

# **Climate Risk Management: Strategies for Building Resilience to Climate Change in the Private Sector**

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## Abstract

Climate action failure, extreme weather, natural disasters, biodiversity loss and human-made environmental disasters all rank as top 10 business risks in both magnitude of impact and likelihood (WEF, 2020). This reality presents a myriad of challenges and opportunities for the private sector. The insurance sector, in particular, is in a unique stakeholder position to understand, predict, model and react to the emerging and evolving risks that accompany climate change. Insurers play two key roles for the purposes of this discussion, as both risk managers actively protecting global assets, and as long-term investors, funding the future of our economy (Golnaraghi, 2018). These factors make the insurance industry a critical part of the climate change adaptation and resiliency solution landscape.

Zurich Insurance is one insurance company at the epicenter of this issue. Working in collaboration with Zurich Insurance, our team explored corporate climate risk management strategies and the role that insurance companies, as service providers, can play to support these transitions. Special attention was paid to climate risk disclosure processes and physical and transition risks and opportunities. Through secondary research, we analyzed academic literature, sector-specific frameworks, company reports, and countless other sources on climate change risks and management approaches. Additionally, we researched climate adaptation best practices, capability maturity models, insurance sector strategies in advancing climate resilience, and corporate climate risk management. We also consulted with over 20 subject-matter experts at Zurich Insurance and other organizations involved in the climate risk value chain.

To answer this research question, our team developed a climate risk maturity model and leadership model, built from guidelines and best practices, including TCFD resources, that can be used by companies to assess their readiness to identify and address climate risks and opportunities, and to identify gaps in their capability. Building from the climate risk maturity model, our team then identified more than 100 key organizations in the evolving climate risk value chain. A value chain can be defined as a connected series of organizations and areas of expertise involved in the development and delivery of value to end customers (Oxfam, 2012). For this context, the climate risk value chain is composed of data providers, risk insights providers, research and thought leadership organizations, advisory and consulting firms, risk engineering firms, and knowledge hubs. The climate risk value chain enabled our team to analyze the feasibility and benefits of creating an ecosystem of service providers that corporations can collaborate with to fill gaps in their climate risk management approach, as identified through their assessment using the climate risk maturity model. This research fills a critical gap in the literature on climate risk management and climate adaptation aimed at the private sector. Moreover, the perspective of financial-sector stakeholders, like investors and insurance firms, can offer a strategic angle and interest area for companies to act.

## Acknowledgements

We want to thank our project sponsors at Zurich Insurance, particularly Justin D'Atri, Joachim Wiesmann, and Eugenie Molyneux who provided invaluable guidance, insight, and feedback throughout the duration of our project. We appreciate the collaborative and open relationship we formed with the Zurich team. We are especially thankful for the time Justin spent organizing our trip to Zurich Insurance's headquarters and ensuring we got the most out of the trip by meeting with various experts across the firm. Having inside access to how one of the world's largest insurance companies thinks about climate resilience was an eye-opening opportunity for our team and advanced our understanding of how the private sector is engaging with sustainability issues.

A huge thanks is extended to our faculty advisor, Professor Andy Hoffman, who helped center our focus and shape our scope, provided support, and connected us to subject matter experts in this field. We also want to thank Professor Ricky Rood who helped us understand some of the complexities related to climate modeling and the importance of scenario analysis for climate risk management.

We also want to thank the various other interviewees who assisted us with understanding the components of the climate risk value chain as well as the challenges companies face in advancing climate risk management strategies. These folks include Professor Ricky Rood, Professor Patrick Regan, Jenny Dissen, Otis Brown, Dr. Jesse Keenan, Dr. Nardia Haigh, and Dr. Henry Pollack.

# 1. Background

## 1.1. Research Question

As the impacts of climate change become more apparent across the globe, corporations are seeking usable data, insights, and recommendations on how to mitigate risks and take advantage of the opportunities associated with a changing climate. Corporations also face external pressure from investors, policymakers, regulators, and consumers to disclose their climate change risks; a pressure that was formalized through the launch of the Financial Stability Board's Task Force on Climate-Related Financial Disclosures, referred to as the TCFD for the remainder of this report.

Many companies are turning to their insurance companies, as experts of risk analysis and catastrophe modeling, to provide them with a comprehensive analysis of their current and future risk to climate change impacts. Although seemingly well positioned to help with these requests, insurance companies do not necessarily possess the full range of capabilities nor do they offer the full suite of services required to holistically help a corporate client identify, prioritize, assess, manage, and mitigate their climate risks. Additionally, the catastrophe models that insurance companies have relied on are built from databases of historical weather events and only consider physical climate risk. Given the uncertainty around how a warming world is impacting weather and climate, models based on historical data are no longer useful for predicting physical climate risk. Martin Bertogg, head of Catastrophe Perils at Swiss Re has stated, "...insurers should be wary of historical loss records in understanding today's state of the socio-economic environment and climate. Averaging out over a past spanning multiple decades can lead to distorted risk assessment" (Howard, 2020). Companies are also tackling addressing transition risks associated with the transition to a low-carbon economy, which is not an area insurance companies are equipped to provide guidance on.

With this in mind, insurance companies are actively exploring their potential role in helping companies proactively manage climate risks and opportunities and provide guidance for disclosure. Simultaneously, an entire value chain of organizations is emerging to support this need. At a high level, the climate risk value chain is composed of data providers, risk insights providers, research and thought leadership organizations, advisory and consulting firms, risk engineering firms, and knowledge hubs. Some organizations in the climate risk value chain are well-established while others are start-ups. Insurance companies are keeping an eye on this dynamic climate risk value chain and assessing how their products and services fit into this emerging market.

Zurich Insurance is one insurance company at the epicenter of this issue. Working in collaboration with Zurich Insurance, our team explored how companies can develop climate risk management strategies and the role service providers, such as insurance companies, can play to support this goal, specifically around navigating climate risk disclosure processes and physical and transition risks and opportunities.

To support this research question, our team developed a climate risk maturity model built from guidelines and best practices, including TCFD resources, that can be used by companies to assess their readiness to identify and address climate risks and opportunities, and to identify gaps in their capability. Building from the climate risk maturity model, our team then identified key organizations in the climate risk value chain, as referenced above. The climate risk value chain enabled our team to analyze the feasibility and benefits of creating an ecosystem of service providers that corporations can collaborate with to fill gaps in their climate risk management approach, as identified through their assessment using the climate risk maturity model.

## 1.2. Motivation

In 2015, the world came together to adopt the Paris Climate Agreement, resulting in a goal to limit global average temperature rise “well below” 2 degrees Celsius compared to pre-industrial levels, with efforts to further limit the temperature rise to 1.5 degrees Celsius (UNFCCC, 2020). Warming beyond the 1.5 to 2 degrees Celsius target is considered “dangerous” by scientists and could lead to unprecedented and potentially irreversible disruption to the global climate system that has allowed life on Earth to flourish (Hansen, et Al., 2013).

Unfortunately, actions to date have not significantly stemmed global temperature rise. According to the NOAA 2019 Annual Global Climate Report, 2019 was the second warmest year in the 1880-2019 record, the five warmest years in this period have all occurred since 2015, and nine of the 10 warmest years have occurred since 2005 (NOAA, 2020). Additionally, global temperatures in 2019 were between 1.1 to 1.3 degrees Celsius higher than pre-industrial levels, depending on the temperature record chosen, putting the world perilously close to the more ambitious 1.5 degrees Celsius Paris Agreement target (Hausfather, 2020).

In response to the lack of action, and likelihood that the world will fail to meet the targets set forth by the Paris Agreement, Zurich Insurance recommends that businesses “act now to adapt to the risks related to climate change.” Zurich’s CEO for Europe, Middle East & Africa (EMEA) and Bank Distribution, Alison Martin, elaborates:

*“...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. It’s crucial for businesses to develop a climate resilience adaptation strategy and act on it now.” (Zurich, 2018)*

Companies must also prepare for transition and liability risk associated with the “transition” to a low carbon economy. Physical, transition, and liability risks associated with climate change come with human, environmental, and economic costs. Munich Re, a reinsurance company that has been analyzing the impacts of anthropogenic global warming on losses caused by weather-related natural disasters, has found that economic losses caused by natural catastrophes is trending upwards. Between 1980 to 2018, total losses as a result of natural disasters equaled \$5 trillion and more than 70 percent of this total was not insured (Munich Re, 2018).

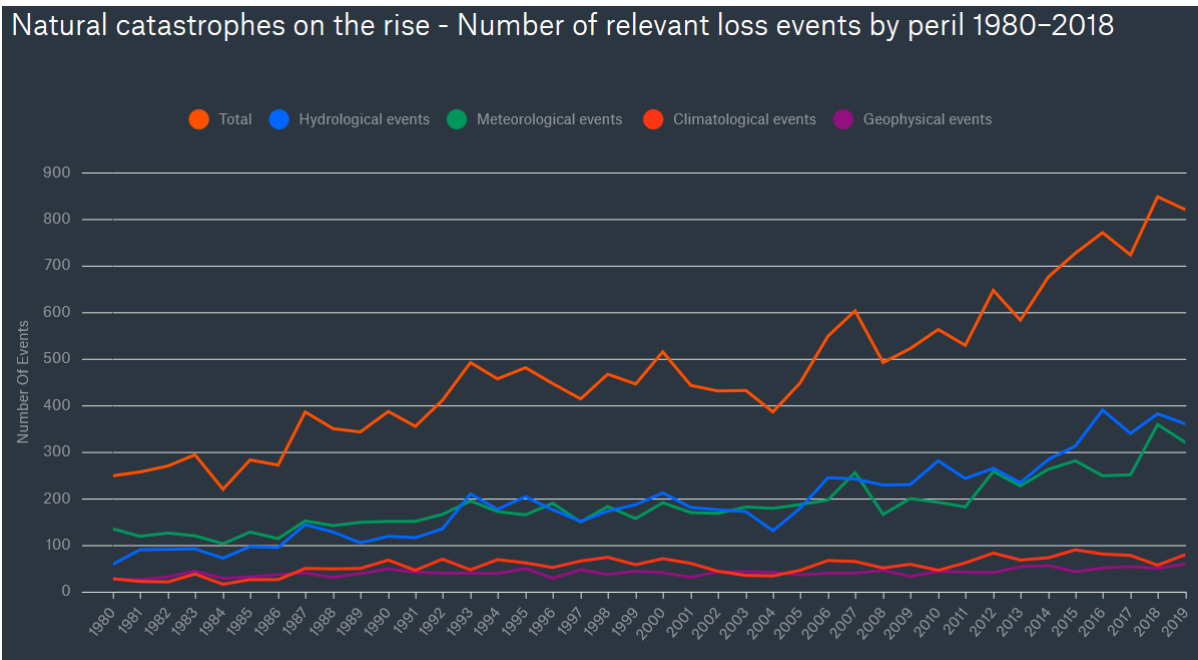


Figure 1: Number of Relevant Loss Events by peril 1980-2018. Source: (Munch Re, 2018)

To decrease the likelihood and extent of insurance payouts, insurance companies have direct motivation to advance climate risk management and proactive resilience measures among their clients, thereby promoting systemic resilience across society. On the other hand, companies must keep in mind the possibility that some risks may become uninsurable and how they will consequently manage these risks. As explained by the CRO Forum, for a risk to be insurable, the insurer must be able to meet the following conditions (CRO, 2019, p. 24):

- Identify and quantify the frequency/severity of potential hazards and the resulting losses.
- Satisfy itself that the risks are unintended (no adverse selection) and unexpected (no moral hazard).
- Demonstrate it can pay potential losses while maintaining its solvency, partly by avoiding major risk accumulations.
- Offer a price that is acceptable to all stakeholders (insurers, reinsurers, policyholders, regulators).

Climate change risks are making it difficult for insurers to meet all of these conditions, since it is difficult to quantify future climate change impacts, particularly at a local level. According to Swiss Re, the failure to take immediate action to mitigate warming temperatures will lead climate systems to reach irreversible tipping points and ultimately jeopardize the insurability of weather risks, particularly in high-exposure accumulation areas (Howard, 2020). This could cause premiums to rise so high that insurance becomes uneconomic or unaffordable for the customer (CRO, 2019, p. 24). CRO elaborates that “where there is an inability to properly model and price the risk, this can also mean that insurers decide to be more cautious, adding a risk margin to the premium or withdrawing capacity. The customer may underestimate the level of risk and consider the price to be excessive, rendering the risk uninsurable” (CRO, 2019, p. 24). Additionally, insurance companies “may decide not to insure a risk that could be insurable, based



on economic, strategic, reputational or ethical considerations” (CRO, 2019, p. 24). In these cases, companies will no longer be able to count on insurance payouts to recover after being affected by certain climate risks.

### 1.3. Approach

To answer our research question, our team conducted primary and secondary research between April 2019 to April 2020. In April 2019, Keely Bosn attended a TCFD conference at Oxford University in the UK to learn about the challenges companies face when it comes to climate risk disclosure.

In August 2019, Keely Bosn, Katherine Cunningham, and Shirui Li traveled to Zurich to interview subject matter experts at Zurich Insurance’s headquarters. Interviews were conducted with 20 people, including a cat modeler, a technical underwriter for Zurich North America, the Risk Manager for Sustainability and Emerging Risk in Group Risk Management, the Head of Sustainability Risk, the Head of Cat Research and Development, the Chief Risk Officer for Commercial Insurance, the Head of Flood Resilience, and the Head of Responsible Investment. Refer to Exhibit 1 in the Appendix for the full list of interviewees. These interviews were instrumental in understanding the landscape of climate risk discussions and potential opportunities from Zurich Insurance’s perspective.

On a weekly or bi-weekly cadence, we spoke with our main point of contact at Zurich Insurance, Justin D’Atri, the Sustainability Change Manager in Group Communications & Public Affairs. Halfway through the project, the Senior Risk Manager for Commercial Insurance, Joachim Wiesmann, joined our regular calls. Our research, particularly the development of the Climate Risk Maturity Model and the climate risk value chain, benefited immensely from iterative collaboration with our Zurich Insurance counterparts.

Our team also interviewed various other subject matter experts in this space, including:

- Professor Ricky Rood, Dow Sustainability Distinguished Faculty Fellow, Climate and Space Sciences and Engineering, University of Michigan
- Professor Patrick Regan, Associate Director, Environmental Change Initiative, University of Notre Dame
- Jenny Dissen, Corporate Relations and Partnerships lead, North Carolina Institute for Climate Studies
- Otis Brown, Founding Director, North Carolina Institute for Climate Studies
- Dr. Jesse Keenan, Graduate School of Design, Harvard University
- Dr. Nardia Haigh, Associate Professor of Management, University of Massachusetts Boston
- Dr. Henry Pollack, Professor Emeritus, Earth and Environmental Sciences, University of Michigan

Through secondary and desktop research, we analyzed academic literature, company reports, TCFD guidance, and countless other sources on climate change risks and management approaches. Additionally, we researched climate adaptation best practices, maturity models, the role of the insurance sector in advancing climate resilience, and how companies are approaching climate risk.

This research fills a critical gap in the literature on climate risk management and climate adaptation aimed at the private sector. Although there has been extensive work done on these topics on the local, state, and federal government levels and in global development agencies, there is very limited publicly available information aimed at how corporations can approach and manage climate risks. Moreover, the perspective of financial-sector stakeholders, like investors and insurance firms, can offer a strategic angle and interest area for companies to act.

On the other hand, this research only represents a starting point in this dynamic field. Within the year (2019-2020) that our team worked on this project, conversations on climate risk management, climate risk disclosure, and climate resilience in the private sector have exploded. This is particularly reflected in the number of providers, both existing and new, that have emerged to offer climate risk management and disclosure services. This has spurred what Dr. Jesse Keenan of Harvard University describes as a “climate intelligence arms race” in which the greater demand for climate change risk data and information in the financial markets is leading to a plethora of new climate service technology (Keenan, 2019).

Additionally, we encountered some limitations while conducting research. To truly understand how companies approach climate risk, it would have been ideal to gain inside access to some companies currently exploring this issue, particularly for the development of the Climate Risk Maturity Model which would have been strengthened by observing behaviors and practices within companies. Organizational behavior and change management insights are inherently linked to the efficacy of this Maturity Model. However, given the scope and timeline of our project this was not possible. Additionally, little information exists publicly that details a company’s climate risk management approach due to the potential liability and reputational risk they face if they publicize specific goals around climate change mitigation and adaptation and do not end up meeting those goals. Therefore, TCFD guidance and other proxy sources were used to piece together the Climate Risk Maturity Model and our other findings. Another limitation we encountered in our research relates to the fact that climate risks vary greatly by industry and thus to truly understand climate risk and effective management, an industry-specific approach is essential. Therefore, we recommend our research serve as an overarching framework for companies to use to understand climate risk, rather than be applied to industry-specific challenges.

## 2. Understanding Climate Change Risks and Opportunities

*“Because each additional degree of warming will be proportionally more destructive, the damage will accelerate and be exponential. To avoid the most severe economic, social and environmental consequences, climate experts warn that the temperature rise must be limited to 1.5°C. This*

*equates to a remaining carbon budget of less than 10 more years of emissions at their current level.” - WEF Global Risks Report 2020 (WEF, 2020)*

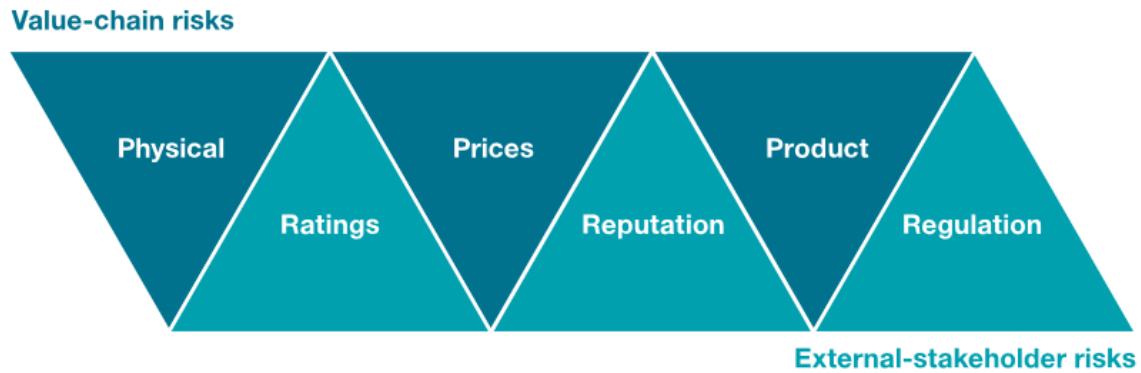
*“With the financial and reputational risks associated with climate change on the rise, companies that fail to account for climate-related risk are not only a threat to the environment, they are also a threat to themselves.” - Alicia Mendonca-Richards, Farrer & Co (Mendonca-Richards, 2019)*

The rapid increase of greenhouse gas emissions in the atmosphere since the Industrial Revolution has led to observed impacts on natural and human systems which will continue into the future, the severity of which will depend on the rate and duration of future warming (IPCC, 2014). Even if the Paris Agreement goals are reached and emissions are drastically reduced today, the emissions released in the past, present, and near-future have already “locked in” some climate change impacts, emphasizing the need for governments and companies to focus on adaptation measures to build resilience to the impacts associated with climate change (University of Exeter, 2017).

These impacts are referred to as climate change risks, or climate risks, for short. This section will outline what the primary categories of climate risk are, provide real-world examples, discuss the economic and financial implications of climate risks, and introduce an argument for why companies should assess, and ultimately manage, climate change risks and opportunities.

Before diving into the specifics of climate risk it is important to understand the general concept of risk. As defined by the group Risky Business, launched by NYC Mayor Michael Bloomberg, former U.S. Secretary of the Treasury Hank Paulson, and business leader and philanthropist Tom Steyer, the risk of a future event is “the probability (or likelihood) of that event combined with the severity of its consequences. The combination of likelihood and severity determines whether a risk is high or low” (Risky Business, n.d.). The ability to assess climate change through a risk lens is necessary in order for companies to quantify and manage its impacts.

A majority of literature on climate risk outlines two primary categories of climate risk: physical and transition. However, the TCFD breaks climate risk into four categories: physical, market and technology, policy and legal, and reputation risk, the latter three which are considered transition risk. In other sources, litigation risk is viewed as a separate category. Furthermore, a 2015 McKinsey & Company analysis identified six categories of climate risks companies should be aware of, each either segmented as a value-chain risk or external-stakeholder risk (see graphic below).



McKinsey&Company | Source: McKinsey analysis

Figure 2: How companies can adapt to climate change - Value Chain Risks. Source: (Engel, Enkvist & Henderson, 2015)

For the purposes of this paper, market, technology, policy, litigation, and reputational risks are all addressed under transition risk.

Physical risks refer to the risks related to the direct physical impacts of climate change. Transition risks refer to the risks associated with the transition to a low- or zero-carbon economy. Research by SASB found that 72 out of 79 Sustainable Industry Classification System (SICS) industries are “significantly affected in some way by climate risk,” which equates to 93 percent of U.S. equities by market capitalization. Since climate-related risk affects nearly all industries, it is considered a systemic, non-diversifiable risk that must be managed (SASB, 2016). The former Secretaries of the Treasury of the U.S., Henry M. Paulson and Robert E. Rubin, have stated that “climate change is the single biggest economic risk the world faces today” (SASB, 2016). This sentiment is echoed in the 2020 World Economic Forum’s Global Risk Report in which the top five global risks in terms of likelihood are all climate-related, including extreme weather, climate action failure, natural disasters, biodiversity loss, and human-made environmental disasters (WEF, 2020). Additionally, the number one risk in terms of impact is failure of climate change mitigation and adaptation, otherwise known as climate action failure.

