354] Moreover, the IPCC has stated that SRM methods are unable to address the harmful effects of increased CO2 levels unrelated to temperature, such as ocean acidification.[355]

A further SRM method is to enhance albedo by increasing the reflectiveness of land surfaces – for example, by increasing the amount of white rooftops and light-colored pavements in urban areas, covering large areas of desert in reflective sheets, or planting crops, shrubs and grasses that are light in color. However, these larger-scale interventions could cause extreme regional cooling and interfere with local weather.[356]

Since 2009, New York City has painted more than 9.2 million square feet of rooftop white to increase reflectivity, as part of a "CoolRoofs" program, with over 1.5 million square feet painted in 2018.[357]

CLOSING THOUGHTS

It is beyond reproach that the Earth's climate is changing in ways that will undoubtedly present negative impacts that will be bourne on some level by every person and business. Many of the scientific models present catastrophic damage scenarios occurring relatively soon – within the lifespan of our children.

The monetary cost of climate change – be it for adaptive actions or failure to adapt, will be enormous, eclipsing the GDP of many developed countries for decades to come. Injury and damage to persons, property, businesses, governments, ecosystems and natural resources, to name but a few, are unfortunately unavoidable at some level.

Given the foregoing, lawsuits against fossil fuel companies and other carbon producers seeking to hold them responsible for the effects of climate change, will continue to grow. Similarly, suits by stakeholders against public companies and their directors & officers will likely proliferate. These suits could involve damages relating to a company's failure to properly disclose the material impact of climate-related risks or an effort to compel the company to properly "align its business model with a low-carbon future."

Coverage actions and decisional law relating to insurance for climate change liability are virtually non-existent, but that will likely change soon, given the rising prominence of the issue, the staggering cost involved and the increased litigation activity by municipalities and private parties against fossil fuel companies and other target defendants.

To date, the underlying plaintiffs have been unsuccessful in seeking to hold the fossil fuel companies liable for climate change – whether it be for monetary damages or orders to compel the company to modify its behavior in some respect. The federal courts have dismissed these cases on justiciability, displacement, preemption and/or standing grounds – holding that the Clean Air Act supplants any private cause of action for common law nuisance and it is for the USEPA to regulate GHG's, not the courts.

However, in the last two years, there have been a proliferation of new climate change suits by municipalities across the U.S., seeking to hold the fossil fuel companies accountable for the past and future costs arising from climate change. There have been no substantive rulings in any of these cases on the merits raised by the plaintiffs. *The New York City* and *San Francisco/Oakland* cases were dismissed on the pleadings and appeals are pending. All of the remaining "big ten" cases are in various stages of motions to dismiss or other "procedural" battles and related appeals, which could be drawn out over several years, especially until the appellate process runs its course. Importantly, the pending big ten suits have been filed in several states (California, Colorado, New York, Maryland and Rhode Island) and therefore, will be addressed by different presiding judges, who may not issue consistent rulings – creating further uncertainty to litigants and insurers.

Even if these climate change suits continue to be dismissed, the defense costs alone to certain insurers could be staggering. Should any of these suits survive motions to dismiss and result in successful judgments, the damages are virtually limitless.

We expect to see financial institutions continuing to divest from fossil fuel related investments, with insurers occupying a big part of that role.

Insurance linked securities, including Cat bond issuance, will almost certainly continue to grow as a vehicle to hedge against uncertain climate-related liability.

Since GHG emissions do not obey political boundaries, climate change will firmly remain an issue to be grappled with on local, state, national and international levels – and an issue that we believe will remain at the forefront for many years to come.

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[1] https://thebestschools.org/features/top-climate-change-scientists/;

https://youtu.be/9XIpTqbLR5Y; https://www.youtube.com/watch?v=FBF6F4Bi6Sg;

https://www.bbc.com/news/world-us-canada-46351940; https://www.psychologytoday.com/us/blog/denying-the-grave/201901/climate-change-denial; https://www.bloomberg.com/graphics/2015-whats-warming-the-world/

[2] https://www.nytimes.com/2018/12/30/opinion/climate-change-weather-2018.html?rref=collection%2Ftimestopic%2FWildfires&action=click&contentCollection=science&region=stream&module=stream_unit&version=latest&contentPlacement=5&pgtype=collection

[3] https://www.nobelprize.org/prizes/economic-sciences/2018/summary/

[4] https://www.youtube.com/watch?v=82iM4cwG7co

[5] Id.