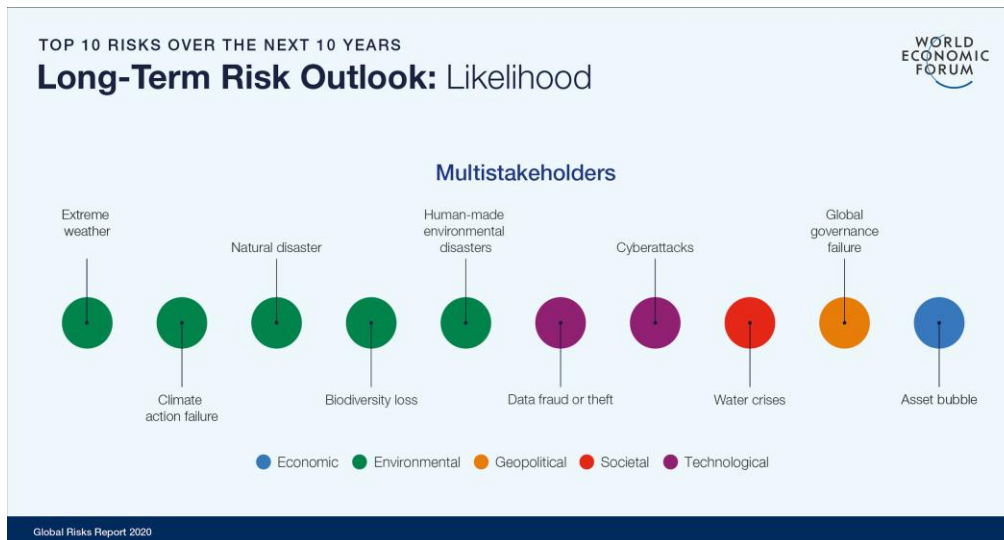


Figure 3: Top 10 Risks Over the Next 10 Years: Global Risks Report 2020. Source: (WEF, 2020)

In addition to climate-related risks, climate change may also lead to opportunities. The consulting firm EY offers a comprehensive definition for climate-related risks versus climate-related opportunities (Nelson, 2019):

- **Climate-related risk:** Physical risks emanating from climate change can be event-driven (acute), such as increased severity of extreme weather events. They can also relate to longer-term shifts (chronic) in precipitation and temperature, and increased variability in weather patterns (e.g. sea level rise). Climate-related risks can also be associated with the transition to a lower-carbon economy, the most common of which relates to policy and legal actions, technology changes, market responses and reputational considerations.
- **Climate-related opportunity:** Efforts to mitigate and adapt to climate change will likely result in new opportunities, such as through resource efficiency and cost savings, the adoption and utilization of low-emission energy sources, the development of new products and services, and building resilience along the supply chain. Climate-related opportunities will vary depending on the region, market and industry in which an organization operates.

Overall, these impacts will have wide ranging implications across society and the economy, cutting across multiple lines of business, sectors, and geographies (Carney, 2019). Given the diverse nature of climate risks, companies must assess these risks through the lens of materiality. Each type of risk is described in further detail in the following three sections, along with real-world examples of how climate risk can impact various companies and industries.

## 2.1. Physical Risk

Physical climate risks are risks that have an impact on physical assets, such as severe drought leading to crop loss, hurricane winds destroying a building, sea level rise leading to more frequent flooding of roads and property, or melting permafrost causing infrastructure to sink.

Physical risk can be caused by acute hazards or chronic hazards or a combination of both. Acute physical risk stems from event-driven hazards such as hurricanes, heat waves, cold waves, wildfires, floods, and extreme precipitation. Acute physical risk impacts can cause damage to assets, supply chain disruptions, and/or electricity grid disruptions. Associated financial impacts can include asset impairment and cost increases from operation disruptions, disruptions to transportation, supply chains, and distribution chains, and increases in insurance premiums (SASB, 2016).

Chronic physical risks arise from long-term changes in climate patterns, such as the progressive impacts of increasing temperatures, changing precipitation patterns, sea level rise, water availability, coastal erosion, and biodiversity migration and loss. Impacts from chronic physical risks include changes to agricultural yields, shifts in growing seasons and species distribution, human disease migration, availability and quality of water resources, and damage to coastal real estate. Associated financial impacts can include revenue loss or demand contraction from lower yields and decreased output, cost increases from natural resource constraints, materials costs increase, and logistics costs increases, asset impairment such as premature impairment or devaluation. On the opportunities side, chronic physical effects could lead to revenue growth from increased agricultural and forestland productivity, increased patient load in health care delivery, or sales growth for heating, ventilation, and air conditioning (HVAC) and associated equipment producers, and cost reduction from reduced material costs as agricultural productivity increases in certain geographies (SASB, 2016).

Acute and chronic hazards can cause both direct and indirect impacts to companies. In the case of direct impacts, physical risks can cause destruction of buildings or a loss of production or work hours due to flooding or heat waves. A company could be impacted indirectly through effects in the value chain or its macro environment, such as changes in demand (e.g. investment, consumption, trade) and supply (e.g. labor supply, energy, food, water and other inputs, capital stock, technology) (Hubert et al., 2018). The graphic below, created by the ClimINVEST Research Project, depicts how physical climate risks can impact the real economy and financial sector.

**FIGURE 1. PROPAGATION CHANNELS OF CLIMATE RISKS TO THE REAL ECONOMY AND THE FINANCIAL SECTOR**

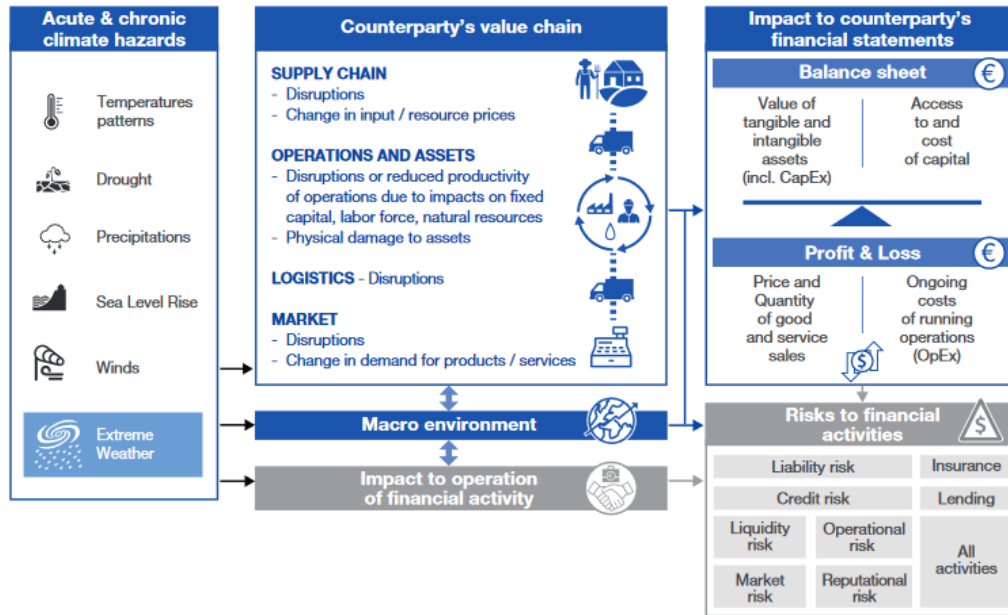


Figure 4: Physical Risk Impacts. Source: (Hubert, Evain, Nicol, 2018)

To understand the impact of physical risk on an organization, physical risk can be broken into several components: hazard, exposure, vulnerability, sensitivity, and adaptive capacity. The definitions and relationships between these components are demonstrated below:

**EQUATION 1. PHYSICAL CLIMATE RISK COMPONENTS**

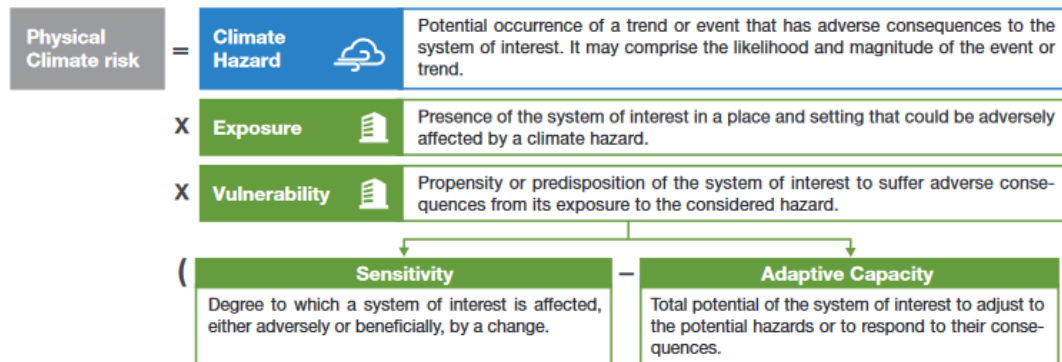


Figure 5: Physical Risk Components. Source: (Hubert, Evain, Nicol, 2018)

A year-long research effort by McKinsey & Company looking at how climate change could impact socioeconomic systems over the next three decades discovered seven characteristics of physical climate risk that stand out. They found that climate hazards manifest locally and thus must be understood in the context of a geographically defined area. Although the direct impact from climate risks is local, it can have “knock-on effects across regions and sectors, through interconnected socioeconomic and financial systems.” The McKinsey study also notes that “the pace and scale of adaptation are likely to need to significantly increase to manage rising levels of physical climate risk” (McKinsey Global Institute, 2020).

In order to be climate resilient, corporations must understand how physical risks impact their supply chain, operations, assets, logistics, and the potential change in demand for products and services across specific localities. Specific examples illustrating this point are offered in the *Financial Impact of Climate Risks and Opportunities* section below.

## 2.2. Transition Risk

Transition risks refer to how the “transition” to a low- or zero-carbon economy could impact a company’s business model and profitability. Transition risks are driven by changes in markets, technology, policy, and changing consumer preferences, which could lead to varying degrees of financial or reputational risks, and/or losing the social license to operate. Companies also face increased risk of being charged with climate-related litigation claims. According to the World Economic Forum, transition risks will increase over the next ten years as the delay in reducing emissions will force companies to adjust more quickly. A more abrupt transition will lead to higher costs, greater economic disruption, and more draconian interventions from policymakers (WEF, 2020).

### Market Risk

Market risk captures the idea that climate change could impact supply and demand for certain commodities, products, and services. McKinsey outlines a similar risk category, product risk, which they define as core products becoming unpopular or unsellable (Engel, Enkvist, Henderson, 2015). Market and product risk could lead a company to lose market share or go out of business.

Dynamics impacting the coal industry are a prime example of market risk. In the U.S., the decline of the coal industry began as a glut of cheaper natural gas was produced with the advent of hydraulic fracturing (fracking) and the downward trend is continuing as more renewable energy is brought online (DiSavino, 2020). Decline of the coal industry is also seen on a global scale. In 2018, the Carbon Tracker Initiative found that 42 percent of global power plants are unprofitable with a projection that by 2030 building new renewables will be cheaper than continuing to operate 96 percent of existing and planned coal plants (Carbon Tracker Initiative, 2018). Unprofitability, in conjunction with the high carbon footprint and negative health impacts associated with coal, has led to more pressure to take coal power plants offline and to shift to renewable energy.

Insurers and financial institutions have played a role in signaling the market shift away from coal power and other fossil fuels through fossil fuel divestment policies. Table 1 summarizes a sampling of fossil fuel divestment announcements made by some of these institutions.



Institution	Industry	Policy Summary
AXA	Insurance	<p>As of November 2019, Axa will:</p> <ul style="list-style-type: none"> <li>- restrict investments in electric utilities that have a coal-based energy mix of over 30% and/or coal power expansion plans of over 300MW (vs 3000MW since 2017).</li> <li>- not invest in mining companies where coal accounts for more than 30% of their revenue and/or that extract over 20MT of coal annually.</li> <li>- not invest in power generation companies with more than 10GW of installed coal-based power production.</li> <li>- extend its existing ban on underwriting new and existing property and construction businesses with any coal-related project, to now include restrictions at client-level, and for any Line of Business, with companies that derive more than 30% of their turnover from coal; have a coal-based energy mix of over 30%; or mines that extract more than 20MT of coal annually.</li> <li>- commit to a long-term coal "exit" strategy, reducing its exposure to the thermal coal industry to zero by 2030 in the European Union and OECD countries, and by 2040 in the rest of the world (AXA, 2019).</li> </ul>
Chubb	Insurance	<p>As of July 2019, Chubb <b>will not</b>:</p> <ul style="list-style-type: none"> <li>- underwrite risks related to the construction and operation of new coal-fired plants</li> <li>- underwrite new risks for companies that generate more than 30% percent of revenues from thermal coal mining. Chubb will phase out coverage of existing risks that exceed this threshold by 2022.</li> <li>- underwrite new risks for companies that generate more than 30% of their energy production from coal. Chubb will phase out coverage of existing risks that exceed this threshold beginning in 2022</li> <li>- make new debt or equity investments in companies that generate more than 30% of revenues from thermal coal mining or that generate more than 30% of energy production from coal (Chubb, 2019).</li> </ul>
Credit Agricole Group	Financial Services	<p>As of June 2019, Credit Agricole:</p> <ul style="list-style-type: none"> <li>- is planning a total phaseout from thermal coal by 2030 for EU &amp; OECD countries, 2040 for China, &amp; 2050 for the rest of the world</li> <li>- will no longer develop business relations with corporations generating more than 25% of their turnover in the thermal coal sector</li> <li>- will stop working with corporations currently developing or planning to develop new thermal coal capacities along the entire value chain (Credit Agricole Group, 2019).</li> </ul>
ING	Financial Services	<p>As of December 2017, ING will:</p> <ul style="list-style-type: none"> <li>- no longer finance clients in the utilities sector that are over 5% reliant on coal fired power in their energy mix by 2025</li> <li>- support new clients in the utilities sector only when their reliance on coal is 10% or less and they have a strategy to reduce their coal percentage to close to zero by 2025</li> </ul>

		- phase out lending to individual coal-fired power plants by the end of 2025 (ING, 2020).
European Investment Bank (EIB)	Financial Services	As of November 2019, EIB will: - end financing for unabated fossil fuel energy projects, including gas, from the end of 2021 onwards (European Investment Bank, 2019).
Goldman Sachs	Financial Services	As of December 2019, Goldman Sachs will: - decline any financings that directly support the development of new coal fired power generation in both developed and developing economies unless it has carbon capture and storage or equivalent carbon emissions reduction technology (Goldman Sachs, 2020).
Zurich Insurance	Insurance	As of June 2019, Zurich generally will <b>no longer</b> underwrite or invest in companies that: - generate more than 30% of their revenue from mining thermal coal, or produce more than 20 million tons of thermal coal per year - generate more than 30% of their electricity from coal - are in the process of developing any new coal mining or coal power infrastructure - generate at least 30% of their revenue directly from the extraction of oil from oil sands - are purpose-built (or “dedicated”) transportation infrastructure operators for oil sands products, including pipelines and railway transportation - generate more than 30% of their revenue from mining oil shale - generate more than 30% of their electricity from oil shale (Zurich Insurance, 2019).

Figure 6: Insurance & Financial Institutions Fossil Fuel Divestment Policy Announcements. Source: Various, see References

### Technology Risk

The transition to a lower-carbon economy has brought the advent of new technologies. Renewable energy, battery storage, carbon capture and storage, energy efficiency, and electrification in the transport sector are a few technologies and trends that will impact “the competitiveness of certain organizations, their production and distribution costs, and ultimately the demand for their products and services from end users” (TCFD (B), 2017). Technology risk, therefore, characterizes the risk companies face as these new technologies displace old systems and disrupt parts of the existing economic system. Some companies will transition to these new technologies proactively, whether by virtue of their industry or leadership on sustainability issues, allowing them to potentially gain a competitive advantage over slower moving companies, particularly if climate-related legislation is passed mandating upgrades to this new technology.

## Policy Risk

The passage of policies that seek to reduce emissions or mandate action on climate adaptation is also considered a transition risk. On the mitigation side, such policies include carbon pricing mechanisms and energy-efficiency measures. For example, as of 2019, more than 40 (national and sub-national) governments worldwide had a carbon pricing policy in place, including Canada, Britain, the European Union, and ten states in the United States (Plumer & Popovich, 2019). Additionally, China plans to roll out a nationwide cap-and-trade program beginning in 2020 that, when complete, would be the largest carbon pricing program in the world (Plumer et al., 2019). On the adaptation side, water efficiency measures and sustainable land use practices are examples of policies that could lead to transition risk.

The changing and uncertain landscape of climate-related policy worldwide makes it difficult for companies to precisely plan for policy risk. However, companies can take a proactive approach to understand possible policy approaches, knowing that the world is moving toward a lower-carbon economy.

## Reputation Risk

External stakeholder awareness regarding the role of a company's contribution to or action to mitigate environmental and social issues, including climate change, is growing. Companies are being held to account for the negative externalities their business operations create. McKinsey & Company states that in the context of climate change reputation risk is "the probability of profitability loss following a business's activities or positions that the public considers harmful" (Engel et al., 2015). Furthermore, McKinsey & Company states that reputation risk "can either be direct, stemming from a company-specific action or policy, or indirect, in the form of public perception of the overall industry" (Engel et al., 2015). A blog post from the UK law firm Farrer & Co states the extent to which companies should be concerned with reputation risk bluntly: "any business with a public profile should now expect to be held accountable for its impact on the environment" (Mendonca-Richards, 2019). Consumer boycotts, local community protests, strained or damaged regulatory and/or investor relationships, and difficulty in retaining or attracting talent are all examples of how reputation risk could materialize.

In trying to get ahead of reputation risk, many companies have launched and promoted sustainability initiatives. However, companies face additional risk from publicizing sustainability measures that could be perceived as greenwashing by external stakeholders or not fulfilling all of their stated pledges. This scenario could lead to litigation, as discussed next.

## Litigation Risk

Climate change also brings increased risk of litigation, which is referred to as litigation or liability risk. Litigation risk has emerged over the past two decades and is defined as when "those who have (or may) suffer losses from physical climate impacts are increasingly seeking compensation from large carbon emitters (countries and/or companies)", according to asset management company DWS Group (Four Twenty Seven, 2018). TCFD also notes that litigation can arise from the failure of organizations to mitigate the impacts of climate change, failure to adapt to climate

change, and the insufficiency of disclosure of material climate risks (TCFD (B), 2017). Such cases have been brought forward by property owners, municipalities, states, insurers, shareholders, and public interest organizations.

As cited in a 2019 report by Nigel Brook and Neil Beresford, of international law firm Clyde & Co, more than 1,200 climate change cases have been filed in over 30 jurisdictions around the world, with the majority of cases (950+) taking place in the United States (Brook & Beresford, 2019). According to figures from another international law firm, Herbert Smith Freehills, climate-related litigation worldwide increased by approximately 72 percent between 2017 and 2019 (see graphic below).

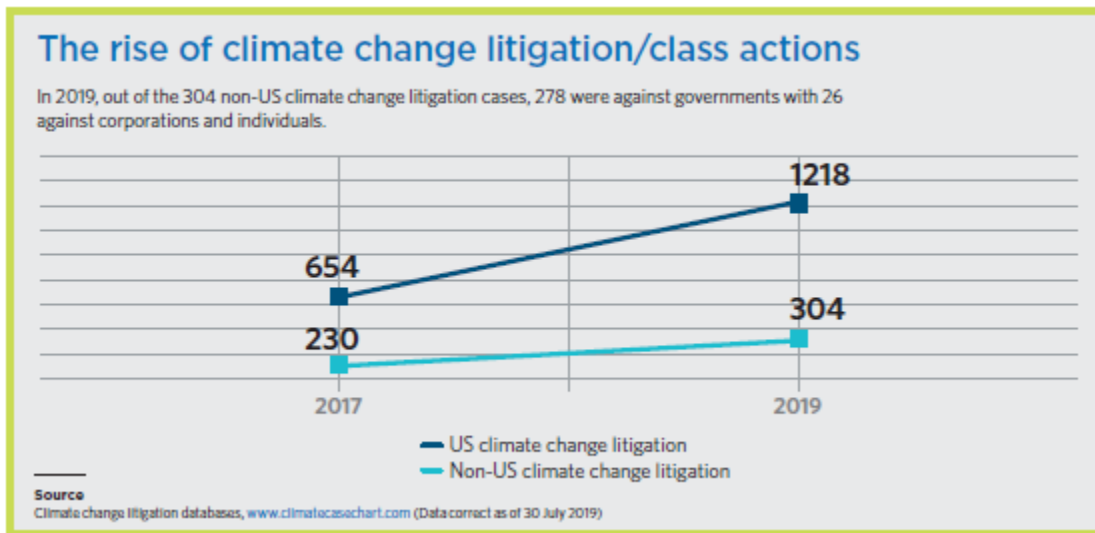


Figure 7: Climate-Related Litigation Trends. Source: (Goldberg & Rubinstein, 2019)

In 2017, the 884 climate-related litigation cases spanned 25 countries:

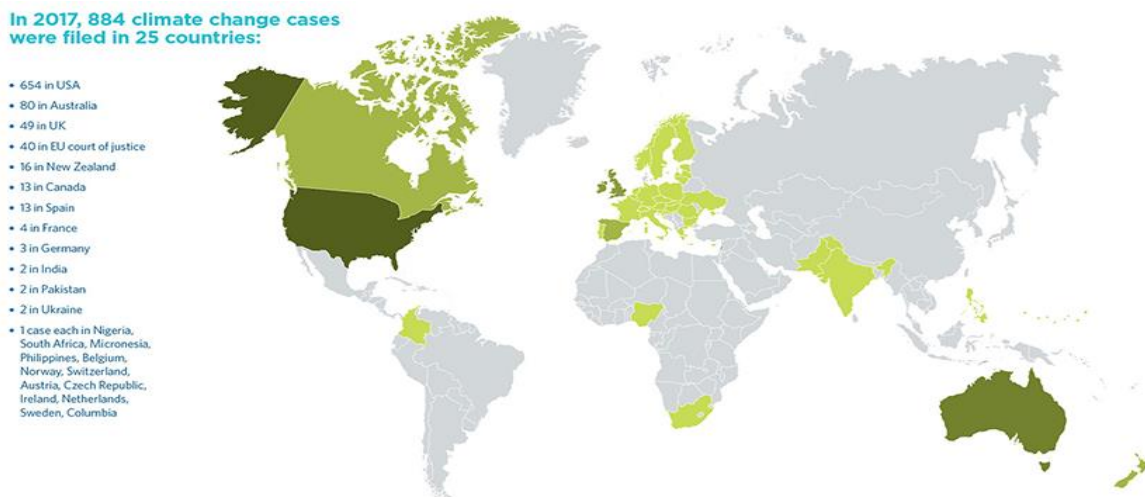


Figure 8: Global Climate-Related Litigation. Source: (Goldberg & Rubinstein, 2019)

Brook and Beresford (2019) outline three types of climate litigation:

1. Administrative cases against governments and public bodies
2. Tortious claims against corporations perceived as perpetrators of climate change
3. Claims brought by investors against corporations for failing to account for possible risks to carbon-intensive assets or for failing to account for or disclose risks to business models and value chains in financial reporting.

The litigation described in the second category targets corporations whose actions emit significant greenhouse gas emissions and thereby contribute to climate change. Tortious claims arise in civil court and are used to redress a wrong done to a person, such as loss of past or future income and pain and suffering, and provide relief from the wrongful acts of others, usually by awarding monetary damages as compensation” (Kenton, 2018). Brook and Beresford point to two “waves” of tortious cases that targeted such companies. The first wave took place between 2005-2015, with the litigation during this period primarily framed in the U.S. as public nuisance claims, which were ultimately not successful due to the difficulty of tracing plaintiffs’ injuries to defendants’ actions. Since 2015, advancements in climate science, particularly the ability to better attribute the severity of specific extreme events to climate change (known as climate change attribution science), along with improved efforts to quantify how much an individual corporation is “responsible” for climate change given their historical emissions, places the second wave of climate litigation in a different context (Brook et. al, 2019, Harvey, 2018). For example, in 2017, CDP and the Carbon Accountability Institute published “The Carbon Majors Database” report which analyzed company greenhouse gas emissions data. The report found that more than 50 percent of global industrial emissions since 1988 can be traced to 25 corporate and state-owned entities and more than 70 percent can be traced to just 100 companies (Griffin, 2017).

As described, there are many factors within the category of transition risk that corporations could consider. However, given the uncertainty surrounding the nature of these risks, it is difficult to accurately measure and price the impact these risks could have on a company, particularly compared to physical risk. Additionally, considering the world’s slow progress toward a low-carbon economy, there is concern that changes in policy, markets, technology, and consumer sentiment will be more abrupt and disorganized and therefore lead to greater costs associated with transition risk (Brown & Nyce, n.d.). Companies should be aware that the lack of a strong policy framework on climate change in conjunction with more severe climate impacts could lead to an increase in liability risk.

### 2.3. Financial Impacts of Climate Risks

*“Climate and corresponding economic risks threaten a 2008-style systemic collapse, unless net human-caused carbon dioxide (CO<sub>2</sub>) emissions fall by 50% by 2030 relative to 2010, and to net zero by 2050.”* – World Economic Forum Global Risks Report 2020 (WEF, 2020)

The complexity and uncertainty inherent in climate modeling make it difficult to financially quantify the future risks climate change poses to the economy and various industries. For

example, natural catastrophe modeling tools that have traditionally been used to price risk are backward looking, focusing on historical data to estimate future conditions in a world that is no longer characterized by the same climate that created these historical data and trends. In addition, the debate around how, and even whether it is possible, to assess, quantify, and value ecosystem services, or the benefits that humans derive from nature (Boerema, Rebelo, Bodi, Esler, Meire, 2016), presents another challenge to comprehensively calculating the financial and economic risk climate change poses to society.

Despite these challenges, recent research efforts by academics, global institutions, and private sector firms aimed at pricing future climate risk have resulted in a range of dollar figures that present a snapshot of the scale of the potential financial implications of climate change. Despite these challenges, recent research efforts by academics, global institutions, and private sector firms aimed at pricing future climate risk have resulted in a range of dollar figures that present a snapshot of the scale of the potential financial implications of climate change. The World Economic Forum's 2020 Global Risk Report includes a few relevant estimates. The report states that economic stress and damage from natural disasters in 2018 totaled \$165 billion, 50 percent of which was uninsured (WEF, 2020). It also cites research done by U.S. federal agencies that suggest climate-related economic damage could reach 10 percent of GDP by the end of the century. Finally, it mentions that 200 of the world's biggest firms "estimated that climate change would cost them a combined total of nearly US\$1 trillion in the case of non-action." The U.N. Environment Program (UNEP) Finance Initiative provides a future estimate of economic costs associated with climate changing, citing conservative estimates of a loss of 5 to 20 percent of gross domestic product (GDP) each year globally, now and forever, if climate change continues unabated (UNEP Finance Initiative, n.d.).

While these high-level estimates paint a picture, they are less helpful to business leaders who are trying to understand the impact of climate change on their specific industry or company. Some research has been done to show that certain industries will be hit harder than others, but it is difficult to come across more granular data. Due to the difficulty of quantifying the financial risks associated with climate change plus the fact that climate change impacts each sector and company differently, companies aiming to understand their specific financial risk will likely need to turn to outside providers that offer bespoke climate risk modeling and quantification services, unless they possess capabilities to do so internally. The rest of this section serves to highlight common ways climate change can impact a company's bottom line with accompanying examples.

TCFD frames the financial implications of climate risks and opportunities under four major categories, divided by how they can potentially impact a company's income statement and balance sheet (TCFD (A), 2017). On the income statement, companies should be aware of how transition and physical climate risks can affect revenues and expenditures. Revenue can be affected by changes in demand for products and services. On the expenditure side, TCFD explains that an organization's response to climate risks and opportunities may depend on its cost structure. Financial risks on the balance sheet include supply and demand changes from climate risks that could impact the valuation of an organizations' assets and liabilities. Companies could face the need for new investments, restructuring, write-downs, or impairment. The stranded

assets example in the fossil fuel industry mentioned above encapsulates this type of financial risk. Finally, climate risks and opportunities could impact a company's capital and financing by changing the debt to equity ratio to compensate for reduced operating cash flows, new capital expenditures, or research and development. Climate risks could also impact a company's ability to raise new debt and/or increase the cost of capital, particularly if lenders do not feel confident that a company is aware of or managing its climate risks properly.

Physical risk can disrupt a company's operations in a multitude of ways. Extreme weather events, such as snow and rainstorms, can block distribution channels, making it difficult for materials to flow across a company's supply chain. Additionally, labor productivity will be significantly affected by extreme heat, particularly for companies that rely on laborers who work outside, such as farmers, construction workers, utility maintenance, and landscaping. Risky Business' study on the economic risks of climate change in the U.S. found that labor productivity of outdoor workers could decrease by as much as 3% by the end of the century, particularly in the Southeast (Risky Business, n.d.).

Outside of the U.S., many of the countries that will experience the brunt of extreme heat tend to be poor. Damon Matthews, a professor in climate science and sustainability at Concordia University, remarked that, "the thresholds of heat exposure leading to labor productivity loss are likely to be exceeded sooner and more extensively in developing countries in warmer parts of the world. These countries are also more vulnerable because a higher fraction of their workforce is employed in... sectors [vulnerable to heat exposure] and because they have less ability to implement infrastructural changes that deal with a changing climate" (Concordia University, 2019). Companies that benefit from cheap labor in these countries need to be cognizant of how such physical risks could impact their labor force and thus impact the entire supply chain.

Physical risk can also lead to decreased production capacity. In the agriculture sector, climate change is increasing the likelihood of extreme drought, early frosts, and higher incidence of disease and pests across some geographies, leading to losses in yield. Risky Business found that without adaptation measures, some Midwestern and Southern counties in the U.S. could see a decline in yields of soy corn, wheat, soy, and cotton of more than 10% over the next 5 to 25 years, with a 1-in-20 chance of yield losses of more than 20% (Risky Business, n.d.). Other recent research with a global lens suggests that climate change has already had an impact on crop production. Ray et al. analyzed the impact of climate change on the top ten global crops over a four-year period. About 83% of consumable food categories come from these ten crops. They found climate change is reducing global production of rice by 0.3% on average each year and wheat by 0.9% on average each year, whereas yields of the more drought-tolerant sorghum crop increased by 0.7% in sub-Saharan Africa and 0.9% yearly in western, southern and southeastern Asia (Ray (B), 2019). Overall, the study found climate change impacts on agricultural yields are mostly negative in Europe, Southern Africa and Australia, generally positive in Latin America, and mixed in Asia and Northern and Central America (Ray (A), 2019).

Another example demonstrating how physical risk could impact revenues is the impact climate change has had on the ski industry. Reduced snowfall and shorter snow sport seasons have led

to significant financial losses. According to an economic analysis by the nonprofit Protect Our Winters, the economic cost associated with low snow years and the subsequent reduction in participation was over \$1 billion and cost 17,400 jobs compared to an average season in the U.S. (Protect Our Winters, 2020).

The above illustrative examples only capture a few ways that physical risk can impact companies and various industries. In addition to supply chain disruptions, decreased labor productivity, decreased production capacity, and asset devaluation, companies may encounter increased operating costs from natural resource scarcity, increased capital costs from damage to facilities, and increased insurance premiums or reduced availability of insurance on high-risk assets, among other impacts (TCFD (B), 2017). Recognizing that the physical risks associated with climate change are an issue that must be paid attention to now will allow companies to build resilience before the severity and frequency of these events become worse.

The scenarios in which transition risk can cause corporate financial impact are diverse. The fossil fuel industry is facing many aspects of transition risk, particularly in the form of market risk and stranded assets. The definition for stranded assets can differ depending on the context. A “meta” definition developed by Caldecott, Howarth, and McSharry, which pulls from various disciplines, proposes that stranded assets are “assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities” (Caldecott, 2017). In the context of climate risk, the Carbon Tracker Initiative adds a helpful distinction to its definition for stranded assets, noting they are “a result of changes in the market and regulatory environment associated with the transition to a low-carbon economy” (Caldecott, 2017). In addition to the fossil fuel industry, other sectors are vulnerable to stranded-asset risk, including infrastructure, agriculture, real estate, mining, and utilities (Caldecott, 2016).

For the fossil fuel industry, research by the Inter-American Development Bank finds that approximately 60 to 80 percent of publicly listed fossil fuel reserves need to be considered “unburnable” to prevent exceeding the global carbon budget (Caldecott, 2016). Some fossil fuel companies are trying to get ahead of this market risk by investing in and diversifying their business toward renewable energy. Research by Matthias Pickl, an economics professor at King Fahd University of Petroleum and Minerals in Saudi Arabia, analyzing whether oil companies are transitioning to become energy companies in the broader sense, found that five of the eight oil majors have taken considerable investment into renewable energy and have formulated an explicit renewable energy strategy (Pickl, 2019). Notable investments include Royal Dutch Shell’s acquisition of NewMotion, Europe’s largest electric vehicle charging company, and a 44% stake in Silicon Ranch, a U.S.-based solar developer, Total’s plan to invest \$500 million per year (3% of total capital expenditure) in renewables, a 60% majority stake in U.S. solar specialist SunPower, and its launch of venture capital arm Total Energy Ventures which has invested almost \$200 million in over 200 startups since 2008, and BP’s 43% stake in Europe’s largest solar power project developer, Lightsource, and a \$20 million investment in StoreDot, an Israeli developer of rapid-charging batteries. Pickl highlighted that all oil majors except ExxonMobil have developed or are developing solar and wind assets (Pickl, 2019).



Although the fossil fuel industry may be an obvious example of an industry that faces market risk in the context of climate change, shifts in supply and demand resulting from climate change impacts, policy, or changing consumer sentiment will cut across many industries.

The *flygskam*, or flight shame, movement growing in Europe, is a good example of how transition risk, specifically reputation risk, can impact a company's revenues. In recognizing the greenhouse gas emissions associated with flying, *flygskam* discourages flying and promotes using less carbon-intensive modes of transportation such as trains. One of the most famous examples of *flygskam* was climate activist Greta Thunberg's decision in 2019 to complete her round-trip travel from Sweden to the U.S. by sailboat so she could attend a climate change conference. However, this movement extends beyond climate activists. European businesses are encouraging more virtual meetings and train or bus transport instead of flying when in-person meetings are necessary. This includes Zurich Insurance, with Alison Martin, Chief Executive Officer for Europe, Middle East & Africa, quoted in Bloomberg saying, "Flying isn't a prerequisite for getting business done" (Wilkes, 2019). *Flygskam* is already having a negative financial impact on some European airlines, such as Scandinavian airline SAS AB which reported a 2% decrease in traffic over a nine-month period compared to the prior year.

Technology risk can be understood through the recent emphasis on shifting to electrification in the transport sector, which has forced automotive companies to consider the future of their industry. Some manufacturers have acted more quickly to develop electric vehicles while laggards have only recently started to embrace this shift. Volkswagen, a current leader in this space, is spending \$34 billion over a five-year period to make an electric or hybrid version of every vehicle in its lineup, hoping to launch 70 new electric models by 2028 (Riley, CNN Business, n.d.). A 2018 Bloomberg article headline succinctly characterizes the race toward electrification and its impact on automotive companies: "In the Switch to Electric Vehicles, Expect a Few Giants to Crash" (Stock, 2018). The automotive industry's attachment to the internal combustion engine, partially due to an abundance of cheap fuel, has caused what David Legget, editor of just-auto and former director of automotive forecasting at the Economist Group, describes as a "culture of industrial inertia and technological conservatism" within the auto industry (Legget, 2017). The ability for automotive companies to forego their technological conservatism and strategically emerge with new business models that embrace electrification will dictate the future viability of their businesses.

As demonstrated by this diverse set of examples, physical and transition risks can lead to potential financial impacts, including changes in revenues, expenditures, the valuation of assets and liabilities, capital structure, and financing across a wide range of industries and geographies. A 2018 CDP analysis based on nearly 7,000 company disclosures to CDP, including 366 of the 500 world's largest companies by market cap included a breakdown (see graphic below) of the most common categories of financial impact as related to climate risks. The top two financial impact drivers reported by companies were increased operating costs due to transition risks and reduced revenue from decreased production capacity related to physical risks. Overall, it is incumbent upon companies to understand their specific climate risk profile to succeed in ameliorating these impacts.

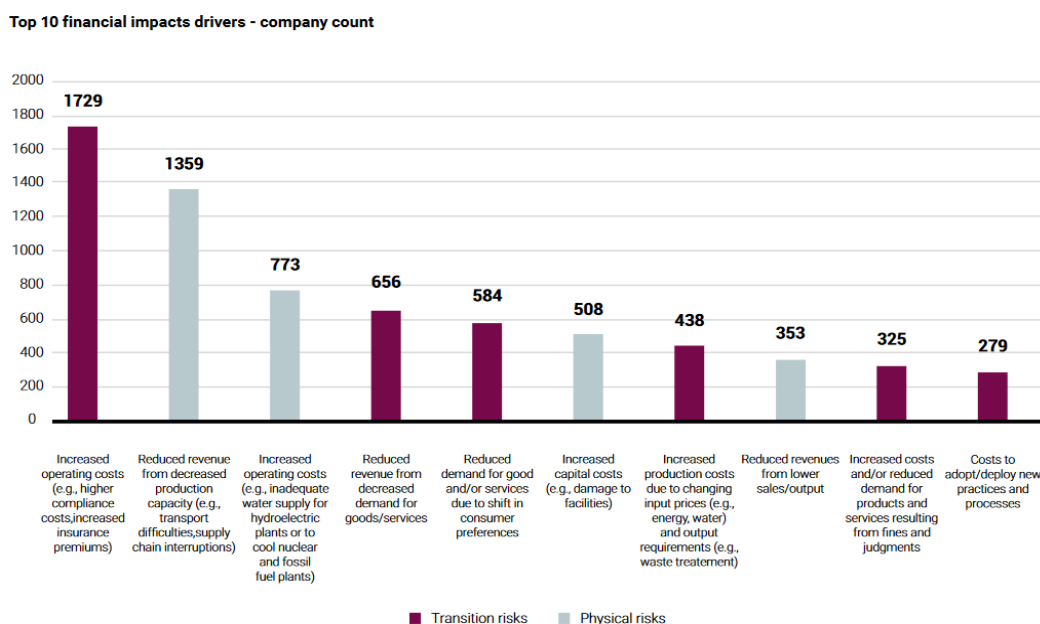


Figure 9: Climate-Related Financial Impacts. Source: (CDP, 2019, p. 13)

## 2.4. Climate-Related Opportunities

Climate change mitigation and adaptation actions also present opportunities for some companies depending on the industry, market, and geographies in which they operate. The Global Commission on the Economy and Climate’s *New Climate Economy* initiative emphasizes the opportunities associated with climate change in a 2018 report, suggesting that the transition to a low-carbon economy could conservatively lead to economic gain of \$26 trillion through 2030 compared to business-as-usual (The New Climate Economy, 2018). The UN CDP’s analysis of company disclosure shows that 51% of all reporting companies (nearly 7,000) identified potential opportunities that could have a substantive or strategic impact on their business, primarily through new products and services, resource efficiencies, and alternative energy sources. Furthermore, CDP notes that 225 of the world’s 500 biggest companies reported that climate-related opportunities represented potential financial impacts totaling over \$2.1 trillion dollars, the majority of which they believe will materialize in the short- to medium-term. This figure, compared to the estimated \$312 billion in costs it would take to realize these benefits, demonstrates that climate change opportunities can outweigh the costs, if action is taken (CDP, 2019).

Opportunities can come in the form of resource efficiency, through the use of energy efficient transport, production and distribution processes, and buildings as well as reduced consumption of water and other raw materials. Adoption of circular economy principles can help a company reframe what is considered waste to help achieve resource efficiency goals.

Focusing on energy sources, by adopting low-emission and renewable energy technologies, shifting toward decentralized energy generation, and participating in carbon markets represent

additional opportunities. These actions could lead to reduced operational costs, reduced exposure to future fossil fuel price increases, less sensitivity to changes in the cost of carbon due to lower GHG emissions, increased capital availability from investors who favor lower-emissions producers, and reputational benefits from stakeholders who also favor lower-emissions producers. According to figures from nearly 7,000 companies that disclosed to CDP in 2018, these companies estimate a collective \$198 billion in increased capital availability by taking advantage of these opportunities (CDP, 2019).

Innovative development of new products and services geared toward the transition to the low-carbon economy are another category of climate opportunities. Companies that can offer low emission goods and services, such as energy efficient appliances, or climate adaptation solutions, such as precision agriculture tools or drought-resistant seeds, will see increased revenue and demand compared to competitors that do not innovate. Referring to the same CDP figures as above, the nearly 7,000 companies estimate a collective \$970 billion in increased revenue for low emissions products and services and \$236 billion for new solutions to adaptation needs (CDP, 2019). Companies can also take advantage of diversifying business activities and picking up on shifting consumer preferences to gain competitive advantage. Citing the CDP figures, the reporting companies estimate a cumulative \$487 billion increase in revenue from better competitive positioning by reflecting shifting consumer preferences (CDP, 2019). In line with developing innovative products and services and diversifying business activities, companies may gain access to new and emerging markets that can bolster revenues and tap into new customer segments. Companies may also be able to use public-sector incentives that promote sustainable, low-emission products and services. Additionally, companies with strong resilience measures in place may realize increased market valuation, as climate change risks become embedded into valuation methodologies across capital markets.

The emerging market for plant-based and clean meat is an example of how food-oriented CPG companies can realize opportunities associated with transition risk. Due to increasing awareness around the environmental footprint of meat production, a growing segment of consumers are reducing or eliminating consumption of animal protein. Start-ups such as Beyond Meat, Impossible Burgers, and JUST, Inc. are capitalizing on this shifting consumer sentiment around animal protein, by producing plant-based alternatives. The success of these start-ups is reflected in their partnerships with fast food restaurants, including Burger King, White Castle, and at least 16 other restaurant chains (Jiang, 2019). The plant-based food market is projected to grow to \$27.9 billion by 2025 with a compounded annual growth rate (CAGR) of 15% between 2019 and 2025 (Markets and Markets, 2019). Analysts from Barclays investment bank estimate plant-based meat sales will reach \$140 billion by 2030 (Franck, 2019). Traditional food CPG companies have taken notice of this trend and some have entered the plant-based meat market with their own products. For example, after selling its stake in Beyond Meat, Tyson Foods launched its own plant-based brand, Raised & Rooted. Nestle has also made a move in this market with its Sweet Earth brand. Other big CPG companies are expected to enter the plant-based and clean meat market as well. Those that are slow to offer plant-based products or choose not to move into this space will lose out on a highly profitable opportunity.