[6] http://www.cirmagazine.com/cir/Businesses-urged-to-consider-climate-change--related-risks.php

[7] https://www.reinsurancene.ws/lloyds-inga-beale-warns-climate-change-impact-re-insurers/

[8] See, ExxonMobil Corporation's April 4, 2018 Response to March 21, 2018 Notice to Defendants Re Tutorial, The People of the State of Calif. v. BP P.L.C., et al., Case 3:17-cv-06012, N.D. Cal.

[9] https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf;

https://www.ipcc.ch/sr15/

[10] https://www.unenvironment.org/resources/emissions-gap-report-2018;

https://www.thelancet.com/climate-and-health

[11] https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

[12] http://columbiaclimatelaw.com/files/2017/05/Burger-Gundlach-2017-05-UN-Envt-CC-Litigation.pdf

See also: http://climatecasechart.com/

[13] https://oceanservice.noaa.gov/facts/weather_climate.html

[14] https://unfccc.int/files/press/backgrounders/application/pdf/press_factsh_science.pdf

[15] http://css.umich.edu/factsheets/climate-change-science-and-impacts-factsheet

[16] https://ozcoasts.org.au/indicators/coastal-issues/greenhouse_effect/

[17] https://climate.nasa.gov/causes/

[18] https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[19] Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle. https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[20] https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[21] Id.

[22] Id.

[23] https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

[24] https://www.c2es.org/content/international-emissions/

[25] 1850 or 1880 is the year typically used as a benchmark for tracking various climate change data, because earlier available data does not cover enough of the earth. https://qz.com/1055629/why-does-all-our-climate-data-start-in-1880/ It also coincides with the start of the "industrial revolution." For temperature since about 1850, scientists can refer to the instrumental record. This is a world-wide record based on standardized thermometer readings from thousands of meteorological stations around the world. While the record of land-surface temperature predates 1880, the level of uncertainty before that year goes up considerably. However, there's believed to be an enormous amount of data that has never been put into digital archives. Millions of weather records, for example, are sitting in old weather offices and in ships' logs around the world and researchers are continuously seeking to uncover and digitize historic weather data. https://www.theatlantic.com/technology/archive/2014/08/the-quest-to-scan-millions-of-weather-records/378962/

The British East India Company, which traveled extensively between 1789 and 1834, collected an enormous amount of weather data and climate scientists are working to collate hundreds of thousands of those records and digitize them to be added to the pre-1880 global climate record. https://www.clim-past.net/8/1551/2012/cp-8-1551-2012.html

[26] https://climate.nasa.gov/vital-signs/global-temperature/

[27] According to NOAA, 2017 finished as the third-warmest year globally since records began (NASA ranked it second-warmest). However, 2017 is the warmest year on record without an El Niño in the Pacific Ocean, as neutral conditions existed in the Pacific until La Niña developed in the fall. See, http://www.climatecentral.org/gallery/graphics/the-10-hottest-global-years-on-record

[28] This U.S. based indicator defines a heat wave as a period of two or more consecutive days where the daily minimum apparent temperature (actual temperature adjusted for humidity) in a particular city exceeds the 85th percentile of historical July and August temperatures (1981–2010) for that city. https://www.globalchange.gov/browse/indicators/us-heat-waves

[29] USGCRP is a Federal program mandated by Congress to coordinate Federal research and investments in understanding the forces shaping the global environment, both human and natural, and their impacts on society. https://www.globalchange.gov/browse/indicators/us-heat-waves

[30] https://public.wmo.int/en/media/press-release/wmo-climate-statement-past-4-years-warmest-record

[31] At present, Antarctica is estimated to be losing six times more ice mass annually than 40 years ago. See, https://www.pnas.org/content/pnas/116/4/1095.full.pdf

[32] https://climate.nasa.gov/evidence/

[33] https://www.esrl.noaa.gov/gmd/ccgg/trends/monthly.html

[34] See, https://climate.nasa.gov/evidence/

[35] "Absolute sea level change" refers to the height of the ocean surface, regardless of whether nearby land is rising or falling. In contrast, "relative sea level change" takes into account whether the nearby landmass has subsided or risen.

[36] https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level

[37] https://downloads.globalchange.gov/sap/sap4-1/sap4-1-final-report-all.pdf

[38] Id.