The need by companies to understand what these climate risks mean for their businesses has created an opportunity for consulting firms, risk engineering firms, insurance companies, and start-ups focused on improving climate modeling and translating climate data into usable and actionable insights. The existence of climate risks has thus created an emerging field that advisory, modeling, and technology-oriented companies are positioned to take advantage of. A 2013 report by Environmental Business International estimated the value of this field at \$2 billion by 2020 (Franzen, 2013). Companies operating in this space are able to monetize climate-related data and consulting services through the development of standardized or bespoke climate risk management strategies that help companies identify and act on climate-related risks and opportunities. Through our analysis of the climate risk value chain, which will be discussed in Chapter 4: Analysis, we found the major consulting firms such as McKinsey & Company, EY, and Deloitte, all offer climate risk management services. Risk engineering firms and risk analytics firms also now tailor their services to include a climate risk lens. Many startups such as Four Twenty Seven and Jupiter Intel have entered the space to fill a gap in the measurement of physical climate risk. Jupiter Intel's ability to raise \$23 million of Series B venture funding, with a total of \$33 million of funding to date, and a 2019 post-valuation of \$76 million (PitchBook, 2020), give a sense of the potential opportunity for legitimate climate-risk startups.

Companies that are successful in identifying and strategizing around both climate risks and opportunities will be more resilient and better positioned compared to competitors.

### 3. Corporate Climate Risk Management

In order to understand the impact of climate change risks and opportunities and ultimately build resilience to climate change, companies must deploy a climate risk management strategy. Depending on the discipline or context, definitions for climate risk management and climate resilience vary. Hill and Martinez-Diaz (2020) offer a succinct definition of climate risk management: the “capacity of a community to reduce, absorb, and recover from the impacts of climate change” (Hill & Martinez-Diaz, 2020). A comprehensive definition is provided by Travis and Bates in the journal *Climate Risk Management*:

*“Climate risk management is a process for incorporating knowledge and information about climate-related events, trends, forecasts and projections into decision making to increase or maintain benefits and reduce potential harm or losses. It is a multidisciplinary activity that calls for an integrated consideration of socioeconomic and environmental issues (Bates, Travis, 2014)”.*

Travis and Bates go on to explain that:

*“A risk management approach invokes the theories, principles, and practices of risk analysis as an aid to decision making and as a guide to reducing expected losses...The defining characteristic of risk is the combination of uncertainty about events and their consequences...A risk management approach to climate problems can also signify certain analytical approaches, including particular attention to the probability of both events and*

*consequences, the framing of response choices along a spectrum of possible outcomes, and targeted efforts to reduce uncertainty or at least to handle better the irreducible uncertainties in climate decision-making. Thus, a risk management approach also invokes the techniques of decision analysis and decision support, including rubrics for judging preferred policies, or choices that offer the least potential for loss (Bates, Travis, 2014)."*

In the context of this research, the definition of climate risk management must incorporate the lens of the corporation. Borrowing language from Travis and Bates, corporate climate risk management can be defined as a process for incorporating knowledge and information about material climate-related risks and opportunities into decision making to increase or maintain benefits and reduce potential harm or losses from a triple bottom line (economic, social, and environmental) perspective. The triple bottom line consideration is important in a climate risk management strategy because actions taken based on only one or two of these attributes could lead to unintended consequences. Zurich Insurance explains the importance of this in their 2019 white paper, *Managing the impacts of climate change: risk management responses*:

*"It is important that risk management actions, whether improving adaptation and resilience to the physical consequences of climate change or the transition risks associated with decarbonizing the delivery of carbon-intensive services, ...be coordinated across business, government and civil society" (Zurich, 2019).*

Zurich provides a few specific examples to elaborate this point. Upland management of land such as tree felling can lead to increased erosion and silt run-off which can clog rivers and lead to flooding. Urban development can compound stormwater run-off issues if large areas of concrete are not built with sustainable urban drainage systems or exacerbate the urban heat island effect leading to increased water and power consumption. The complex and interconnected nature of climate change impacts demands a holistic view be considered by corporate leadership in decision-making.

Ultimately, the goal of corporate climate risk management is to build climate resilience. The definition risk service provider Marsh & McLennan Companies offers for climate resilience provides greater context to the above definition of corporate climate risk management. According to Marsh & McLennan Companies, climate resilience is:

*"The capacity not only to survive, but also to adapt and succeed in the face of climate change and its direct and indirect impacts, including changes in regulation and policy. It encompasses the ability to capitalize on the strategic opportunities presented by the shift to a lower-carbon and resource-constrained economy" (Marsh & McLennan, 2017, p. 6).*

Zurich Insurance's white paper (Zurich, 2019, p. 22) provides a visual representation of how a climate risk management response leads to climate resilience:

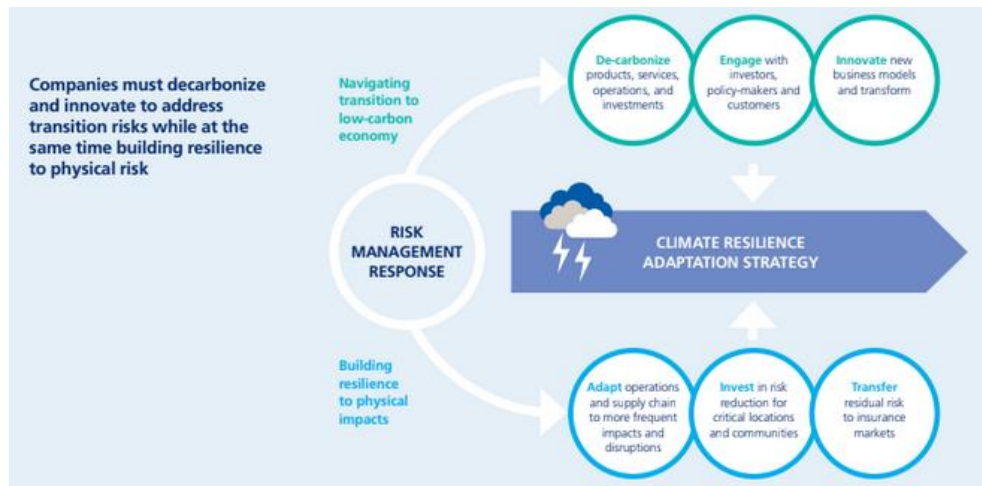


Figure 10: Climate Resilience. Source: (Zurich Insurance, 2019, page 24)

In the “Corporate Climate Risk Management: Best Practices” section below, we articulate what constitutes best practice for climate risk management by reviewing core components gathered from our research across the public and private sectors.

### 3.1. Climate Risk Management and Competitive Advantage

*“If some companies and industries fail to adjust to this new world, they will fail to exist.” - Mark Carney, François Villeroy de Galhau and Frank Elderson (Carney et al., 2019)*

In the business world, competitive advantages are attributes that allow a firm to produce a good or service of equal value at a lower price or in a more desirable fashion compared to competitors. The stronger a company’s competitive advantage is, the harder it is for competitors to catch up or neutralize the advantage. Competitive advantage can derive from cost structure, branding, product quality, distribution network, intellectual property, customer service, economies of scale, efficient internal systems, and geographic location (Twin, 2020). The de facto framework for how to create a sustainable (long-lasting) competitive advantage was created by Harvard professor Michael Porter in 1985. According to Porter’s framework, companies must focus on cost leadership, differentiation, and focus. Cost leadership means companies provide reasonable value at a lower price. Differentiation refers to a company’s ability to deliver better benefits than competitors, including through a unique or high-quality product or faster delivery. Differentiation allows a company to charge a premium price. Finally, focus speaks to the ability of company leadership to service their target market better than competitors (Amadeo, 2019). In order to maintain a competitive advantage, companies must consider what benefit their product or service offers and stay up on new trends and technology that could impact the product or service.

Within the Porter framework, there is an argument to be made for why climate risk management can enhance a company’s competitive advantage. Awareness and management of physical risk is intertwined with the idea of cost leadership. As mentioned previously in this paper, physical risk can impact a company’s supply chain, operations, assets, and logistics. A robust climate risk management strategy will be necessary to identify risks along a company’s value chain and

subsequently keep costs down. For example, detailed analysis of the relative likelihood that specific suppliers in different geographic areas will be impacted by physical risks can prompt a company to diversify its supplier base or set up resiliency measures that would ensure the suppliers can continue to operate despite exposure to hazards. These actions will help a company maintain low supplier costs, or at least not be subject to increases in prices due to resource scarcity or during an emergency, particularly compared to competitors who are not aware of their climate risks and have not put contingency measures in place. Companies who are proactive in this approach will be able to maintain a lead over competitors who may find it difficult to catch up, especially if they are not able to recover from the financial costs of ongoing physical risks.

Resource efficiency is another avenue through which a company can realize cost leadership. The transition to renewable energy sources and energy efficient buildings and transportation along with reduced water and other raw material consumption can lead to significant cost savings that are significant enough to set a company apart from its competitors. Employing circular economy practices aimed at eliminating waste and the continual use of resources can lower material costs and mitigate the impact of volatility in materials prices (Working Group Finance, 2016). A 2015 study by the Ellen MacArthur Foundation showed at a macro level that adoption of circular economy processes would increase Europe's resource productivity by 3 percent by 2030, generating cost savings of €600 billion a year and €1.8 trillion more in other economic benefits (Ellen MacArthur Foundation, Sun, McKinsey Center for Business and Environment, 2015).

In the context of climate risk, a company may be able to enhance competitive advantage through differentiation by focusing on reputational risk and tapping into shifting consumer sentiment. For example, leading the movement toward sustainable packaging, such as some CPG companies have done with their transition to plant-based plastics or reusable packages as part of their partnership with Loop, could appeal to the growing segment of sustainability-conscious consumers who would rather buy from a company that is aware of and mitigating the global plastic pollution crisis. This type of initiative may also help a company get ahead of regulation and decrease the likelihood of steep transition costs, fines, or litigation.

There is perception among many business leaders that paying attention to environmental and climate change issues is a cost to the company. This is a narrow view that does not account for costs avoided from climate change impacts if resilience measures were in place. Indeed, there is a positive return on investment for climate risk management and resiliency measures. This return on investment would differ for each company but research done by the World Bank focused on investment in resilient infrastructure shows each \$1 dollar invested results in \$4 of benefits (World Bank, 2019). Of the 192 out of the world's largest 500 companies that disclose to CDP, the majority reported much lower costs to manage climate change risks than their potential implications (CDP, 2019).

Companies who recognize the value of climate risk management will build resilience to climate change impacts, thereby saving money, maintaining and expanding its customer base, and gaining a competitive advantage over rivals who are slow to move in this area. For companies that are slow to address climate risks, they may soon be confronted with having to quickly come

up to speed on this issue as the possibility of climate risk disclosure grows. The following sections will review the drivers for corporate climate risk disclosure and the framework that has emerged to standardize climate risk disclosures, TCFD.

### 3.2. Climate Risk Disclosure: Drivers

As climate change impacts have become more severe and frequent, pressure has grown for companies to disclose climate risks in financial filings. This pressure has been led by external stakeholders, most notably investors, policymakers and regulators, and insurers.

Advocates for climate risk disclosure believe increased transparency will lead to more accurately priced climate risks and more appropriate allocation of capital in the global economy. Investors and regulators are worried that climate risks are underpriced in the current market, leading to market inefficiency. Market efficiency is the idea that prices fully reflect all available information about a particular stock and/or market at any given time (Hall, 2019). There is limited academic literature exploring the issue of market efficiency and climate risk, however, a 2018 analysis by Hong et al shows that stock markets are inefficient with respect to information about drought trends, one type of climate risk, and suggests that to the extent climate risk information related to natural disasters are incorporated into stock prices, it is only after significant delay (Hong, Weikai, Xu, 2018).

This section will identify the primary stakeholders advocating for transparent climate risk disclosure and their underlying motivations.

#### Investors

As climate change risks become increasingly financially material, investors have pushed for transparency and disclosure from companies on how climate risks specifically impact their bottom line. Investors need this information to determine whether their portfolios are exposed to climate risks and the likelihood for potential losses. In a public statement, a Commissioner at the U.S. Securities and Exchange Commission, Allison Herren Lee, commented on the demand for climate risk disclosure by investors:

Perhaps most importantly in terms of SEC attention, investors are overwhelmingly telling us, through comment letters and petitions for rulemaking, that they need consistent, reliable, and comparable disclosures of the risks and opportunities related to sustainability measures, particularly climate risk. Investors have been clear that this information is material to their decision-making process, and a growing body of research confirms that (Herren Lee, 2020).

Ilhan et al (2019) captured the same sentiment through surveys they administered to assess institutional investors' views and preferences on climate risk disclosure. They found "51% of respondents believe that climate risk reporting is as important as traditional financial reporting, and almost one-third considers it to be more important" (Ilhan, Krueger, Sautner, Starks, 2019). These research results also suggest that investors care more about disclosure of physical risks



due to the firm- and location-specific nature of physical risk, which make it difficult for investors to glean information about its financial impact from other sources. Comparatively, investors may be able to gather information about transition risk from sources outside the specific firm in question since they tend to stem from external factors such as policy or regulatory changes.

Investor demand for climate risk disclosure is also reflected in the establishment of various industry groups focused on this issue. TCFD, the leading organization in this space aimed at standardizing climate risk disclosure, is discussed in depth later in this paper. Other organizations involved in this effort include CDP which characterizes itself as a “not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts” (CDP, 2020). CDP has been working with asset owners, asset managers, banks, and insurers for nearly two decades and through their membership platform, these stakeholders can access data on climate change, deforestation and water security.

In addition to collaborative working and networking groups, the Ceres Investor Network, made up of over 175 institutional investors who collectively manage more than \$29 trillion in assets, pressures stock exchanges and capital market regulators to improve climate and sustainability risk disclosure (Ceres, 2018). For example, in 2016 members of the Ceres Investor Network sent a letter to the U.S. Securities and Exchange Commission (SEC) calling for stronger climate risk reporting in issuers’ SEC filings, citing the need for this information “to make informed investment and proxy voting decisions” (Ceres, 2016).

In Europe, the Institutional Investors Group on Climate Change (IIGCC) is a membership body of more than 230 members, mainly pension funds and asset managers, with over €30 trillion in assets under management. IIGCC’s members view climate risk management as a fiduciary duty and the group works to support and define corporate behaviors that address long-term climate change risks and opportunities (IIGCC, 2020).

Climate Action 100+, launched in 2017, is a group of 450 investors with more than USD \$40 trillion in assets under management. The group’s mission is to work with the companies they invest in that make up the 100 “systemically important emitters to: curb emissions, improve governance, and strengthen climate-related financial disclosures. Climate Action 100+ is coordinated by the Asia Investor Group on Climate Change (AIGCC); Ceres; Investor Group on Climate Change (IGCC); Institutional Investors Group on Climate Change (IIGCC); and Principles for Responsible Investment (PRI). Other initiatives, led by PRI, the World Business Council for Sustainable Development (WBCSD), the Institute of International Finance (IFF), and more, are also working to drive movement around climate risk disclosure, in alignment with TCFD guidelines.

In addition to the above investor initiatives, leaders of major investment institutions have also spoken out about the importance of climate risk disclosure. A monumental example of this was CEO of BlackRock, Larry Fink’s, 2020 annual letter to CEOs titled “A Fundamental Reshaping of Finance.” In this letter, Fink referred to climate change as a “defining factor in companies’ long-term prospects” and said that “[t]he evidence on climate risk is compelling investors to reassess core assumptions about modern finance” (Fink, 2020). Fink goes on to say that investors

recognize that climate risk is investment risk and that “every government, company, and shareholder must confront climate change” (Fink, 2020).

Fink warns that in the absence of taking action on climate change and disclosing the impacts of climate risk, companies will face growing skepticism from the market and consequently a higher cost of capital. The letter concludes by asking the companies BlackRock invests in to disclose climate-related risks in line with the TCFD’s recommendations by the end of 2020. For companies that choose not to disclose or do not release robust disclosures, BlackRock will assume that those companies are not adequately managing risk. The consequence of inaction, as detailed by Fink, is that BlackRock will “vote against management and board directors when companies are not making sufficient progress on sustainability-related disclosures and the business practices and plans underlying them” (Fink, 2020). In February 2020, the German industrial company Siemens, known for its sustainability efforts, experienced what this type of intervention from BlackRock looks like. BlackRock criticized Sieman’s failure to fully consider risks associated with an infrastructure deal with the Carmichael coal mine in Australia and said the company needs to improve their risk assessments for environmental, social, and governance issues (Mooney, Miller, Smith, 2020).

In conjunction with the release of the annual letter, BlackRock announced several new initiatives, which include “making sustainability integral to portfolio construction and risk management” and “exiting investments that present a high sustainability-related risk” (Fink, 2020). As the largest asset manager in the world, with approximately \$7T in assets under management, BlackRock’s position on climate risk and Larry Fink’s pointed language in his annual letter send a strong signal to corporations and investors around the world regarding the urgency and severity of climate risks and what impact they could have on the future of the global economy. BlackRock itself will release TCFD-aligned disclosure by the end of 2020 (Fink, 2020).

Major announcements like Fink’s fit within the burgeoning movement by investors demanding transparent and robust climate risk disclosure. Disclosure of this information will allow investors to understand how climate change risks and opportunities could affect their return on investment and inform decision-making, ultimately funneling investments into sustainable and resilient companies.

### Policymakers and Regulators

Policymakers and regulators have many of the same concerns as investors but view the issue from a lens of how climate change risks will affect the stability of the global financial system. In this context, climate change is considered a systemic risk, one that has the potential to destabilize the normal functioning of the financial system and lead to serious negative consequences for the real economy (Gelzinis & Steele, 2019). Regulators are therefore considering and implementing policies that can proactively guard the financial system against climate change risk, including by promoting both voluntary and mandatory corporate climate risk disclosure.

The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) is one group leading an organized approach on the regulatory side. Established by Banque de France

and eight other central banks and supervisors in 2017, NGFS's goal is to "analyze the consequences of climate change for the financial system and to redirect global financial flows in order to enable low-carbon economic growth" (Deutsche Bundesbank, n.d.). The group recognizes there is a "a strong risk that climate-related financial risks are not fully reflected in asset valuations" and that there is a need for collective leadership and globally coordinated action to address this risk. It serves as a knowledge hub that defines and promotes best practices of climate risk management in the financial sector. As of 2019, the group had 34 members and 5 observers.

In 2019, NGFS issued six recommendations aimed at central banks, supervisors, policymakers and financial institutions with the goal of greening the financial system and managing environment and climate-related risks. The fifth recommendation calls for robust and internationally consistent climate and environment-related disclosure in alignment with TCFD guidelines. Specifically, NGFS urges "policymakers and supervisors consider further actions to foster a broader adoption of the TCFD recommendations" (NGFS, 2019, p. 5-6).

Regulatory bodies in the EU have taken the lead in this effort. In 2015, France became the first country to introduce mandatory climate risk disclosure through Article 173 of the French Energy Transition for Green Growth Law. Article 173 covers publicly traded companies, banks and credit providers, and institutional investors. The requirements include the following (UNEP Finance Initiative et al., 2016).

- **Public companies** shall disclose in their annual report: financial risks related to the effects of climate change; the measures adopted by the company to reduce them; the consequences of climate change on the company's activities and of the use of goods and services it produces.
- **Banks and credit providers** shall disclose in their annual report: the risk of excessive leverage and the risks exposed by regular stress tests.
- **Institutional investors** shall disclose in their annual report: information on how ESG criteria, including physical and transition risks, are considered in their investment decisions; how their policies align with the national strategy for energy and ecological transition.

Despite the fanfare associated with Article 173 in the climate risk disclosure community, constructive criticism has emerged relating to the Article's "comply or explain" provision which allows companies to not report if they can justify, they do not have any material climate risks. In reviewing disclosure trends in France since the passage of Article 173, the UN-backed Principles for Responsible Investment cited room for improvement and stated Article 173 "has not yet achieved its original intent" (Rust, 2019).

Regulators in the EU, including France and the Netherlands, and the UK are also considering climate stress tests for banks and insurance companies. In France, the regulatory body of the Banque de France, ACPR, announced financial institutions would be stress tested against two to

three climate change scenarios beginning in 2020 to ensure they are properly managing climate-related risks (Thomas, Williams, 2019).

The Bank of England announced a similar initiative, considered the world's strictest climate stress tests, as laid out in their Biennial Exploratory Scenario ('BES') exercise framework. Institutional investors will be tested on three scenarios, with the most severe testing performance against temperature rise of 4 degrees Celsius by 2080. The goal of the stress tests is to raise awareness about risks on lenders' and insurers' balance sheets (Financial Times, 2019). The significance of the Bank of England climate stress tests is captured in a quote by former Governor of the Bank of England, Mark Carney:

*"The BES is a pioneering exercise, which builds on the considerable progress in addressing climate related risks that has already been made by firms, central banks and regulators. Climate change will affect the value of virtually every financial asset; the BES will help ensure the core of our financial system is resilient to those changes."* (Bank of England, 2019)

The U.S. has been slow to advance regulation related to climate risk disclosure. In 2010, the SEC published interpretive guidance on "existing SEC disclosure requirements as they apply to business or legal developments relating to the issue of climate change" (U.S. Securities and Exchange Commission (A), 2010). The guidance identified four existing items in Regulation S-K that *may* require disclosure related to climate change, if a company finds climate risks to be "material" under federal securities laws. Legally, a fact is defined as material "if there is a "substantial likelihood" that a reasonable shareholder would find its omission to alter the total mix of available information significantly" (Su & Vanatko, 2019). The four items in Regulation S-K that could be impacted include description of business, legal proceedings, risk factors, and management's discussion and analysis of financial condition and results of operations (U.S. Securities and Exchange Commission (B), 2010). However, this guidance does not explicitly require publicly traded companies to disclose climate-related risks, nor does any other federal securities law (Su & Vanatko, 2019). Unfortunately, an update to Regulation S-K in 2020 that sought to "modernize" the four items mentioned above did not incorporate strengthened language on climate risk disclosure nor address investors' need for standardized disclosure (Herren Lee, 2020).

The other primary initiative in the U.S. is the Climate Risk Disclosure Act of 2019. The bill states "many sectors of the economy of the United States and many American businesses are exposed to multiple channels of climate-related risk," including physical and transition risks and that "assessing the potential impact of climate-related risks on national and international financial systems is an urgent concern"(Congress.gov, 2019). Regarding disclosure, the bill states "companies have a duty to disclose financial risks that climate change presents to their investors, lenders, and insurers" and "requiring companies to disclose climate-related risk exposure and risk management strategies will encourage a smoother transition to a clean and renewable energy, low-emissions economy and guide capital allocation to mitigate, and adapt to, the effects of climate change and limit damages associated with climate-related events and disasters"

(Congress.gov, 2019). The legislation has been passed by the House Financial Services Committee, but it has not been put before a full vote by the U.S. House of Representatives.

## Insurers

Insurance companies are an important player in the push for increased climate risk disclosure. As risk managers and long-term investors funding the economy, insurance companies have incentive to advance climate resilience across society, from both the risk manager and investor perspective. On the risk manager and underwriting side of the business, insurance companies need access to climate risk information to properly assess, price, assume, and transfer risk on behalf of their policyholders. As insurance claims and losses increase due to climate change, insurance companies are further incentivized to help clients assess, manage, and mitigate climate risks to reduce the likelihood of future insurance payouts. In discussing the potential for increased losses that could reduce profits, Munich Re's global head of climate and public-sector business development, Ernst Rauch, explained in an interview that the company "can only accept risk and put risks on our books if we understand them properly. [That is] why we are so interested in climate change" (Hope and Friedman, 2018).

To understand climate risks properly, insurers must be aware of the full scope of their clients' risk profiles, which are now in flux as climate change impacts become more frequent and severe. Additionally, the Geneva Association found that insurance companies face limited access to risk information, which in turns limits their development and expansion of effective risk transfer solutions (Golnaraghi, 2018, p. 5), highlighting the need for greater climate risk information, including by corporate clients. Information insurers need to integrate physical risks into underwriting include: knowledge of risk location, nature of the risk (building, contents), and interconnection between risks through portfolio management (including interconnected risks and supply chains) (CRO, 2019, p. 27). The CRO Forum notes that transition risks, such as reputation and regulatory risks, can also impact underwriting if they lead to shrinking demand for insurance or increased reputational risks on behalf of the insurer, as could be the case with carbon-intensive industries (p. 28).

As conservative, long-term investors, insurance companies need to be confident that the investment decisions they make are incorporating climate risk considerations. Insurers have a fiduciary duty to make smart investment decisions and are increasingly weighing climate risks into those decisions. According to the Geneva Association, "climate change is being considered as a risk factor and an emerging investment theme by the majority of the [Chief Investment Officers], who recognize the importance of 'climate aware investing'. The insurance industry is increasingly integrating climate change considerations into their investment strategies and processes..." (Golnaraghi, 2018, p. 19). In interviews with more than 60 C-level executives, the Geneva Association found that insurance companies are implementing ESG investment strategies. The trend toward ESG investment strategies by insurers may increase the pressure on companies to strengthen their ESG practices, including disclosure of climate risks.

Additionally, insurance companies are requesting climate risk disclosure from their corporate clients as they begin building out climate risk service offerings to generate additional revenue

streams. In order to develop effective climate risk service offerings, insurers need to understand their customers' needs when it comes to climate risk. Therefore, insurance companies are working closely with clients to gain access to this information. However, this process would be made easier if clients identify and assess their climate risk in a standardized way, which is why insurance companies are encouraging clients to follow existing disclosure frameworks such as TCFD.

With the growing pressure from investors, policymakers and regulators, and insurers for transparent, robust, and consistent climate risk disclosure, companies are, to varying degrees, beginning to pay attention to this demand and figuring out whether they should disclose, to what extent, and how to do it properly. To help companies through this process, TCFD was created to provide guidance on and standardize the climate risk disclosure process.

### 3.3. TCFD

The Task Force on Climate Related Financial Disclosures (TCFD) has emerged as the leading framework for companies to understand, address, and publish their vulnerabilities to climate risk. Assembled in 2015 by the Financial Stability Board (FSB), an international financial monitoring body, the TCFD's core objective is to develop high-level, uniform, comparable, and voluntary climate-related financial risk disclosures for financial sector organizations (UNEPFI, 2018). Financial sector organizations can include corporations, banks, insurance companies, asset managers, investors, and more generally, organizations who will need to evaluate climate-change related risks in their portfolios (Deloitte, 2019). Many organizations in this area commonly experience a large lack of reliable information regarding financial institutions' exposure to climate change related risks and opportunities (Bloomberg Professional Services, 2018). This lack of clear information may explain a delay in and lack of action on sustainability and climate issues from stakeholders in the global financial system. Thus, the intention of the TCFD was to increase the amount and visibility of reliable information on this topic, contributing to a stronger industry understanding of climate risks.

The TCFD network and resources all serve to underline a critical idea, that climate risks and opportunities can financially impact a company, and therefore, financial-sector stakeholders and organizations need to play a more active role in climate risk management. The TCFD recommendations are designed to help lenders, insurers and investors better estimate and price these risks. Identifying climate challenges and associated opportunities, and then disclosing preparedness to handle these changes, is essential to understanding a company's resilience to climate change, thus enabling investors to make more informed decisions. An accompanying benefit of disclosing more information on how climate change will impact a company could lead companies to adjust their strategies and processes to be more sustainable and resilient through actions such as reducing carbon emissions. Many hope that TCFD disclosure efforts can help move capital towards more sustainable investments in the long-term. Collectively, these actions are what is needed to slow climate change (Bloomberg Professional Services, 2018).

Companies and investors are beginning to take action to understand how climate change risks will impact their bottom lines, a topic Mark Carney, the former Governor of the Bank of England, has spoken about a number of times. In a speech at the Task Force on Climate Related Financial Disclosures (TCFD) Summit in Tokyo in October 2019, Carney said:

The transition to a low carbon economy will also bring its own risks and opportunities. Changes in climate policies, new technologies and growing physical risks will prompt reassessments of the values of virtually every financial asset. Firms that align their business models to the transition to a net zero world will be rewarded handsomely. Those that fail to adapt will cease to exist. The longer that meaningful adjustment is delayed, the greater the disruption will be. (Carney (A), 2019).

The TCFD released its first Status Report in September 2018, publishing an overview of current disclosure practices as they align with four key TCFD recommendations, along with the support of 513 organizations (TCFD (A), 2018). The four recommendation sections represent how organizations operate - Governance, Strategy, Risk Management, and Metrics and Targets. These recommendations are also voluntary, widely applicable across different sectors, and align with financial filing standards. The TCFD's suggested categories and framework to analyze climate-related risks and opportunities, and their financial impact on the company, are summarized in the writing and graphic below.

1. Governance: Disclose the organization's governance around climate-related risks and opportunities.
2. Strategy: Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material.
3. Risk Management: Disclose how the organization identifies, assesses, and manages climate-related risks.
4. Metrics and Targets: Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.

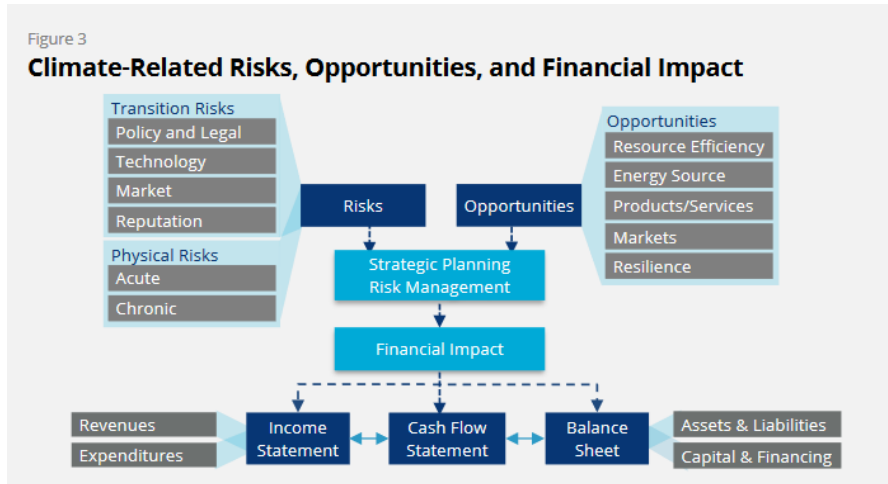


Figure 11: Climate-Related Risks, Opportunities, and Financial Impact. Source: (TCFD 2017)

The TCFD has now been active for roughly five years, and a few consistent gaps and deficiencies have emerged in the climate and sustainability practitioner community.

First, the reach of the TCFD platform is not yet widespread enough, despite strong support from financial industry sectors. As of February 2020, 1,027 organizations have signed on to support the TCFD, representing a market capitalization of over \$12 trillion (TCFD (C), 2020). But this support is not industry-agnostic and relatively few companies disclose the organizational and financial impacts of climate change to date (OECD, 2015). The Climate Disclosure Standards Board has found that only 38% of companies in the EU even mention TCFD in their filings (CDSB, 2019). Though support for the TCFD is often vocal, it does not yet represent a transformative market shift.

Second, though uniform disclosure practices have evoked a remarkable industry response, thorough information on the resilience of companies' strategies is very limited (CDSB, 2018). Disclosure remains most often found in sustainability or corporate social responsibility reports and hasn't yet fully integrated with financial filings. The 2018 Status Report also included a review of nearly 1800 companies across eight organization types (four financial groups: banks, insurance companies, asset managers, and asset owners; four non-financial groups: energy, transportation, materials and buildings, and agriculture, food, and forest products) (Bloomberg Philanthropies, 2018). The majority of these companies had already disclosed some pieces of information aligned with TCFD recommendations, but this review process also demonstrated that further work was needed for disclosures to envelop more decision-useful climate information (Bloomberg Philanthropies, 2018).

Though TCFD recommendations are applicable across sectors, they have a particular focus on high impact industries (Deloitte, 2019). Enhancing disclosure frameworks and encouraging risk assessment and objective-setting are certainly a first step. But more crucial are the actual changes that companies undertake to reduce their emissions and mitigate major risks. These changes may require industry-specific resources and guidance. Though the TCFD framework does outline strategic first steps and guidance in disclosure, it does not provide a clear roadmap or



actionable items for organizations attempting to improve their management of climate risks and opportunities.

### 3.4. Core Components of Climate Risk Management

While a variety of frameworks and resources exist to help public entities assess and address climate change risks, parallel resources designed for corporations and the private sector are more scarce. Resources for public sector climate risk management can be found tailored to specific geographies, community types, and categories of infrastructure. The public sector can thus provide a model for various applications of climate risk management and climate adaptation frameworks. In a review of 1630 corporate climate adaptation strategies, significant gaps were found in companies' assessments of their climate change impacts and in their development of strategies for managing these impacts (Goldstein, Turner, Gladstone, 2019). There is also a clear differentiation to be noted between soft and hard adaptation approaches. Soft adaptation approaches include strategic planning processes, finance, knowledge management, human resources development, supply chain changes, and other measures that are substantial decisions yet are physically intangible responses to climate impacts (Goldstein, 2019). Hard adaptation approaches represent capital investments in infrastructure and technology (Goldstein, 2019).

Though no universally agreed-upon climate adaptation framework exists, we find six consistent themes and components of climate risk management strategies - Leadership & Governance, Corporate Strategy, Metrics & Targets, Risk & Opportunity Management Process, Reporting, and Resources - that can be applied in the private sector. Below, we provide an overview of each theme essential for a robust corporate climate risk management approach.

#### Leadership and Governance

Evaluating leadership & governance issues through the lens of climate risk management means assessing high-level, institutionalized decision-making at the Board and Management levels of a corporation. Specific areas of consideration include: Governance Structure, Decision-Making Capacity, Incentive & Communication Systems, Industry Leadership and the planned time frame of action.

Governance structure and coordination at the Board & Management levels of a company can strongly influence an organization's ability to manage climate risk issues. Companies that have reported investor pressure on climate risk are more likely to have integrated the monitoring and management of climate risks in their governance processes (Deloitte, 2019). This is an indication that risk-aware boards and management can help promote climate-risk strategies.

Climate change is simply another issue that impacts financial risks and opportunities. While corporate boards are inherently required to address this issue like they would any other business risk or opportunity, climate change risks carry unique characteristics that may require additional training and strategic planning. Climate change is an emerging, complex issue for many boards, and includes grappling with scientific, macroeconomic and policy uncertainties across broad time scales and beyond board term limits (WEF (A), 2019). Generic board governance is not yet

detailed enough for effective board governance of climate issues (WEF (A), 2019). Corporate boards play a key role in long-term corporate performance and direction and help ensure that companies are aware of and able to navigate an ever-changing business landscape (CERES, 2018). Because boards have power to create internal policy, make influential personnel and human resources decisions, and drive company-wide strategic changes, they are integral to a comprehensive climate risk management strategy. Given a growing appreciation of the business impacts of climate risks, and increasing public scrutiny around corporate sustainability efforts, boards need to proactively evaluate how climate risk oversight is integrated into governance and oversight functions.

Directors and management level employees also need to play an active role in climate risk management. Whether impacts around climate risk are material, and directly or indirectly impact core business, directors need to include oversight of these issues as part of their fiduciary responsibility. By definition, fiduciary responsibility includes the expectation for individuals to adequately inform themselves on these types of issues prior to making a business decision (Frankel, 2015). Fulfilling fiduciary responsibility in today's era must now include climate risk literacy, in order for decision-makers to understand and assess arising risks and opportunities. This likely requires additional training for management and employees across departments.

Consequently, companies must also demonstrate decision-making capacity around climate risk issues. Once climate-risk has landed on the board and management levels of leadership, climate risk considerations and more generally, environmental costs, need to be embedded into decision-making across the company. The management of environmental issues can no longer be siloed within sustainability teams.

Expectations around company performance are often accompanied by professional or financial incentives. A board may want to consider adding climate-related targets and KPIs into executive incentives structures, to better influence employee behaviors. According to the Climate Standards Disclosure Board, while 8 out of 10 companies oversee climate change at the board level, only 1 in 10 companies reporting oversight on climate-related issues currently provides incentives for board members to manage those issues (CDSB, 2019). These are merely figures at the board level, but for effective and long-term results, incentive structures should be encouraged across management levels.

Like any other company-wide objective, communication channels may need to be adapted to reflect enhanced climate-risk strategies. Lastly, when addressing leadership & governance issues, industry leadership is an area that sets apart status quo from exceptional companies.

### Corporate Strategy

Following strong practices in leadership and governance, climate risk issues need to be embedded into corporate strategy processes and plans. This is a key area that distinguishes between levels of preparedness and maturity across different companies (Marsh & McLennan Companies, 2017). This step can help ensure that climate risk management is fully integrated into operational areas of the company and folded into strategic initiatives. This can also help insert

climate risk issues into short, medium and long-term business horizons, as opposed to an ad-hoc or one-off inclusion. When this strategic planning match is not made, climate risk issues may be siloed, not selected for additional resource allocation, and less prioritized in the organization at large.

This transition, moving climate issues as a mere financial cost or risk to be mitigated, to viewing climate issues as an organizational opportunity, is where the future of this work lies. This transition can be likened to the sustainable business transition underway, of firms moving from “enterprise integration” and a focus on low-hanging fruit and mitigation measures, to “market transformation”, in which business transforms the market itself and models fundamentally shift focus (Hoffman, 2018). Conventional corporate sustainability measures attempt to make existing business practices less wasteful, energy-intensive, and largely less unsustainable. This approach is largely insufficient for addressing the magnitude of concerns inherent in climate risk issues (Marsh & McLennan Companies, 2017). This added step, linking sustainability and climate issues to corporate strategy, is the key to finding aligned and ambitious organizational changes. Strategic planning processes assemble the most core and material business concerns, ranging from market changes to operations to stakeholder engagement (TCFD (A), 2017). These are some of the areas of business that climate risk management needs to permeate. Furthermore, companies that integrate climate risk issues into existing strategic planning processes and plans will be best positioned to reap competitive advantages (Marsh & McLennan Companies, 2017).

#### Metrics and Targets

In order to achieve any progress on climate risk management, an organization must have consistent, credible data across different metrics related to climate change risk. The TCFD definition of six Climate-Related Metrics and their associated risk types, shown below, are the best fit for the purposes of this analysis. Companies need to establish climate risk management objectives, and track progress with established metrics and KPIs. Lastly, it’s strongly advised that companies commit to using the Science Based Targets Initiative (SBTI) guidelines and use science-based targets to guide target-setting. There are a number of similar alternative frameworks to the SBTI, that may be better tailored to certain industries and sectors and should be considered in target-setting activities.

Table 1

**Categories of Climate-Related Metrics and Associated Risk Types**

Category	Subcategory	Risk Type	Description of Metric
<b>Greenhouse Gas (GHG) Emissions</b>	Emission Level	Transition	Total emissions (by type of GHG, by source, by Scope)
	Emission Intensity	Transition	Emissions per output scaling factor (e.g., revenues, sales, units produced)
	Embedded Emissions	Transition	Emissions per unit of fossil fuel reserves
<b>Energy/Fuel</b>	Energy Usage	Transition	Total energy consumption (megawatt hour [MWh] or gigajoules [GJ] per year)
	Energy Intensity	Transition	Total energy consumed per output scaling factor (e.g., revenues, sales, units produced, floor area)
	Energy Mix	Transition	Percent of energy by type of energy source (e.g., renewable, hydro, coal, oil, natural gas) (MWh or GJ)
<b>Water</b>	Water Usage	Physical	Total freshwater withdrawn (cubic meters)
	Water Intensity	Physical	Amount used per output scaling factor (e.g., revenues, sales, units produced) (cubic meters)
	Water Source	Physical	Amount withdrawn from areas of high baseline water stress (cubic meters) Amount treated and recycled (cubic meters)
<b>Land Use</b>	Land Cover	Physical	Percent of land by cover type (e.g., grassland, forest, cultivated, pasture, urban) Annual change in cover type
	Land Use Practices	Transition	Percent of land used for agriculture tillage, grazing practices, sustainability practices, or conservation practices
<b>Location</b>	Coastal Zone	Physical	Locations within a coastal zone
	Flood Zone	Physical	Locations within a designated flood zone
<b>Risk Adaptation &amp; Mitigation</b>	R&D	—	Amount invested in developing low-carbon products, services and/or technology
	CapEx	—	Amount invested in deployment of low-carbon technology, energy efficiencies, etc. Amount invested in resiliency capabilities

Figure 12: Categories of Climate-Related Metrics and Associated Risk Types. Source: (TCFD, 2017)

## Risk and Opportunity Management Process

Companies must initially focus on adopting a risk framework that can accurately capture the nuances of climate risk management. Two existing frameworks, Enterprise Risk Management (ERM), and Scenario Analysis, are helpful tools in this area and stage. The outputs and findings of these tools must then inform corporate strategy and business function decisions, in order to navigate risks and take advantage of opportunities.

ERM can provide a helpful existing framework for how an organization can build capacity and strategies around climate risk management. ERM is a business strategy that aims to identify, evaluate and prepare for risks, both physical and non-physical, that may impact an organization's core operations and objectives (Kenton, 2020). ERM builds on traditional risk measures by requiring a documented plan of action, available to all key company stakeholders (Kenton, 2020). ERM can be understood as a hybrid of traditional risk management approaches, but one that is aligned with influential risk governance structures (Lundqvist, 2015). This is where climate risk management and enterprise risk management align. Environmental risks now dominate business risk concerns, accounting for three of the top five risks by likelihood and four by impact, in the World Economic Forum's annual Global Risks Perception Survey (WEF, 2020). This indicates that environmental risks are overtaking economic and geopolitical risks. However, companies today rarely address conventional risks and environmental or climate risks equally. Resilient business strategies for the future must incorporate both an ERM approach, as well as sustainability risks of material importance to the company, such as climate change impacts, natural resources availability, and social volatility (Abbot, 2018). The World Business Council for Sustainable Development has found that less than one in three issues identified in sustainability materiality assessments are disclosed as risk factors in legal filings for investors (WBCSD, 2017). Incorporating sustainability into ERM can strengthen a company's understanding of its full suite of risks, improve its sustainability management and enhance overall business performance.

Likewise, incorporating an ERM lens into materiality assessments can help to translate results into language relevant to the business (Bolton, Despres, Pereira da Silva, Samama, Svartzman, 2020).

Scenario Analysis planning is a generalized method for developing adaptable strategic plans for a range of future scenarios (TCFD (A), 2020). Because predictions and planning are essential for both general strategy management and climate-risk management, this approach can be highly useful in a company's climate risk management process. Given uncertainty around climate change impacts, and the differing probabilities and magnitudes of risk issues, scenario analysis is a particularly useful tool in this application and complementary to financial analysis toolkits (Raynaud, Rottmer, 2020). TCFD provides extensive guidance on scenario analysis, a snapshot of which is displayed in Exhibit 2 in the Appendix.