[39] See, CSIRO (Commonwealth Scientific and Industrial Research Organisation) 2015 update to data originally published in: Church, J.A., and N.J. White. 2011. Sea-level rise from the late 19th to the early 21st century. Surv. Geophys. 32:585–602. www.cmar.csiro.au/sealevel/sl_data_cmar.html;

NOAA (National Oceanic and Atmospheric Administration). 2016. Laboratory for Satellite Altimetry: Sea level rise. Accessed June 2016. www.star.nesdis.noaa.gov/sod/lsa/SeaLevelRise/LSA_SLR_timeseries_global.php

[40] See, https://www.ipcc.ch/about/

[41] See, https://www.ipcc.ch/reports/

[42] https://en.wikipedia.org/wiki/Representative_Concentration_Pathway

[43] https://en.wikipedia.org/wiki/Representative_Concentration_Pathway

[44] https://curryja.files.wordpress.com/2018/11/special-report-sea-level-rise3.pdf

[45] The 2018 Special Report was prepared by approximately ninety-one authors and review editors from 40 countries, cites more than 6,000 scientific references and spans over 1,000 pages.

[46] https://www.ipcc.ch/sr15/

[47] https://www.theguardian.com/environment/climate-consensus-97-per-cent/2016/feb/24/earth-is-warming-is-50x-faster-than-when-it-comes-out-of-an-ice-age

[48] Id.

[49] https://www.ipcc.ch/site/assets/uploads/sites/2/2018/10/SPM1_figure-final-e1541758557589.png

[50] https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/

[51] https://www.vox.com/2018/10/8/17948832/climate-change-global-warming-un-ipcc-report

[52] Even under a 1.5 degree C increase, the IPCC is still reporting an almost total loss of coral reefs.

[53] https://nca2018.globalchange.gov/

[54] More than 300 federal and non-federal experts—including individuals from federal, state, and local governments, tribes and Indigenous communities, national laboratories, universities, and the private sector assisted to produce the assessment.

[55] https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf

[56] https://climatenexus.org/climate-issues/science/4th-u-s-national-climate-assessment-notable-findings-v2/

[57] https://nca2018.globalchange.gov/

[58] https://unfccc.int/resource/annualreport/

[59] https://www.unenvironment.org/resources/emissions-gap-report-2018

[60] https://unfccc.int/resource/annualreport/

[61] Those nations are: Brazil, China, India, Japan, Russia and Turkey.

[62] https://www.thelancet.com/climate-and-health

[63] https://link.springer.com/article/10.1007/s10584-013-0986-y

[64] https://link.springer.com/content/pdf/10.1007/s10584-017-1978-0.pdf

[65] https://link.springer.com/content/pdf/10.1007/s10584-017-1978-0.pdf

[66] https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en

[67] When a country becomes a signatory to a treaty, it declares its intention to make the terms of the treaty legally binding on itself, but that action itself does not create a binding document. It is a country's ratification of a treaty that makes the terms of the treaty legally binding, once the treaty's requirements for entry into force are met. See, http://ask.un.org/faq/14594

[68] https://news.un.org/en/story/2017/08/562872-un-officially-notified-us-intention-withdraw-paris-climate-pact

[69] https://www.whitehouse.gov/briefings-statements/statement-president-trump-paris-climate-accord/

[70] Id.

[71] Id.

[72] Id.

[73] https://medium.com/@ClimateMayors/climate-mayors-commit-to-adopt-honor-and-uphold-paris-climate-agreement-goals-ba566

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[74] https://www.cnn.com/2018/12/15/health/cop24-climate-change-talks-agreement/index.html

[75] http://www.un.org/en/climatechange/

[76] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/04/Global-trends-in-climate-change-legislation-and-litigation-2018-snapshot-3.pdf

[77] http://www.climateaction.org/news/eu-to-be-carbon-neutral-by-2050?utm_source=ActiveCampaign&utm_medium=email&utm_content=EU+to+be+carbon-neutral+by+2050+-+Climate+Action+News&utm_campaign=CA+Newsletter+30th+November+2018

[78] See, for example, California's Fourth Climate Assessment: http://www.climateassessment.ca.gov/state/docs/20180827-StatewideSummary.pdf; the Rand Report for Miami-Dade County: https://www.rand.org/pubs/research_reports/RR1932.html ; the Hawaii Sea Level Rise Vulnerability and Adaption Report: https://climateadaptation.hawaii.gov/wp-content/uploads/2017/12/SLR-Report_Dec2017.pdf; the Boulder, Colorado Climate Change Impact Report: https://assets.bouldercounty.org/wp-content/uploads/2018/04/resilient-analytics-report-impacts-of-climate-change-boulder-county-colorado.pdf; and the NYC Plan to Align with the Paris Agreement: https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/1point5-AligningNYCwithParisAgrmtFORWEB.pdf

NOAA National Centers for Environmental Information has also prepared State Climate Summaries: https://statesummaries.ncics.org/

[79] https://legistar.council.nyc.gov/View.ashx?M=F&ID=6796408&GUID=5C920759-C060-478D-B1D4-37EDA731195A

[80] https://www.huffingtonpost.com/entry/nyc-climate-bill_us_5c070847e4b0680a7ec9eea7

[81] https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal); https://www.wri.org/blog/2015/06/infographic-what-do-your-countrys-emissions-look; https://www.wri.org/blog/2017/04/interactive-chart-explains-worlds-top-10-emitters-and-how-theyve-changed

[82] https://www.bloomberg.com/opinion/articles/2018-10-14/china-is-the-climate-change-battleground

[83] Id.

[84] https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

[85] http://blogs.discovermagazine.com/d-brief/2019/01/02/climate-change-is-ramping-up-chinas-electricity-consumption/#.XGOJ2vIKjIU

[86] https://www.cbc.ca/news/world/china-complicated-role-fight-climate-change-1.4945974

[87] http://blogs.discovermagazine.com/d-brief/2019/01/02/climate-change-is-ramping-up-chinas-electricity-consumption/#.XGSIO1VKhph

[88] https://climateactiontracker.org/countries/china/

[89] Id.

[90] Id.

[91] Id.

[92] https://www.cbc.ca/news/world/china-complicated-role-fight-climate-change-1.4945974

[93] https://www.greenclimate.fund/who-we-are/about-the-fund

[94] https://www.thegwpf.org/content/uploads/2018/12/China-U-Turn.pdf

[95] https://www.greenclimate.fund/home

[96] https://endcoal.org/wp-content/uploads/2018/09/TsunamiWarningEnglish.pdf

[97] Id.

[98] Id.

[99] Id.

[100] https://www.theguardian.com/science/2018/dec/13/china-demands-developed-countries-pay-their-debts-on-climate-change; https://www.ft.com/content/7c1f16f8-e7ec-11e8-8a85-04b8afea6ea3

[101] http://blogs.edf.org/edfish/2019/01/10/china-confronts-the-effects-of-climate-change-on-fisheries/

[102] http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports

[103] Miami, New York and New Orleans ranked 2-4, respectively.

http://www.worldbank.org/en/news/feature/2013/08/19/coastal-cities-at-highest-risk-floods

[104] Id.

[105] https://www.sustainablefinance.hsbc.com/-/media/gbm/reports/sustainable-financing/climate-costs-for-asia-pacific-ports.pdf

[106] Id.

[107] Id.

[108] Id.

[109] Id.

[110] https://en.wikipedia.org/wiki/Representative_Concentration_Pathway

[111] Id.

[112] https://www.nytimes.com/interactive/2017/04/07/world/asia/climate-change-china.html

[113] Id.

[114] https://www.nature.com/articles/s41893-019-0220-7.epdf?referrer_access_

[115] Id.

[116] Id. The "greening" observed in China and India is not enough to offset the loss of the world's tropical rainforests. See, https://www.carbonbrief.org/one-third-worlds-new-vegetation-in-china-and-india-satellite-data-shows

[117] https://www.research.hsbc.com/R/10/NWFgvbMVDKaV

[118] Id.

[119] Id.

[120] Id.

[121] https://www.germanwatch.org/sites/germanwatch.org/files/Global%20Climate%20Risk%20Index%202019_2.pdf

[122] Id.

[123] https://www.rand.org/blog/2018/10/mitigating-indias-climate-change-misery.html

[124] Id.

[125] Id.

[126] https://www.vikramsolar.com/blog-climate-change-how-it-is-affecting-india/

[127] Id.

[128] https://weather.com/en-IN/india/news/news/2018-11-30-climate-change-will-widen-inequality-gap-in-india

[129] https://phys.org/news/2018-08-india-devastating-climate.html

[130] Id.

[131] https://climateactiontracker.org/media/documents/2018/4/CAT_2017-11-07_CountryAssessment_India.pdf

[132] Id.

[133] https://www.nature.com/articles/s41893-019-0220-7.epdf?referrer_access_

[134] https://www.thethirdpole.net/en/2018/10/29/india-seeking-ways-to-limit-climate-change-after-ipcc-report/

[135] https://climateactiontracker.org/media/documents/2018/4/CAT_2017-11-07_CountryAssessment_India.pdf

[136] Id.