Aside from ERM and scenario analysis, other tools to manage risks and opportunities include vulnerability assessments, materiality assessments, SWOT analysis, supply chain evaluation, and asset screening. While no single scenario plan can provide comprehensive information to decision-makers, inclusion of certain parameters can improve a scenario with regards to climate risk issues. These may include how technologies, policies, behaviors, macroeconomics and climate patterns will interact in the future; the corresponding metrics that can be used to follow these factors; and linking climate risks with appropriate mitigation actions (Bolton, 2020).

### Reporting

As discussed in the "Disclosure Drivers section", there is a rapidly increasing pressure from regulators' and investors' to establish strong disclosure and reporting practices. Reporting issues concern how leadership interacts with climate risk management performance, with a focus on the external disclosure of climate risks. Companies should use standardized frameworks to report on climate-risk issues, ideally the TCFD framework. In line with company metrics and targets, companies should also follow the TCFD categories of six climate-related metrics (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation & Mitigation). Consistency in reporting procedures is also essential. Climate risks and opportunities should be updated and reported each fiscal year.

### Resources

Resource alignment is a key structural area for ensuring climate risk management. In this context, resources can be understood as financial, human and network. Like any other strategic organizational change within a company, resource demands may shift with increased attention on climate risks. When working on climate risk management, human resources, data access, knowledge management and capacity building rank among the top resource changes. There may also be adjustments needed with technological advancements and modeling tools. Sufficient financial budget allocation to climate risk management and initiatives is paramount, and limited financial resources can delay and stifle progress. Corresponding team structures and human capital play an important role in implementing and institutionalizing climate risk management into operations. Certain resources are necessary inputs for decision-making, such as data access

and technology. Lastly, network resources are key for a company to be able to tap into lessons learned and best practices for climate risk management.

### 3.5. Climate Risk Management Challenges

Companies face many challenges when it comes to implementing climate risk management. Translating climate science into actionable strategies and accounting for the large-scale and long-term nature of climate change are part of this problem. Additionally, decision-makers face cognitive impediments, governance and change management barriers, and a dearth of public information for best practices in corporate climate risk management. The TCFD summarizes this challenge succinctly:

*“While climate change affects nearly all economic sectors, the level of exposure and the impact of climate-related risks differ by sector, industry, geography, and organization. Furthermore, the financial impacts of climate-related issues on organizations are not always clear or direct, and, for many organizations, identifying the issues, assessing potential impacts, and ensuring the material issues are reflected in financial filings may be challenging. Key reasons for this are likely because of (1) limited knowledge of climate-related issues within organizations, which may inhibit the identification of such risks; (2) the tendency to focus mainly on near-term risks without paying adequate attention to risks that may arise in the longer term; and (3) the difficulty in quantifying climate-related risks.” (TCFD, 2017).*

Below, we summarize key challenges consistently addressed in climate risk management literature.

#### Management Challenges

Climate risk management requires accurate, consistent, and high-quality data. Data is crucial for planning different scenarios, understanding ranges of threats, and strategizing different management approaches. Successful translation of climate data and information into action commonly raises three elements - salience, credibility and legitimacy (Bates, 2014). Without appropriate training, it’s difficult for decision-makers to translate climate science into usable information.

Compounding this issue is the fact that the production of climate science is fragmented, particularly in the United States, leaving decision-makers with uncertainty about what data to use or trust. With different government agencies and universities producing climate science, it is time consuming for decision-makers to locate the information they need. When information is found, it is not clear if this is the “industry standard” scientific data that should be used. As articulated by Judge Alice Hill of the Council of Foreign Relations, uncertainty around what climate science information to use can have significant ramifications in climate adaptation and mitigation. For example, the communities that make up the San Francisco Bay have not been able to agree on what level of sea level rise to plan for, with some organizations planning for two feet of sea level rise whereas others are planning for nine feet. Unfortunately, these discrepancies

could hinder the effectiveness of resilience measures if organizations move forward with strategies that are not aligned. This illustrates the fact that despite the existence of good climate science, it is difficult for leaders to make decisions when it comes to climate risk (Parsons, 2019).

Another challenge related to this issue, of data quality and access, is that companies must have internal inventories of accurate, consistent and high-quality data, across climate-related metrics, but especially with regards to greenhouse gas inventory information. Before a company can consider disclosure of climate-related financial impacts, they need to deeply understand and analyze their own emissions and other environmental impacts (WRI, 2008). This may include a more focused analysis of carbon intensity and risks embedded within the supply chain. While relatively few organizations have developed this area, it's a key area of business exposure to analyze (CDP, 2017).

Decision-makers must also consider the locality of climate risk impacts. Different geographies will experience different impacts from climate hazards. Therefore, the level of detailed information needed to make informed decisions is immense.

There are many solution providers offering apparently 'simple' solutions. But these involve models built on layers of assumptions which produce climate change risk results that are not credible to the front line. This creates a tension between "compliance" and good risk management. There are also significant business process integration challenges of fitting "climate change risk" into existing risk taxonomies and models" (Zurich, 2019).

There may also be cognitive impediments to climate risk, namely loss aversion and an availability bias. Loss aversion, in the context of climate risk, means that humans value losses more highly than equivalent gains. An availability bias means that humans are likely to judge risk based on what has previously been experienced. As climate change impacts accelerate, historical risk is not an accurate portrayal of future risks (Parsons, 2019).

Creating tailored, actionable responses to climate risk is difficult because of a combination of the factors discussed above, and because of the large-scale and long-term nature of the problem. Economic decision-making around issues this complex and long-term do not feel relevant for corporate actors (TCFD (A), 2017).

Lastly, governance remains one of the more deep-rooted issues that a company may face, and few companies have a governance and steering mechanism in place to develop and implement comprehensive climate strategies. In a recent Deloitte survey of 1168 CFOs in European companies, results revealed a mixed picture in terms of corporate climate action and performance. A commonly expressed problem lies in governance structures and pressure to act. Few adopt a more systematic approach and properly assess climate-related risks or include them in their governance and management structure (Deloitte, 2019). Companies which report that they feel the pressure coming from investors are more likely to have included the management and monitoring of climate risks in their governance processes. This demonstrates that risk-aware investors can help to promote climate-related transformation in companies.

## Disclosure Challenges

Challenges also exist on the disclosure side. A challenge with integrating disclosure systems and public data inventories is that companies may hesitate to be publicly benchmarked. This is because the ramifications of failing to reach objectives or falling behind in ESG ratings may present a risk itself. This is a decision point that has guided companies towards the TCFD recommendations, and away from CDP guidelines (Keenan, 2019).

As mentioned above in the disclosure section, the SEC has no standardized, mandatory framework for these types of filings. This has led to a lack of robust disclosure in the U.S., that SEC Commissioner Allison Herren Lee commented about in a recent public statement:

*“It is also clear that the broad, principles-based “materiality” standard has not produced sufficient disclosure to ensure that investors are getting the information they need—that is, disclosures that are consistent, reliable, and comparable....Indeed, investors and shareholders have undertaken an arguably unprecedented and massive campaign to obtain climate-related disclosure from issuers.”* (Herren Lee, 2020)

This means that most large, public companies disclose limited aspects of their sustainability performance. But these disclosures remain voluntary. Because of this, disclosure practices vary from company to company, making industry or sector comparison impossible. Without established metrics, this information is not particularly helpful for investors (SASB, 2016). There is also an administrative cost that comes with unclear disclosure principles, and questions around the reliability of materials disclosed due to a lack of third-party verification (Herren Lee, 2020).

## 4. Analysis

### 4.1. Defining an Ecosystem Model of Climate Risk Management Services

*“The creation of a consortia of partners is essential to enhance the existing in-house resources and to foster innovation: by pooling together competences and expertise, agents can fill their gaps and engage in a mutual learning process. This holds for both research-dominated components (such as modelling and framework creations), as well as for business-related aspects (e.g. marketing and budgeting). Boosting these forms of exchange is key to design, create and spread climate innovation. Interestingly enough, the Value Network plays a significant role for both projects and private firms.”* (Larosa & Mysiak, 2020)

#### Overview of an Ecosystem Strategic Approach

The term “ecosystem” has seen several uses and definitions (Hwang, 2014). As it relates to business strategy, the term ecosystem was developed in the 1990s by James F. Moore, who first originated the strategic planning concept of a business ecosystem in his book entitled *The Death*



*of Competition: Leadership and Strategy in the Age of Business Ecosystems (Moore, 1996)*. Here, Moore details and describes his rationale behind the concept and how he correlates business ecosystems with successful businesses due to their ability to rapidly and efficiently evolve:

*“Successful businesses are those that evolve rapidly and effectively. Yet innovative businesses cannot evolve in a vacuum. They must attract resources of all sorts, drawing in capital, partners, suppliers, and customers to create cooperative networks.... I suggest that a company be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries. In a business ecosystem, companies co-evolve capabilities around a new innovation: They work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations.” (Moore, 1993)*

Moore’s strategic ideas for an ecosystem approach were initially widely adopted across the high-tech community as a response to the need for platform sharing amongst industry players (Business Ecosystem Model, 2020). In more recent years, however, many corporations and/or strategists in industry areas outside of high-tech have begun increasingly using the word ecosystem to describe a particular business environment, separate from formal strategic alliances, in which their organization has the ability to widen their product and services offerings to clients. This is achieved by aligning themselves with other organizations to expand opportunities for collaboration and create greater value-generation across both players through their expanded offerings of products and services.

In a 2018 report by Accenture entitled “Cornerstone of Future Growth: Ecosystems”, the idea of a business ecosystem is defined as “the network of cross-industry players who work together to define, build and execute market-creating customer and consumer solutions.” The report goes on to highlight that an ecosystem is “defined by the depth and breadth of potential collaboration among a set of players: each can deliver a piece of the consumer solution, or contribute a necessary capability”(Lyman, Ref, & Wright, 2018). The report summarizes a series of corporate surveys across various industries in which the survey developers attempt to obtain insights into how and to what degree organizations are capturing ecosystem opportunities. For example, when asked, 46% of executives surveyed responded that they were actively seeking ecosystems as a new business model. Nearly half responded they either had already built or were pursuing building an ecosystem in response to industry disruptions. Furthermore, 76% of business leaders surveyed agreed that current business models will be unrecognizable in the next 5 years, stating that ecosystems will be the main change agent.

It is clear that ecosystems have grown both in popularity and pursuit in recent years, primarily due to the increasing need to address complex and difficult problems such as climate change and other major industry disruptions. In an article by the UNDP, climate change is described as being a “wicked problem needing a wicked solution” (Kurukulasuriya, 2018). The authors go on to state that “The data we have just isn’t as good as it should be – especially in the developing world. And siloed approaches, turf wars, reliance on outdated technologies and practices, and a status-quo approach are hindering efforts to modernize climate services. Taken further, many smaller

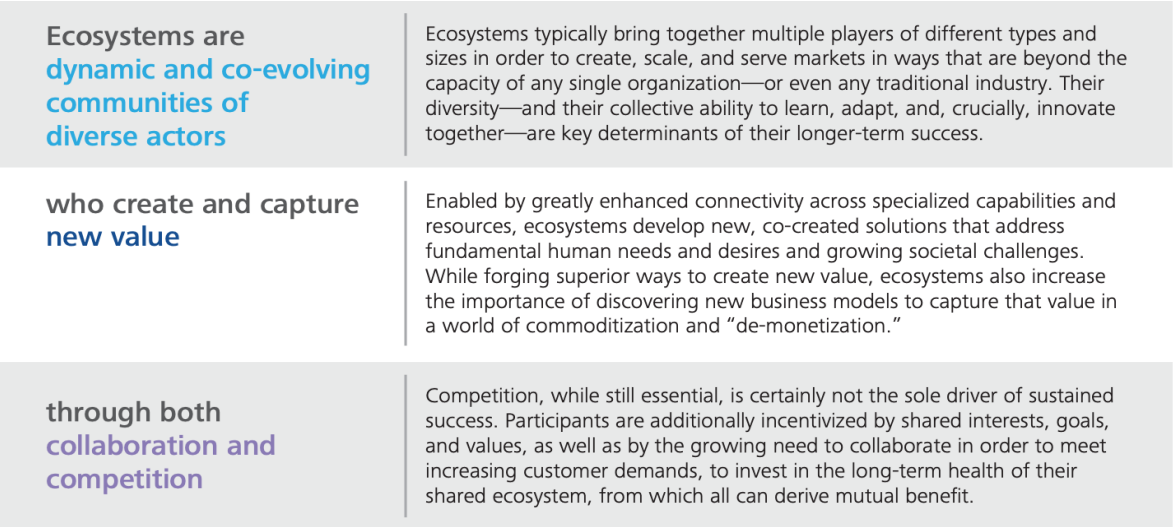
enterprises along the “long tail” that connects people with industry, lack the tools, know-how, and sometimes willingness to look at the data, and transform and evolve their business strategies to align with the unique challenges that climate change brings.” The UNDP’s overarching solution for this problem is for the various industries to establish an open source approach to climate data collection, analysis and distribution.

Climate change presents itself as a major potential disruptor to many industries, with a heightened risk to the insurance and reinsurance industry. As decision-makers and business leaders grapple with ways to identify potential climate change material impacts along with finding strategies to overcome the effects of these impacts, the prospect of creating and managing an ecosystem of partners to help face uncertainties and disruptions becomes more appealing. In a recent article by the World Economic Forum, the author states that “the need to act on climate change...is the greatest catalyst for innovation for those willing to harness it” (Topping, 2019). Business ecosystem innovation is one strategic way in which organizations can rethink their existing networks and overcome the uncertainties and risks associated with climate change.

For the insurance industry in particular, another set of disruptions has also begun to threaten the ways in which organizations do business with the introduction of insurtech companies. These new players, equipped with machine learning (ML) and artificial intelligence (AI) technology, are challenging the insurance industry status quo and changing how customers are acquired and how products and services are sold (Nonninger, 2019). Historically, insurance companies have been able to operate by utilizing legacy data and systems. Insurtechs have the opportunity to begin fresh with their data collection without the burden of sifting through historical data sets and past analysis to focus solely on opportunities in order to capture emerging value (Hould, 2020). This showcases an added need for standard insurance organizations to extend their capability to adapt and adopt new technologies to increase their competitive advantage.

More than simply an effort to collaborate across industries, ecosystems are also considered a completely new way of approaching business strategy and require a certain work culture by which corporations can adopt a new outlook or perspective on their overall business strategy. In his initial paper, Moore specifically highlights the necessity of ecosystem partners to co-evolve, work cooperatively, and also work competitively amongst each other in order to innovate together through shared knowledge and capabilities, which speaks to the need for both creativity and transformational thinking when embarking on attempts at planning an ecosystem strategic approach. By adopting this new mindset to value creation, organizations have the opportunity to not only widen their ability to meet client needs but also to address any gaps in product or service offerings they may have. This allows for more rapid adoption of new technologies or services within the organization than if an organization were to pursue a more traditional method of strategic alliance such as merger and acquisition (M&A) or joint venture (JV). These types of formal strategic alliances can have disadvantages such as being slow to actualize, creating difficulties in communication or culture, and they can often be even more difficult to exit than to initially create. On the flipside, business ecosystems with their ability to be flexible and dynamic

present a rapid method to grow and scale capability without requiring a firm commitment to a potentially stagnant and inflexible partnership.



Source: Deloitte analysis.

Graphic: Deloitte University Press | DUPress.com

Figure 13: Defining Business Ecosystems. Source: (Kelly, 2015)

Ecosystem partnerships have many benefits. In addition to providing a rapid method of obtaining new products or services, ecosystems have been shown to provide a new approach to how to tap into new profits and enhanced social value (Brock, Curasi, Hogg, & Guest Contributor, 2015). In order to unlock this value, however, organizations must first foster and adopt a collaboration culture to enable new approaches to products and services as well as new methods to allocate resources (Smith, 2006).

Ecosystem Landscape & Design

Ecosystem Planning & Design

When planning and designing an ecosystem of partner organizations, it is important to take a step-by-step approach to first identify the value chain in which the ecosystem partners will be operating and adding value. Second, the value chain players and the network that is already embedded among potential partners should be analyzed to identify the various climate risk management organizations and establish any pre-existing network connections. Third, a look into where and how the value chain players capture value should be conducted. Finally, an analysis should be performed on the capability gaps in which potential ecosystem partners can enter and create value (Wieringa, 2019).

Ecosystems typically span across a variety of players - consultants, startups, digital platforms, organizations, non-profits, researchers, knowledge hubs, and others (Semle, 2018). As climate risks have become more pronounced and taken into consideration by governments, companies,

and other organizations across the world, a burgeoning industry of climate risk data, intelligence, management, and advisory services has emerged.

#### Step 1: Analyzing the Climate Risk Value Chain

When speaking of the insurance value chain and its ability to serve customers, Tom van den Brulle, Global Head of Innovation at MunichRe, is quoted as recently saying

*“The insurance value chain seems to become increasingly fragmented. We don’t have one insurer that covers the entire value chain from the capital market to the customer front end. It’s rather, and this is also what we see in the insurtech space, a range of very different players that are contributing different concepts and processes of value to serve the customer. It would be exciting if a platform existed that brings all these different experts and excellence together.”* (Feniks, 2019)

To understand this burgeoning industry of climate risk service providers, our team embarked on an evaluation of the larger climate risk value chain. As stated previously, the climate risk value chain is made up of several distinct, yet in some cases overlapping, segments. It represents all of the players, whether government, non-governmental, or private sector, that provide information or services related to the field of climate risk intelligence and management. Some of the firms in the ecosystem are startups while some are more established or larger firms. According to research reported in *The Economist*, “most climate-service firms are small startups led by scientists” that feed public climate data into economic models, resulting in a dollar value on the risks that climate change poses to physical assets and businesses (*The Economist*, 2019).

In the past few years there has been a surge of activity in the climate risk value chain, from the emergence of new players, the formation of partnerships, and in some cases, acquisitions. For example, after acquiring an initial 40 percent stake in Sustainalytics in 2017, Morningstar fully acquired the company in 2020 due to increased demand from investors for ESG data, research, ratings, and solutions (Morningstar, 2020). In July 2019, Moody’s, a financial services company that is known for its credit rating agency, acquired a majority stake in Four Twenty Seven, a climate risk intelligence firm founded in 2012 (Four Twenty Seven, 2019). Four Twenty Seven’s Founder and CEO, Emilie Mazzacurati, stated, “Four Twenty Seven’s climate risk analytics, combined with Moody’s global coverage and extensive analytical capabilities, provides an ideal path to help market participants integrate climate impacts into risk management and investment decisions” (Four Twenty Seven, 2019). MSCI, a leading provider of critical decision support tools and services for the global investment community, acquired Carbon Delta, an environmental fintech and data analytics firm with expertise in scenario analysis for physical and transition risks, in 2019 (MSCI, 2019). According to MSCI (2019), the goal of the acquisition was to “create an extensive climate risk assessment and reporting offering for the institutional market, providing global investors with solutions to help them better understand the impact of climate change on their investment portfolios and company with mandatory and voluntary climate risk disclosure initiatives and requirements.” Also in 2019, The Climate Service, a climate analytics company that quantifies climate risk in financial terms, joined the Wells Fargo Startup Accelerator (Wells Fargo, 2019).

As the above-mentioned acquisition activity demonstrates, the climate risk value chain is rapidly evolving. Our team researched the full landscape of companies operating in the climate risk value chain to identify specific services being offered and which companies are already collaborating. In one of our sections above, “Corporate Climate Risk Management: Best Practices”, we identified areas of competencies based on research findings. Below, we match those areas of competencies with overarching categories our team developed to organize the different segments of the climate risk value chain:

- Data Provider
- Risk Insights
- Advisory
- Implementation Solutions
- Research/Thought Leadership
- Knowledge Hub
- Customer

#### *Climate Risk Value Chain Category Descriptions*

*Data Provider.* The beginning of the value chain consists of government meteorological or climate science agencies, such as NASA, NOAA, or the UK Met Office, that provide public climate data. This category also contains data collection technology companies such as drones, satellites, etc. These institutions have not engaged deeply in asset-level measurement and modeling as a service, and therefore other climate data providers have emerged within the climate risk value chain (Keenan, 2019).

*Risk Insights.* This category includes various data analysis organizations, climate analytics, spatial finance, climate AI, and modeling/forecasting firms. These companies generally take information from data providers to analyze or interpret and generate risk insights for their users, thereby allowing customers to better predict and manage climate risks. Such companies may use public climate data as a foundation but have developed further capability to assist companies in the more detailed analysis needed to comprehensively understand how climate risks will impact their business.

*Advisory.* Consulting, climate vulnerability advisory, financial advisory, TCFD advisory, and legal services make up this particular climate risk value chain category. These organizations focus on obtaining data and risk insights in order to propose potential solutions tailored to their clients’ individual needs.

*Implementation Solutions.* This part of the value chain consists of climate risk implementation solutions such as risk engineering companies, supply chain optimization, and other technological solutions such as geoengineering.

*Research/Thought Leadership.* Many organizations are actively researching and providing thought leadership on the subject of climate risks and its management and can provide the most

up-to-date information to other value chain participants. For this reason, we have included this category in our own research.

*Knowledge Hub.* This category consists of a climate change risk community of practice, or a group of people who interact regularly to share knowledge on a particular subject.

*Customer.* At the end of the value chain, all current and potential future corporate clients of the key organization in question are referenced within this category.

#### *Identifying Climate Risk Value Chain Landscape*

During our extensive research of the various industry players falling within this value chain, we identified over 100 organizations operating in differing roles across the climate risk landscape. See a sampling of organizations in the climate risk value chain featured in Exhibit 3 in the Appendix.