[137] Id.

[138] https://www.bbc.com/news/world-asia-india-45949323

[139] http://www.globalcement.com/news/itemlist/tag/Roadmap

[140] Id.

[141] https://economictimes.indiatimes.com/news/international/world-news/next-decade-to-be-critical-for-climate-change-what-the-world-expects-from-india/articleshow/67107335.cms

[142] https://science.house.gov/legislation/hearings/state-climate-science-and-why-it-matters

[143] Id.

[144] Id.

[145] Id.

[146] Id.

[147] http://thoughtleadership.aonbenfield.com/Documents/20180124-ab-if-annual-report-weather-climate-2017.pdf

[148] https://www.munichre.com/en/media-relations/publications/press-releases/2018/2018-01-04-press-release/index.html

[149] https://www.munichre.com/en/media-relations/publications/press-releases/2019/2019-01-08-press-release/index.html

[150] The United States made up an approximately 50 percent share of global insured losses last year, compared with just over 30 percent on average. See, https://www.nytimes.com/2018/01/04/climate/losses-natural-disasters-insurance.html

[151] https://www.ncdc.noaa.gov/billions

[152] https://nca2018.globalchange.gov/

[153] The total area of each circle represents projected damages under RCP8.5, whereas the lighter shaded area represents estimated damages under RCP4.5.

[154] https://www.ipcc.ch/sr15/

[155] A 2018 Stanford University Report concluded that by the end of this century, there is a more than 75% chance that limiting warming to 1.5 °C would reduce economic damages relative to 2 °C, and a more than 60% chance that the accumulated global benefits will exceed US$20 trillion under a 3% discount rate (2010 US dollars). These gains would come primarily from avoiding rising health care costs, productivity losses, and declining agricultural output, according to the authors. The analysis does not even factor in costs resulting from major environmental disruptions such as sea level rise, extreme storms, and more. See, https://www.nature.com/articles/s41586-018-0071-9.epdf?referrer_access_token=9Ki6x-9jH_16L9MwdW3aFtRgN0jAjWel9jnR3ZoTv0OskypFEzLGji1pAcPpJpRUDDQraVc1GUbSttWiyoT8Bi1pPPUBvzQkXsSwsop6pwTTmrTF3TJVtOUocs8BSFPYGT2mVdykqHOro6Vfedhn1Ddd5OhF-lWG9-FR5Py6z1ce0iTSeKlf3pUfNVseH8WJvcaJMET8CuoFVtq629sCOYDbXerqaSH1cn-cNOMZBKmjxMu5pkN5de1f0wBSl5_XZ52Xh5z2rMsriiKfyf3pPO2LctAjHABMfjrNJaCa1BE%3D&tracking_referrer=www.technologyreview.com

[156] https://www.cnbc.com/2017/11/14/richest-1-percent-now-own-half-the-worlds-wealth.html https://www.marketwatch.com/story/this-is-how-much-money-exists-in-the-entire-world-in-one-chart-2015-12-18 As of 2017, the global real estate market was valued at roughly $280 trillion. See, https://www.savills.com/impacts/economic-trends/8-things-you-need-to-know-about-the-value-of-global-real-estate.html

[157] https://nca2018.globalchange.gov/

[158] Id.

[159] https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf

[160] https://www.ucsusa.org/sites/default/files/attach/2018/06/underwater-analysis-full-report.pdf

[161] https://www.zillow.com/research/ocean-at-the-door-21931/

[162] https://tidesandcurrents.noaa.gov/publications/techrpt86_PaP_of_HTFlooding.pdf

[163] https://www.nbcdfw.com/news/local/Galveston-Rethinks-Drainage-Master-Plan-After-Heavy-Rainfall-505559971.html

[164] Id.

[165] Id.

[166] http://news.mit.edu/2017/texas-odds-harvey-scale-rainfall-increase-end-century-1113

[167] https://www.miamidade.gov/green/library/vulnerability-septic-systems-sea-level-rise.pdf

[168] Id.

[169] Id.

[170] https://www.weforum.org/agenda/2019/01/the-world-s-coastal-cities-are-going-under-here-is-how-some-are-fighting-back/

[171] https://medium.com/@davidfurphy/what-on-earth-is-an-rcp-bbb206ddee26

[172] https://mediacentre.christianaid.org.uk/download?id=4170&pn=21e38f435ea050ce63ac6b7e52c58d72-pdf

[173] https://www.axios.com/hurricane-florence-epic-flooding-record-rains-carolinas-b140b416-829e-462a-a88c-0845f75899f5.html

[174] As of December 2018, 78 cities across the United States were believed to be on track to have their wettest years on record, with the continental United States as a whole on pace expected to record its fifth wettest year on record. See, https://wtvr.com/2018/12/18/eight-us-states-are-on-track-to-have-their-rainiest-year-on-record/;

[175] https://www.nwfdailynews.com/news/20181230/hurricane-michael-was-one-for-record-books-photos; https://www.cnn.com/2018/10/09/weather/hurricane-michael-stats-superlatives-wxc-trnd/index.html

[176] https://www.bizjournals.com/losangeles/news/2018/11/27/calif-wildfires-property-losses-could-reach-19b.html

[177] https://www.usatoday.com/story/news/2018/12/04/hurricane-maria-economic-impact-puerto-rico/2209231002/; https://www.cnn.com/2018/08/29/us/puerto-rico-growing-death-toll/index.html; https://www.thebalance.com/hurricane-damage-economic-costs-4150369; https://www.vox.com/identities/2018/8/15/17692414/puerto-rico-power-electricity-restored-hurricane-maria

[178] http://thoughtleadership.aonbenfield.com/Documents/20180328-ab-if-hurricane-maria-recap.pdf

[179] Id. Aon also notes that a majority of the insured loss was commercial, as a large number of the residents did not own hazard insurance - and had homes which were built illegally.

[180] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/04/Global-trends-in-climate-change-legislation-and-litigation-2018-snapshot-3.pdf

[181] In April 2018, the Dutch environmental organization Milieudefensie sent Shell a notice of intent to sue, which is a perquisite under Dutch law. https://en.milieudefensie.nl/news/noticeletter-shell.pdf/++pdfpeekimages++1_preview

[182] http://climatecasechart.com/case-category/common-law-claims/

[183] See, Comer v. Murphy Oil USA, 585 F.3d 855 (5th Cir. 2009); Am. Elec. Power, et. al. v. Connecticut, et al, 564 U.S. 410 (2011); Native Village of Kivalina v. ExxonMobil Corp., 696 F.3d 849 (9th Cir. 2012).

[184] http://climatecasechart.com/case-category/common-law-claims/

[185] N.D.Cal., No. 17-cv-04929, as removed.

[186] N.D.Cal., No. 17-cv-04935, as removed.

[187] N.D.Cal., No. 18-cv-00450, as removed.

[188] N.D.Cal., No. 18-cv-00732, as removed.

[189] N.D.Cal., Nos. C 17-06011 and C 17-06012, as removed.

[190] S.D.N.Y, No. 18-cv-00182.

[191] D.Colo., No. 18-cv-1672, as removed.

[192] W.D. Wash., No. 18-cv-00758, as removed.

[193] D.R.I, No. 18-cv-00395, as removed.

[194] N.D.Md., No. 18-cv-02357, as removed.

[195] http://climatecasechart.com/case-category/common-law-claims/

[196] The San Mateo, Marin, Santa Cruz & Richmond suits were remanded back to state court, where appeals by the defendants are pending. http://climatecasechart.com/case-category/common-law-claims/

[197] http://blogs2.law.columbia.edu/climate-change-litigation/wp-content/uploads/sites/16/case-documents/2017/20171220_docket-17CV03242-_complaint.pdf

[198] From Smokes to Smokestacks: Lessons from Tobacco for the Future of Climate Change Liability, The Georgetown Envt'l Law Review (2018), https://gielr.files.wordpress.com/2018/04/zsk00118000001.pdf

[199] http://blogs2.law.columbia.edu/climate-change-litigation/wp-content/uploads/sites/16/case-documents/2018/20180625_docket-317-cv-06011_order-2.pdf

[200] http://www.fljustice.org/fort-lauderdale-considers-suing-big-oil-.html; https://wattsupwiththat.com/2018/11/24/lead-or-sue-pacific-islands-take-twin-tracks-on-climate-change/

[201] http://blogs2.law.columbia.edu/climate-change-litigation/wp-content/uploads/sites/16/case-documents/2018/20181114_docket-CGC-18-571285_complaint.pdf

[202] The Complaint contains five causes of action: nuisance, strict liability for failure to warn, strict liability for design defect, negligence, and negligent failure to warn. The plaintiff seeks compensatory damages, equitable relief including abatement of the nuisance, punitive damages, disgorgement of profits, and attorneys' fees and costs.http://blogs2.law.columbia.edu/climate-change-litigation/wp-content/uploads/sites/16/case-documents/2015/20150910_docket-615-cv-1517_complaint-1.pdf