#### *Step 2: Evaluating Existing Value Chain Network Connections*

In this step of the climate risk value chain analysis, our team attempted to discover and evaluate any pre-existing value chain network connections among the organizations we identified, but this step proved to be challenging. It was found that the climate risk industry is extremely fragmented, and many organizations are reliant on word of mouth, direct referrals, or through organic search. It is known that an existing web of value chain players likely exists, however, bringing these types of network connections to light through our research was beyond our ability to establish or decipher given the scope of the project and timeline. That said, some organizational network connections were uncovered by conducting an individual analysis of organizations' websites or through published case studies. These network connections were noted in our final climate risk value chain organization list given to Zurich Insurance.

#### *Step 3: Discovering Where & How Value Chain Players Capture Value*

For this stage of our analysis, we sought to discover the various ways in which climate risk value chain organizations at present are capturing value or profit. The increased need for climate risk disclosure, mitigation, and adaptation to climate change has left many companies scrambling to find resources to aid them in reducing risks. Mid to large companies seeking climate risk products or services often turn to large consulting firms first to assist them with devising strategies and solutions (or create their own internal teams to combat climate risk management), however, smaller companies are often left with few resources to assist. Many value chain players have monetized in this space by providing products or services that are highly tailored and customized to the clients' needs and through niche technological advancements or innovations. Because of the fragmented nature of the industry (low barriers to entry), it is currently ripe for new value chain players to enter, so our team expects to continue to see growth in this space as new startups emerge and technological advancements occur. Companies need clear climate data and risk insights to help inform decisions as well as tailored advice and implementation solutions. The complexity of climate change has produced a plethora of arenas in which value chain players can inject products and services to assist both the private and public sectors.

#### Step 4: Investigating Where & How Ecosystem Partners Can Create Value

This is where a tailored capability maturity model can enter the process. A capability maturity model is a framework or structure that can help assess and grade a company's ability to effectively manage climate risk issues (California Natural Resources Agency, 2018). For the purposes of this project, a capability maturity model must combine elements of a traditional capability model, enterprise risk management, sustainability performance, and climate adaptation tactics. Within this management context, capability maturity models typically involve five maturity levels and five key characteristics, summarized below (Kaner, Karni, 2005).

- **Maturity Levels:** Differing stages or levels that demonstrate a process or continuum of capability in a subject and skill area. Continuous process improvement is the mechanism through which entities progress up levels.
- **Key Components:** A set of related but discrete functions or skills that together, comprise the range of expertise to excel within a subject and skill area.
- **Goals:** Each maturity level corresponds to a certain goal or achievement within the subject and skill area. How well respective goals have been accomplished indicates the maturity of the organization in this area.
- **Common Features:** There are practices that support the implementation and institutionalization of these goals. The five types of common features: commitment to perform, ability to perform, activities performed, measurement and analysis, and verifying implementation.
- **Key Practices:** These describe the key organizational elements of practice to remain capable or mature in this area.

The original Capability Maturity Model is rooted in software management, but it's overarching framework has relevant applications in general management and emerging areas of business and decision-making expertise. This model, and others that have built on it, can provide a process-oriented framework for how an organization can improve its performance, grow expertise, and build capability within a certain area.

For the purposes of this project, a few key source areas first built the foundations of our Climate Risk Capability Maturity Model. These include enterprise risk management, sustainability capability processes, climate adaptation tactics, and the core TCFD recommendations. Following an extensive literature review across these areas, and frequent consultation with Zurich Insurance, common themes in climate risk management began emerging. These themes became the 6 pillars of the Climate Risk Capability Maturity Model and are summarized in Section 3.4: Core Components of Climate Risk Management. They are as follows: Leadership & Governance, Corporate Strategy, Opportunity & Risk Management, Metrics & Targets, Reporting, and Resources.

Under each of these pillars, there are between 3-11 specific criteria items, tailored to describe one aspect of a capability within that area. These criteria have key performance indicators (KPIs) associated with them. These 6 pillars were then extended across 5 different maturity levels. Level 1, the lowest level, characterizes an organization that is not prepared to properly manage climate

risks. Level 5, the highest level, characterizes an organization that is highly prepared, capable, and adaptable when managing climate risks. For an organization to progress through the 5 levels and various criteria, they need to meet KPI thresholds within each pillar. This is where the leadership model begins its role. An organization attempting to improve and grow their capability on climate risk management issues will first be assessed and placed at a particular status. To progress through the Climate Risk Capability Maturity Model, they must follow and use the provided KPIs to track their performance. Organizations demonstrating leadership will have shown dedication to this area, in the form of additional resources, improved disclosure practices, and formalized climate risk management processes, for example. Refer to Exhibit 4 in the Appendix for the main components of our Climate Risk Capability Maturity Model.

### Ecosystem Risks & Challenges

Ecosystem approaches pose some risks and challenges to their participants which may include:

*Data Sharing.* One drawback or risk associated with setting up a business ecosystem is the potential for exposure or risks associated with data sharing among ecosystem partners.

*Time Required to Evaluate Partnerships.* Another challenge in pursuing the ecosystem approach is the amount of time spent determining the quality of a product or service offered by an ecosystem partner which may be lengthy.

*Disputes.* A lack of a formal partnership could lead to disputes or legal issues without clear negotiated terms.

*Lack of regulation.* It could prove difficult to determine how an ecosystem should be regulated and by whom.

*Reputational Risks.* A company that engages in an ecosystem and offers these types of services could risk tarnishing its existing reputation.

## 5. Recommendations

Specific recommendations were made to the client, within the final presentation and deliverables. These are removed within this version, for discretion of the client.

## 6. Conclusion

After analyzing the maturity model, ecosystem strategy and climate risk value chain, our team provided a set of recommendations for Zurich Insurance to consider. While these recommendations were tailored to the client's specific perspective, there are many transferable lessons for the private sector at large. The urgency of climate change and the range of physical and transition risks that companies now face both emphasize the need for strong corporate climate risk management practices. Our research on climate risk management best practices and the accompanying maturity model lay the foundation for companies, service providers, and other interested stakeholders to understand what good climate risk management looks like. The value chain highlights prominent players in this evolving industry and what services they're uniquely providing in the area of climate risk. Finally, we explored the idea of business ecosystems as a



way for service providers, such as insurance companies, to enter/engage with the climate risk value chain and innovate ways to ensure their clients' climate risk needs can be addressed.

We hope this research fills some of the gap that exists on resources related to corporate climate risk management. Much work remains to be completed, including the development of sector-specific climate risk management guidelines, given the fact that climate change risks impact sectors and geographies differently.

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## Appendix

**Exhibit 1: Zurich Insurance Interviewee List**

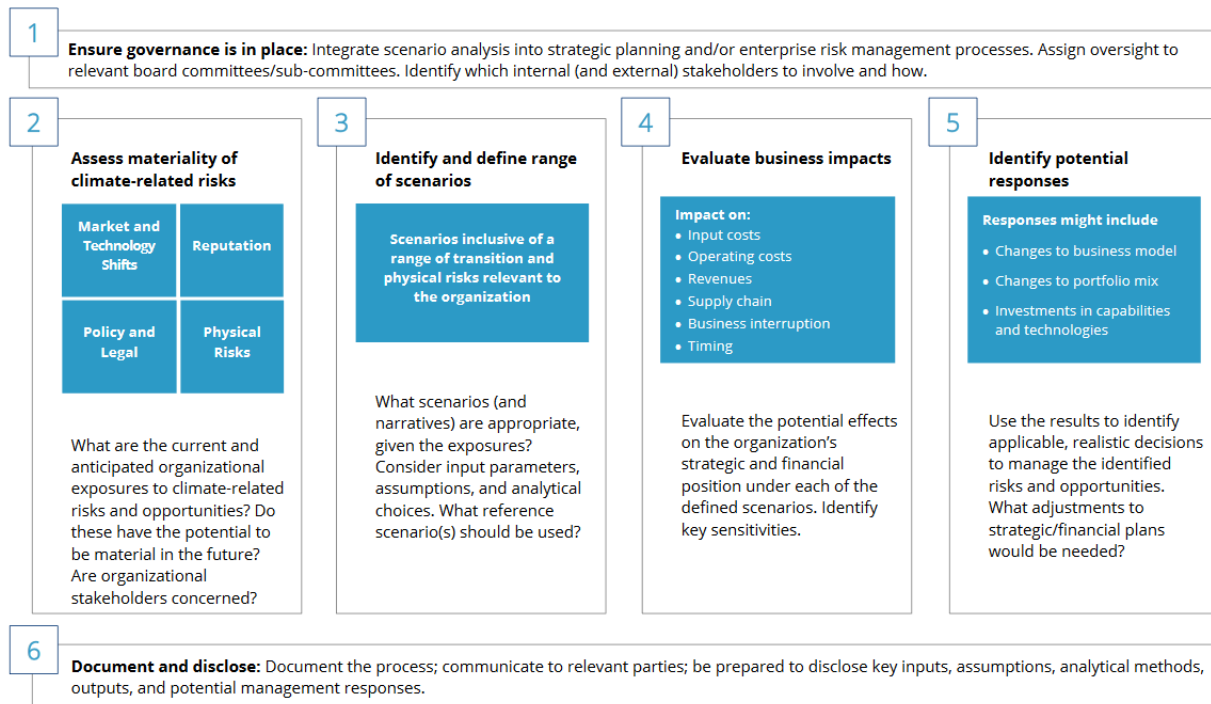
<b>Name</b>	<b>Title</b>	<b>Group</b>
Annemarie Buettner	Cat Modeler	
Benjamin Harper	Technical Underwriting - Environmental	Zurich North America
Dr. John Scott	Head of Sustainability Risk	Group Risk Management
Dr. Mathias Graf	Head of Cat Research and Development	
Eugenie Molyneux	Chief Risk Officer	Commercial Insurance
Gregory Renand	Head of Strategic Partnerships and Integrated Campaigns	
Iwan Stadler	Head of Accumulation Management	Group Underwriting Excellence
Jean-Pierre Krause	Global Head of Risk Engineering	
Johanna Koeb	Head of Responsible Investment	
Juergen Stanofsky	Group Strategist	
Justin D'Atri	Sustainability Change Manager	Group Comms. & Public Affairs
Manuel Lewin	Head of Risk Strategy and Reporting	Group Risk Management
Michael Schoni	Head of Flood Resilience	
Nariman Maddah	Risk Engineer	
Olaf Margeirsson	Real Estate Strategy Manager	
Robert Wyse	Senior Risk Manager	ERM, Group Risk Management
Roberta Limone	New Ventures	
Ron Davis	Key Account Global Relationship Lead	
Sarah Peterson	ZUK Risk Advisory Consultant	
Tomas Arronsson	Data Scientist in Policy360	
Wen Lin	Strategic Assistant to CRO	

Source: Paper Authors

## Exhibit 2: TCFD guidance on scenario analysis

Figure 2

### A Process for Applying Scenario Analysis to Climate-Related Risks and Opportunities



Source: TCFD, June 2017, p. 7



### Exhibit 3: Sampling of Organizations in the Climate Risk Value Chain

Name	Value Chain Category	Type of Risk Analyzed	Service Offerings
<b>Data Providers</b>			
Actuaries Climate Index	Data Provider	Physical	Meteorological data downloads
Azavea	Data Provider	Physical	Open-source machine learning aerial imagery data, Climate API with 22 indicators.
Ecometrica	Data Provider	Physical	Sustainability reporting software
Munich Re	Data Provider	Physical	NatCatService online database for natural catastrophes
NASA	Data Provider	Physical	Climate modeling tools, U.S. and global climate datasets
National Center for Atmospheric Research	Data Provider	Physical	Atmospheric models and data services
Risk Management Solutions	Data Provider	Physical	Catastrophe risk modeling
UK Met Office	Data Provider	Physical	Weather and climate datasets and API
World Resources Institute	Data Provider	Physical	Datasets, including Aqueduct Global Flood Risk maps
Cervest	Data Provider	Physical	Earth science AI, Interactive tools, visualisations, maps to make investment and asset decisions.
<b>Risk Insights</b>			
Carbon Delta MSCI	Risk Insights	Physical, Transition	Climate-Value-at-Risk, scenario analysis for risks and opportunities, etc
Fathom: Flood Risk Intelligence	Risk Insights	Physical	Flood risk quantification and mitigation tools
Four Twenty Seven	Risk Insights	Physical, Transition	Climate risk scores across 7 hazards; corporate risk

			assessments, site-specific risk assessments, scenario analysis, etc
Jupiter Intelligence	Risk Insights	Physical	Climate risk scores across 7 hazards, asset-level predictions
Nephila Climate	Risk Insights	Physical, Transition	Risk transfer products
Oasis	Risk Insights	Physical	Open-source catastrophe modeling
Rhodium Group	Risk Insights	Physical, Transition	Physical risk assessments, risk quantification, economic modeling, Climate Impact Lab
The Climate Service	Risk Insights	Physical, Transition	Climate risk analytics and quantification in financial terms
The CO-Firm	Risk Insights	Transition	Scenario-based assessment tool of transition risks
Vivid Economics	Risk Insights	Physical, Transition	Net Zero Toolkit analysis impact of transition risk on financial assets, etc
<b>Advisory</b>			
Acclimatise	Advisory	Physical, Transition	Climate risk and vulnerability assessments, disclosure advisory; risk analytics
Ceres	Advisory	Physical, Transition	Disclosure guidance, mitigating risk in investment portfolios
Deloitte	Advisory	Physical, Transition	Climate risk assessments, scenario analysis, mitigation actions, disclosure guidance
EY	Advisory	Physical, Transition	Supply chain advisory, climate risk and vulnerability assessments, adaptation strategies
Marsh & McLennan	Advisory	Physical, Transition	Risk management solutions, risk engineering
McKinsey	Advisory	Physical, Transition	Climate risk integration into decision making, materiality assessments of climate risks, scenario analysis, adaptation and mitigation strategies, portfolio

			restructuring
Polecat	Advisory	Transition	Corporate reputation management tool
Right.based on science	Advisory	Transition	Analysis on specific company's or portfolio's contribution to climate change
The 2 degree investing initiative	Advisory	Transition	Free PACTA climate scenario analysis tool
Trucost	Advisory	Physical, Transition	Physical climate risk dataset, Green Transition Tool, Corporate Carbon Pricing Tool, Water Risk Monetizer
<b>Implementation Solutions</b>			
3Degrees	Implementation Solutions	Transition	Carbon reduction programs
Black & Veach	Implementation Solutions	Physical	Plan, design, build sustainable projects for drainage, flood & coastal defense, etc
Cadmus	Implementation Solutions	Physical, Transition	Mitigation and adaptation planning, climate risk and vulnerability assessments
Carbon Intelligence	Implementation Solutions	Transition	Energy and emissions data management
Dewberry	Implementation Solutions	Physical	Adaptation planning, coastal analysis, extreme weather event analysis, hazard mitigation planning, risk and vulnerability assessment, etc
Paragon Risk Engineering	Implementation Solutions	Physical	Natural catastrophe analysis
Ramboll	Implementation Solutions	Physical, Transition	Carbon accounting and verification, energy management for GHG reduction, climate resilience planning
re:focus	Implementation Solutions	Physical, Transition	Resilient infrastructure solutions

<b>Research/Thought Leadership</b>			
Bank of England	Research/ Thought Leadership	Physical, Transition	Stress testing
First Street Foundation	Research/ Thought Leadership	Physical	U.S. flood risk
Notre Dame Global Adaptation Initiative	Research/ Thought Leadership	Physical	Annual country index, Urban Adaptation Assessment
Principles for Responsible Investment	Research/ Thought Leadership	Physical, Transition	Disclosure guidance, investment strategies for climate risks and opportunities
Transition Pathway Initiative	Research/ Thought Leadership	Transition	TPI Tool assesses companies' preparedness for transition to low- carbon economy
Wharton Risk Management Center	Research/ Thought Leadership	Physical, Transition	Risk-related research and policy analysis on disaster risk management, climate risk and resilience, risk communication and decision-making, behavioral science and technology, political risk
Woods Hole Research Centre	Research/ Thought Leadership	Physical, Transition	Research on physical, economic, societal risks associated with climate change, develop climate risk assessments
World Economic Forum	Research/ Thought Leadership	Physical, Transition	Annual global risks report
<b>Knowledge Hub</b>			
ClIMA Climate Modeling Alliance	Knowledge Hub	Physical	Climate modeling
ClimateAI	Knowledge Hub	Physical	Climate AI for agriculture
ClimateWise	Knowledge Hub	Physical	Aimed at insurance companies to understand climate-risk protection gap

Climate Risk Financial Forum	Knowledge Hub	Physical, Transition	Best practices for managing financial risks from climate change
Climate Risk Institute	Knowledge Hub	Physical	Climate change impacts and adaptation decision and planning support
Clyde&Co Resilience Hub	Knowledge Hub	Physical, Transition	Resilience awareness, guidance on risk management and regulatory issues
Global Resilience Partnership	Knowledge Hub	Physical, Transition	Research on policies, practices, innovations needed to build resilience
Global Sustainability and Climate Risk Resource Center	Knowledge Hub	Physical, Transition	Climate change concepts aimed at financial stakeholders and risk managers

Source: Authors' research

## Exhibit 4: Key Components of Climate Risk Capability Maturity Model

### 6 pillars: Definitions and Sub-categories

<b>Leadership &amp; Governance: Concerns high-level, institutionalized decision-making at the Board and Management level</b>	<b>Corporate Strategy: Concerns how climate risk management is embedded into organizational strategy</b>	<b>Metrics &amp; Targets: Concerns how climate risk management is measured, tracked and utilized</b>
Governance Structure	Strategic Planning	Climate Risk Management Metrics & Targets
Climate Risk Management Decision-Making Capacity	Commitments	TCFD Climate-related Metric Categories
Incentive Systems	Operational Integration	Science-Based Targets
Communication		
Mission/Vision/Values		
Industry Leadership		
Timeframe		

<b>Risk &amp; Opportunity Management: Concerns the process by which climate risk management is conducted, and the components included</b>	<b>Reporting: Concerns how leadership interacts with climate risk management performance, with a focus on the external disclosure of climate risks</b>	<b>Resources: Concerns human, financial and network resources that advance climate risk management</b>
Risk Framework	Standardized Frameworks	Financial Resources
Inclusion of Physical and Transition Risks	Oversight	Human Resources
Financial Impact Analysis	Reporting Consistency	Network Resources
Timeframe		Data Access
Scenario Analysis		Technology
Adaptive Capacity		Knowledge Management & Capacity Building
Risk Response Strategy		

## Maturity Model Matrix

	Leadership & Governance:	Corporate Strategy	Metrics & Targets:	Risk & Opportunity Management:	Reporting:	Resources:
<b>Maturity Level I: Not aware of climate change</b>	(Governance Structure) Climate risk management nor sustainability teams exist. No standard processes in place for managing sustainability or climate risk management issues at the leadership level. Climate risk management only enters leadership conversations in cases of compliance, inspection and regulation.	(Strategic Planning) Climate risk management initiatives are not embedded into any strategic planning processes. There is no discussion or direction on the topic.	(TCFD Climate-Related Metrics Categories) No data related to climate risk are collected or analyzed, including TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation & Mitigation).	(Risk Framework) No climate risk management processes or practices are available.	(Standardized Frameworks) Company does not publicly disclose climate risks and opportunities using TCFD framework or any other system.	(Financial Resources) Company does not allocate financial resources to manage climate risk management issues. Climate risk projects have never been funded.
	(Board) (Climate Risk Management Decision-Making Capacity) Board is not engaged in climate risk issues. Board has not received any training on sustainability and climate change issues and does not frame decision-making through these lenses. No processes in place for	(Commitments) Climate risk management is not considered a strategic priority at the department or company level. Climate risk issues have not been published into company-wide documents.	(Targets) Company has not established climate risk management objectives nor a set of metrics and KPIs for any of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water,	(Risk Framework) No formalized climate risk management approach exists and climate risk considerations are not linked to overarching risk management framework. Events or problems connected to climate change are not identified as such and are mischaracterized as one-off	(Oversight) No oversight mechanism exists regarding climate risk disclosure.	(Human Resources) Climate risk management teams, nor sustainability/CSR teams exist. Company does not yet have the appropriate team structures and internal expertise working on climate risk management issues.

	managing sustainability or climate risk management at the leadership level.		Land Use, Location, Risk Adaptation & Mitigation).	issues. There is an inconsistent management approach and actions are ad hoc or reaction-driven. There are no climate risk processes in place.		
	(Management) (Climate Risk Management Decision-Making Capacity) Management and employees are not engaged in climate risk issues. They have not been trained on how to consider climate risks and opportunities. Management only engages with climate risks on an ad hoc and reactionary basis. Any action on climate risk management depends on individual efforts, not on support from leadership/senior management. No standard processes in place for managing climate risk management at the management level.	(Operational Integration) There are no policies at the department or company level to ensure that external consulting agencies tasked with strategy projects include a climate risk management lens in their scope.	(Science Based Targets) Company does not use or is not aware of Science Based Targets Initiative guidelines to set greenhouse gas emissions reductions target.	(Risk Framework) There is little to no understanding of how climate change could impact the organization's businesses, strategy, and financial planning. There is no link between climate risks and the following areas: supply chain, operations, distribution, existing and new customers and markets, demand for goods/services, ability to do business, product offerings, and returns in investment portfolios.	(Reporting Consistency) Company does not disclose consistently.	(Knowledge Management) Employees do not have understanding of climate risks and opportunities. Company does not provide education and training to learn how to incorporate climate risk and opportunity lens into decision-making processes.