[203] https://www.supremecourt.gov/orders/courtorders/110218zr2_8ok0.pdf

[204] In Colombia and the Netherlands, citizens won court rulings in 2018 ordering their governments to cut emissions and protect forests. By framing climate change in terms of human rights, these cases are transforming how the courts address the issue. See, https://www.reuters.com/article/us-colombia-deforestation-amazon/colombias-top-court-orders-government-to-protect-amazon-forest-in-landmark-case-idUSKCN1HD21Y; https://www.rechtspraak.nl/Organisatie-en-contact/Organisatie/Gerechtshoven/Gerechtshof-Den-Haag/Nieuws/Paginas/State-must-achieve-higher-reduction-in-greenhouse-gas-emissions-in-short-term.aspx

[205] https://pdf.wildearthguardians.org/support_docs/Opinion_Westwide_3-19-2019.pdf

[206] https://pubs.er.usgs.gov/publication/sir20185131

[207] https://en.milieudefensie.nl/climate-case-shell

[208] https://ag.ny.gov/sites/default/files/summons_and_complaint_0.pdf

[209] https://ag.ny.gov/press-release/ag-underwood-files-lawsuit-against-exxonmobil-defrauding-investors-regarding-financial

[210] https://www.bostonglobe.com/metro/2019/01/07/supreme-court-refuses-block-healey-bid-investigate-exxonmobil/NuOpBuqIej6qzIL6X45BOM/story.html

[211] https://www.courthousenews.com/wp-content/uploads/2018/04/SJC-Exxon-decision.pdf

[212] The underlying suit alleged damages to the residents' native village in Alaska due to rising sea level from global warming/GHGs.

[213] There are some exceptions, where judicially created federal "common law" is applied, such as matters involving "uniquely federal interests" (e.g. interstate controversies). And Federal courts construing a federal statute will apply federal law precedents.

[214] See, Oak Ford Owners Ass'n v. Auto-Owners Ins. Co., 510 F. Supp. 2d 812 (M.D. Fla. 2007) (Court held insured's dredging of a creek to make it deeper and wider without proper permit and damage to wetlands constituted damage to tangible property. Court stated "injury has occurred even though the effects such as flooding and erosion would increase over time).

[215] See, Farm Bureau Mut. Ins. Co. v. Earthsoils, 812 N.W.2d 873 (Minn. Ct. App. 2012) (Farmer had only half the crop yield due to fertilizer with insufficient nitrogen content. Court ruled no coverage because less than anticipated crop yield did not result from physical injury to the crop itself). But see, W. Heritage Ins. Co. v. Green, 54 P.3d 948 (Idaho 2002) (Alleged misapplication of fertilizer caused some of the potato plants to form yellow foliage, poor root systems and misshapen potatoes. Court found physical injury to plants was a covered loss).

[216] 8 A.3d 399 (N.H. 2010)

[217] https://en.wikipedia.org/wiki/Regulation_of_greenhouse_gases_under_the_Clean_Air_Act

[218] See, AES Corp. v. Steadfast Ins. Co., supra (Supreme Court of Virginia found that the underlying allegations asserting that the insured intentionally released tons of carbon dioxide and GHGs into the atmosphere as part of its business operations did not constitute an "occurrence" within the terms of the policies.)

[219] Allocation of damages goes hand-in-hand with trigger and could result in the insured being able to select any triggered policy to pay "all sums" (subject to that selected insurer's contribution rights) or each triggered policy solely obligated to pay a pro-rata share of the damage/injury that took place during its policy period. Climate change-related property damage could implicate many years of coverage or a relative few.

[220] See, e.g., Am. Elec. Power Co. v. Connecticut, 564 U.S. 410 (2011).

[221] See, Donaldson v. Urban Land Interests, Inc., 564 N.W.2d 728 (Wis. 1997) (Court held that exhaled carbon dioxide was not unambiguously a "pollutant" and the "exclusion did not plainly and clearly alert a reasonable insured that coverage was excluded for personal injury claims that had their genesis in activities as fundamental as human respiration.") See also, Motorists Mut. Ins. Co. v. RSJ, Inc., 926 S.W. 2d 679 (Ky. Ct. App. 1996) (finding carbon dioxide leaking from insured's boiler vent stack did not constitute a "pollutant" under the exclusion, and thus suit by neighbor alleging injury was covered). But see, Essex Ins. Co. v. Tri-Town Corp., 863 F. Supp. 38 (D. Mass. 1994) (finding carbon dioxide constitutes "pollutant" under pollution exclusion).

[222] https://insider.zurich.co.uk/app/uploads/2018/05/Zurich-Claims-Quarterly-Journal-Spring-2018.pdf

[223] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/04/Global-trends-in-climate-change-legislation-and-litigation-2018-snapshot-3.pdf

[224] https://www.sec.gov/rules/interp/2010/33-9106.pdf

[225] https://www.ourenergypolicy.org/wp-content/uploads/2014/11/Ceres_SECguidance-append_020414_web.pdf

[226] https://www.dandodiary.com/2014/06/articles/director-and-officer-liability/is-climate-change-a-do-liability-and-insurance-issue/

[227] https://www.nytimes.com/2016/01/24/business/energy-environment/sec-is-criticized-for-lax-enforcement-of-climate-risk-disclosure.html?login=email&auth=login-email

[228] Id.

[229] https://www.gao.gov/assets/700/690197.pdf

[230] https://www.asyousow.org/press-hits/2018/4/11/sec-gives-exxon-a-pass-on-shareholder-climate-proposal-but-not-chevron As discussed, supra, the New York and Massachusetts Attorney General Offices are investigating potential investor "climate fraud" by ExxonMobil, with New York recently bringing suit.

[231] Chevron had unsuccessfully argued to the SEC that the requested disclosure will aid plaintiffs in the pending climate change suits. Id.

[232] https://www.theguardian.com/australia-news/2017/sep/21/commonwealth-bank-shareholders-drop-suit-over-non-disclosure-of-climate-risks

[233] https://www.theguardian.com/australia-news/2017/nov/29/banks-warned-of-regulatory-action-as-climate-change-bites-global-economy

[234] https://www.documents.clientearth.org/download/15460/

[235] https://www.fsb-tcfd.org/about/#

[236] https://www.fsb-tcfd.org/wp-content/uploads/2018/08/FINAL-2018-TCFD-Status-Report-092518.pdf

[237] Id.

[238] Id.

[239] Id.

[240] http://cms.ipressroom.com.s3.amazonaws.com/240/files/20190/Master+the+disaster+-+CFO+natural+disaster+preparedness+in+2019+and+beyond.pdf

[241] Id.

[242] Id.

[243] Id.

[244] http://www.climateaction.org/news/legal-and-general-investment-bosses-warn-about-climate-catastrophe

[245] Id.

[246] Sealed Air Corp. v. Royal Indem. Co., 404 N.J. Super. 363 (NJ Sup. Ct., App. Div. 2008).

[247] Owens Corning v. Nat. Union Fire Ins. Co., 1998 U.S. App. LEXIS 26233 (6th Cir. 1998) (asbestos exclusion).

[248] 271 F. Supp. 2d. 926 (S.D. Texas 2003)

[249] https://www.zurich.com.au/content/dam/au-documents/business-insurance/financial-lines/directors-and-officers/directors-and-officers-liability-policy.pdf

[250] https://www.nature.com/articles/nclimate1979; https://www.wsj.com/graphics/climate-change-forcing-insurance-industry-recalculate/

[251] https://www.zillow.com/research/ocean-at-the-door-21931/

[252] https://www.wsj.com/graphics/climate-change-forcing-insurance-industry-recalculate/

[253] https://link.springer.com/content/pdf/10.1007%2F978-3-319-72026-5.pdf

[254] https://aodproject.net/wp-content/uploads/2018/05/AODP-Got-It-Covered-Insurance-Report-2018.pdf

[255] http://www.floods.org/ace-images/MillerCapstoneMay2018.pdf

[256] Id.

[257] https://www.blackrock.com/us/individual/insights/blackrock-investment-institute/physical-climate-risks

[258] https://www.claimsjournal.com/news/national/2019/04/18/290488.htm

[259] Id.

[260] https://www.insurancejournal.com/news/west/2018/02/07/479845.htm

[261] https://insideclimatenews.org/news/30042018/exxon-california-cities-climate-lawsuit-bond-fraud-allegations-sec-investigation-competitive-enterprise-institute

[262] https://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-reauthorization-guidance

[263] https://www.washingtonpost.com/opinions/flood-insurance-reform-wont-be-pleasant-but-its-necessary/2019/03/30/8f07f198-4a72-11e9-93d0-64dbcf38ba41_story.html?utm_term=.14b0ee6ce838

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