	<p>(Climate Risk Management Decision Making Capacity) KPIs for 0 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are used by leadership bodies to inform climate-related decision-making. No other sustainability or climate change-related KPIs are used either.</p>	<p>(Operational Integration) Climate risk strategy objectives and targets have not been identified.</p>		<p>(Risk Framework) Climate risk management is not integrated into operational areas of the company. Operational processes and business strategies are not linked to climate risk.</p>		<p>(Data Access &amp; Resources) Company has access to a range of data sources and data types that are appropriate for the industry. This may include data on supply chain, areas of operations, and historical company sustainability and risk data (e.g. CO2 emissions, management response to previous risks).</p>
	<p>(Management) (Incentive System) Management and employees across departments are not encouraged nor incentivized to consider climate risks and opportunities in decision-making. Employee incentives are not aligned with climate risk management and efforts to influence employee behaviors, education, and communication have not been established.</p>	<p>(Strategic Planning) Company's strategic plan does not include considerations for short-, medium-, or long-term climate risk implications.</p>		<p>(Risk Framework) Climate risk actions are reactionary and taken after an event and are not classified as being associated with climate change, and thus a potentially recurring problem.</p>		<p>(Technological Resources) Company has no access (either internally or through a partnership) to technical resources (AI capability, CAT modeling capability, etc) to address CRM. There are no technological tools to support sustainability not climate issues.</p>

	<p>(Communication) There are no formal communication processes or channels established by which management and employees are informed about climate-related issues. All communication on this topic is informal, ad-hoc, and reactionary. Communication through the governance structure does not contribute to the formation of a standardized climate risk management process.</p>			<p>(Inclusion of Physical and Transition Risks) Company is not aware of suite of potential climate risks and is not familiar with differentiation between physical and transition risks. Also not aware of potential opportunities associated with climate change.</p>		<p>(Network/Ecosystem) Company has no established industry network to tap into lessons learned and best practices for climate risk management. Company does not discuss sustainability nor climate issues in any external or network forums.</p>
	<p>(Mission/Vision/Values) Climate risk issues are not integrated into the mission, vision and values of the company.</p>			<p>(Financial Impact Analysis) Company is not able to calculate how material climate-related risks and opportunities impact its future financial position, as reflected in its income statement, cash flow statement, and balance sheet. The company does not understand how climate risks could impact its financial bottom line.</p>		

	(Industry Leadership) The company does not support the development of partner organizations' climate risk management plans, and does not have the capacity to take a leadership role on climate-related issues in the industry.			(Timeframe) Company responds to immediate climate risks but does not have a mechanism to assess and manage short-, medium-, or long-term climate risks.		
	(Timeframe) Decision-making on sustainability and climate change issues is reactionary and thus does not extend beyond the immediate short-term.			(Scenario Analysis) Company does not use scenario analysis techniques to consider broader range of assumptions, uncertainties, and potential future states to develop climate risk management strategy.		
				(Risk Response Strategy) Company does not understand different geographically localized impacts of climate change nor understand which locations are most vulnerable to climate change risks.		

				(Risk Response Strategy) Company does not conduct on-site assessments of the reliability and effectiveness of emergency response and business continuity plans, any peril-specific protection measures (e.g., mobile flood protection elements, etc.), and quality of structures, infrastructure and utilities.		
				(Adaptive Capacity) Company does not adaptively manage its risk strategy toward climate risks. No formal mechanism exists to update risk approach with new scientific findings or to expand approach beyond existing climate risks covered.		

<b>Maturity Level II: Aware of climate change but not the impact</b>	(Governance Structure) A climate risk management team does not exist nor are climate risk issues captured under a sustainability or risk team. No standard processes in place for managing climate risk management at the leadership level. Climate risk management only	(Strategic Planning) Climate risk management is not embedded into the company's strategic planning processes, nor into the strategic plan itself. Climate risk management initiatives are not embedded into short-, medium- or long-	(TCFD Climate-Related Metrics Categories) Some data related to climate risk are collected or analyzed. 1-2 of TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water,	(Risk Framework) No formalized climate risk management approach exists and climate risk considerations are not linked to overarching risk management framework. Climate risk problems are identified informally and no climate risk management processes are defined. There is an inconsistent	(Standardized Frameworks) Company discloses some sustainability metrics but not comprehensively on climate risks and opportunities due to lack of awareness of climate change impacts. Not aware of TCFD framework.	(Financial Resources) Company has not appropriately allocated financial resources to manage climate risk management issues. Financial resources are allocated in one-off situations, in an ad hoc manner. Financial allocation does not yet align with organizational
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	enters leadership conversations in cases of compliance, inspection and regulation.	term strategic planning processes.	Land Use, Location, Risk Adaptation & Mitigation) are measured and analyzed.	management approach. Actions are ad hoc or reaction-driven. Climate risk processes are unpredictable and poorly controlled.		climate risk objectives. This may include necessary capex for new technology or facilities and/or R&D.
	(Board) (Climate Risk Management Decision-Making Capacity) Board has received training on broad climate change issues but not on how climate risks and opportunities specifically impact the company. Board is intermittently updated on high-level climate change issues as they pertain to the short-term.	(Commitments) Specific departments within the company have discussed the impact of climate change on strategy goals but climate risk management is not defined as a strategic priority at the departmental or company level. Climate risk issues have not been published into company-wide documents.	(Targets) Company has established climate risk management objectives, and a set of metrics and KPIs to measure progress towards these objectives for 1-2 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation & Mitigation).	(Risk Framework) No climate risk management approach exists to understand climate change impact to the organization's businesses, strategy, and financial planning. No link between climate risks and the following areas: supply chain, operations, distribution, existing and new customers and markets, demand for goods/services, ability to do business, product offerings, and returns in investment portfolios.	(Oversight) No oversight mechanism exists regarding climate risk disclosure.	(Human Resources) Sustainability teams are in initial stages. Climate risk management teams do not exist. Company does not yet have the appropriate team structures and internal expertise working on climate risk management issues. Climate risk management remains under the responsibility of a few key individuals.
	(Management) (Climate Risk Management Decision-Making Capacity) Management and employees across departments are not trained on how to consider climate risks and opportunities. Management only	(Operational Integration) There are no policies at the department or company level to ensure that external consulting agencies tasked with strategy projects include a climate risk management lens in	(Science Based Targets) Company is aware of Science Based Targets Initiative but has not yet set greenhouse gas emissions reduction targets accordingly.	(Risk Framework) Climate risk management is not integrated into operational areas of the company. Operational processes and business strategies are not linked to climate risk.	(Reporting Consistency) Company does not disclose consistently on sustainability metrics.	(Knowledge Management) Company provides very limited education and training for its leadership and employees at all levels to learn how to incorporate climate risk and opportunity lens into decision-making processes. Employees across all departments

	<p>engages with climate risks on an ad hoc and reactionary basis. No standard processes in place for managing climate risk management at the management level.</p>	<p>their scope.</p>				<p>and management levels do not yet have basic familiarity with climate-related issues.</p>
	<p>(Climate Risk Management Decision Making Capacity) KPIs for 1-2 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are used sporadically by leadership bodies to inform short-term decision-making.</p>	<p>(Operational Integration) Climate risk strategy objectives and targets have not been identified.</p>		<p>(Risk Framework) Climate risk actions are reactionary and taken after an event.</p>		<p>(Data Access &amp; Resources) Company has access to some data sources and data types that are appropriate for the industry. This may include data on supply chain, areas of operations, and historical company sustainability and risk data (e.g. CO2 emissions, management response to previous risks).</p>
	<p>(Management) (Incentive System) Management and employees are not encouraged nor incentivized to consider climate risks and opportunities in decision-making. Employee incentives are not aligned with climate risk management and efforts</p>	<p>(Strategic Planning) Company's strategic plan does not include considerations for short- medium- or long-term implications of climate risk.</p>		<p>(Inclusion of Physical and Transition Risks) Company is not aware of suite of potential climate risks and is not familiar with differentiation between physical and transition risks. Also not aware of potential opportunities associated with climate change.</p>		<p>(Technological Resources) Company has access (either internally or through a partnership) to technical resources (AI capability, CAT modeling capability, etc) to address CRM. These resources are not yet leveraged into use.</p>

	to influence employee behaviors, education, and communication have not been established.				
	(Communication) There are no formal communication processes or channels established by which management and employees are informed about climate-related issues. All communication on this topic is informal, ad-hoc, and reactionary. Communication through the governance structure does not contribute to the formation of a standardized climate risk management process.			(Financial Impact Analysis) Company is not able to calculate how material climate-related risks and opportunities impact its future financial position, as reflected in its income statement, cash flow statement, and balance sheet. The company does not understand the importance of linking climate risks to financial metrics.	(Network/Ecosystem) Company has certain industry contacts, but not yet an established industry network, to be able to tap into lessons learned and best practices for climate risk management.
	(Mission/Vision/Values) Climate risk issues are not integrated into the mission, vision and values of the company. Certain individuals view climate risk management as a way to build competitive advantage and promote business prosperity, but this is a limited view across the company.			(Timeframe) Company responds to immediate climate risks but does not have a mechanism to assess and manage short-, medium-, or long-term climate risks.	

	<p>(Industry Leadership) The company does not support the development of partner organizations' climate risk management plans, and does not have the capacity to take a leadership role on climate-related issues in the industry.</p>			<p>(Scenario Analysis) Company does not use scenario analysis techniques to consider broader range of assumptions, uncertainties, and potential future states to develop climate risk management strategy.</p>		
	<p>(Timeframe) Decision-making on climate risk management issues is reactionary and thus does not extend beyond the immediate short-term.</p>			<p>(Risk Response Strategy) Ad-hoc climate risk approach does not account for geographically localized impacts of climate change nor understand which locations are most vulnerable to climate change risks. The approach does not account for the company's "critical" locations.</p>		
				<p>(Risk Response Strategy) Ad hoc climate risk management approach does not include on-site assessments of the reliability and effectiveness of emergency response and business continuity plans, any peril-specific protection measures (e.g., mobile flood protection elements, etc.), and quality of structures, infrastructure and utilities.</p>		



				(Adaptive Capacity) Climate risk management approach is ad hoc and not standardized, therefore, it is difficult for company to measure and evaluate effectiveness of current approach and identify lessons learned to incorporate into approach moving forward. No formal mechanism exists to update climate risk approach with new scientific findings or to expand approach beyond existing climate risks covered.		
<b>Maturity Level III: Aware of some climate risks now</b>	(Governance Structure) Internal organizational structure has climate risk management issues partially embedded and distributed across a limited number of relevant internal stakeholders.	(Strategic Planning) Climate risk management is partially embedded into the company's strategic planning processes, but not into the strategic plan itself. Climate risk management initiatives are embedded only into short-term strategic planning processes, but not medium- or long-term strategic planning processes.	(TCFD Climate-Related Metrics Categories) Some data related to climate risk are collected or analyzed. 3 of TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation & Mitigation) are measured and analyzed.	(Risk Framework) Climate risk management approach is not embedded into overall company risk management framework. Climate risk management is functionally isolated and managed under separate business unit, such as the sustainability department. The process is not standardized and is instead based on experience with previously implemented tasks and projects. Therefore, processes related to climate risk management cannot be easily repeated.	(Standardized Frameworks) Company publicly discloses on 3-4 of TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation & Mitigation) using TCFD framework. However, disclosure language is vague and does not include metrics. Company struggles to understand process and strategy around sustainability or climate risk disclosure.	(Financial Resources) Company has recently begun allocating financial resources to manage climate risk management issues. Financial allocation does not yet align with organizational climate risk objectives. This may include necessary capex for new technology or facilities and/or R&D.

	<p>(Governance Structure) Climate risk management is not part of overarching risk management (or oversight) team. Risk management (ERM), climate risk management, and sustainability teams are siloed and do not coordinate or communicate across potentially overlapping workflows.</p>	<p>(Commitments) Specific departments within the company have defined climate risk management as an organizational strategic priority but this is not a company-wide priority. Climate risk issues have not been published into company-wide documents.</p>	<p>(Targets) Company has established climate risk management objectives, and a set of metrics and KPIs to measure progress towards these objectives for 3 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation).</p>	<p>(Risk Framework) Climate risk management framework analyzes how climate risks and opportunities impact the organization's businesses, strategy, and financial planning. It looks at impacts on at least 3 of the 8 following areas: supply chain, operations, distribution, existing and new customers and markets, demand for goods/services, ability to do business, product offerings, and returns in investment portfolios.</p>	<p>(Oversight) Company uses regulatory oversight to ensure disclosed information is externally verified.</p>	<p>(Human Resources) Company has the appropriate team structures for sustainability. Internal expertise working on climate risk management issues is growing.</p>
	<p>(Board) (Climate Risk Management Decision-Making Capacity) Board has received training on how to consider climate risks and opportunities in short-term decision-making but there is a lack of understanding on how to address all types of climate risks. Board is updated regularly on climate-related issues as they pertain to the short-term.</p>	<p>(Operational Integration) Specific departments within the company ensure that external consulting agencies tasked with strategy projects include a climate risk management lens in their scope but this is not a company-wide policy.</p>	<p>(Science Based Targets) Company is in process of setting greenhouse gas emissions reductions target in line with Science Based Targets Initiative guidelines.</p>	<p>(Risk Framework) Climate risk management is integrated into some departments on an ad hoc basis, but not systematically across all operational areas of the company. Operational processes and climate risk management processes are not streamlined.</p>	<p>(Reporting Consistency) Climate risks and opportunities using TCFD framework are disclosed each fiscal year but not always updated from prior year's disclosure.</p>	<p>(Knowledge Management) Company provides limited, informal education and training for its leadership and employees at all levels to learn how to incorporate climate risk and opportunity lens into decision-making processes. Employees across all departments and management levels have basic familiarity with climate-related issues, with core group of subject matter experts.</p>

	<p>(Management) (Climate Risk Management Decision-Making Capacity)  Management and employees across departments are trained on how to consider climate risks and opportunities in short-term decision-making but there is a lack of understanding on how to address all climate risk issues. Climate risk and opportunity considerations and environmental costs are not embedded into decision-making processes across the company.</p>	<p>(Operational Integration)  Climate risk strategy objectives and targets are identified but not necessarily quantifiable nor measured. They are secondary and viewed as separate to core business objectives and targets.</p>		<p>(Risk Framework)  Climate risk approach is evolving to include more preventative measures but majority of actions occur after an event.</p>		<p>(Data Access &amp; Resources)  Company has access to some data sources and data types that are appropriate for the industry. This may include data on supply chain, areas of operations, and historical company sustainability and risk data (e.g. CO2 emissions, management response to previous risks).</p>
	<p>(Climate Risk Management Decision Making Capacity)  KPIs for 3 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are used regularly and consistently by leadership bodies to inform short-term</p>	<p>(Strategic Planning)  Company's strategic plan includes considerations for short-term climate risk implications, but not medium- or long-term implications.</p>		<p>(Inclusion of Physical and Transition Risks)  Company assesses a limited number of actual and potential physical and transition risks, but blind spots exist for a majority of climate risks. Climate risk approach does not include analysis for opportunities associated with climate change. For example, company may assess their flood risk and policy risk</p>		<p>(Technological Resources)  Company has access (either internally or through a partnership) to technical resources (AI capability, CAT modeling capability, etc) to address CRM. These resources are not yet leveraged into use.</p>

	<p>decision-making and monitor progress on climate risk management.</p>			<p>related to a carbon tax, but does not assess physical risk across all hazards nor transition risk across all risk-types.</p>		
	<p>(Management) (Incentive System)  Management and employees across departments are encouraged to consider climate risks and opportunities in decision-making, but are not formally incentivized. Employee incentives are not aligned with climate risk management and efforts to influence employee behaviors, education, and communication have not been established.</p>			<p>(Financial Impact Analysis)  Company is not able to calculate how material climate-related risks and opportunities impact its future financial position, as reflected in its income statement, cash flow statement, and balance sheet. However, understands the importance of doing so and is working toward adding this capability to their climate risk management approach.</p>		<p>(Network/Ecosystem)  Company has an established industry network that allows it to tap into lessons learned and best practices for climate risk management. Company actively discusses best practices with industry peers in an effort to create a community of practice.</p>
	<p>(Communication)  Company is starting to establish communication processes and channels by which management and employees are informed about climate-related issues. At this point, communication remains primarily informal, leading to the lack of one standardized</p>			<p>(Timeframe)  Climate risk management strategy incorporates short-term climate-related risks and opportunities into management practices but there is less or no emphasis on the medium- and long-term.</p>		

	<p>climate risk management process that is repeatable across departments and functional units.</p>					
	<p>(Mission/Vision/Values) Climate risk issues are not integrated into the mission, vision and values of the company. Certain individuals view climate risk management as a way to build competitive advantage and promote business prosperity, but this is a limited view across the company.</p>			<p>(Scenario Analysis) Company uses scenario analysis techniques to consider broader range of assumptions, uncertainties, and potential future states to develop forward-looking climate risk management strategy. Primarily uses qualitative scenario narratives or storylines to illustrate potential pathways and outcomes, with limited or no use of quantitative information. The analysis is not applied to the whole value chain; instead it focuses on direct effects of specific business units or operations. The analysis considers a limited number of physical or transition risks, leading to significant gaps.</p>		

	<p>(Industry Leadership) The company does not support the development of partner organizations' climate risk management plans, and does not have the capacity to take leadership role in the space.</p>			<p>(Risk Response Strategy) Climate risk approach accounts for regional, but not necessarily location- or asset-specific, impacts of physical climate risks. The approach does not prioritize or make a distinction based on the company's "critical" regions.</p>		
	<p>(Timeframe) Decision-making on climate risk management issues only considers short-term implications and scenarios.</p>			<p>(Risk Response Strategy) Climate risk management approach does not currently include on-site assessments of the reliability and effectiveness of emergency response and business continuity plans, any peril-specific protection measures (e.g., mobile flood protection elements, etc.), and quality of structures, infrastructure and utilities. Company is beginning to think about incorporating this into climate risk management approach and is identifying service providers to help with this. (Source: Zurich, 2019)</p>		

				<p>(Adaptive Capacity) Climate risk management approach remains more or less static over time. Difficult for company to measure and evaluate effectiveness of current approach and identify lessons learned to incorporate into approach moving forward. No formal mechanism exists to update climate risk approach with new scientific findings or to expand approach beyond existing climate risks covered.</p>		
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<p><b>Maturity Level IV: Strategy delivered for some climate risks by 2030</b></p>	<p>(Governance Structure) Internal organizational structure has climate risk management issues partially embedded and distributed across several but not all relevant internal stakeholders.</p>	<p>(Strategic Planning) Climate risk management is embedded into the company's strategic planning processes, and into the strategic plan itself. Climate risk management initiatives are embedded into short- and medium-term strategic planning processes, but not long-term strategic planning exercises.</p>	<p>(TCFD Climate-Related Metrics Categories) Some data related to climate risk are collected or analyzed. 4-5 of TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are measured and analyzed.</p>	<p>(Risk Framework) Climate risk management approach is embedded into overall company risk management framework. The process is standardized, well-defined, repeatable, measured, and in alignment with other core processes.</p>	<p>(Standardized Frameworks) Company publicly discloses on 4-5 of TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) using TCFD framework. Some metrics are included and certain aspects of disclosure are robust but other language is vague.</p>	<p>(Financial Resources) Company has appropriately allocated financial resources to manage climate risk management issues. Financial allocation does not yet align with organizational climate risk objectives. This may include necessary capex for new technology or facilities and/or R&amp;D.</p>
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	<p>(Governance Structure) Climate risk management is part of overarching risk management (or oversight) team.</p>	<p>(Commitments) Company has public-facing evidence of climate risk management as an organizational strategic priority. It has been published into company-wide documents.</p>	<p>(Targets &amp; Metrics) Company has established climate risk management objectives, and a set of metrics and KPIs to measure progress towards these objectives in line with 4-5 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation).</p>	<p>(Risk Framework) Climate risk management framework analyzes how climate risks and opportunities impact the organization's businesses, strategy, and financial planning. It looks at impacts on at least 5 of the 8 following areas: supply chain, operations, distribution, existing and new customers and markets, demand for goods/services, ability to do business, product offerings, and returns in investment portfolios.</p>	<p>(Oversight) Company uses regulatory oversight to ensure disclosed information is externally verified.</p>	<p>(Human Resources) Company has the appropriate team structures and internal expertise working on climate risk management issues.</p>
	<p>(Board) (Climate Risk Management Decision-Making Capacity) Board has received training on how to consider climate risks and opportunities in decision-making but is not yet confident how to address all climate risk issues. Board is updated regularly on climate-related issues, and considers climate risks and opportunities in some decision-making.</p>	<p>(Operational Integration) Company ensures that external consulting agencies tasked with strategy projects include a climate risk management lens in their scope. This is a company-wide policy.</p>	<p>(Science Based Targets) Company uses Science Based Targets Initiative guidelines to set greenhouse gas emissions reductions target.</p>	<p>(Risk Framework) Climate risk management is integrated into operational areas of the company. Operational processes and climate risk management processes are streamlined.</p>	<p>(Reporting Consistency) Climate risks and opportunities using TCFD framework are updated and disclosed each fiscal year.</p>	<p>(Knowledge Management) Company provides education and training for its leadership and employees at all levels to learn how to incorporate climate risk and opportunity lens into decision-making processes. Employees across all departments and management levels have basic familiarity with climate-related issues, with core group of subject matter experts.</p>



	<p>(Management) (Climate Risk Management Decision-Making Capacity)  Management and employees across departments are trained on how to consider climate risks and opportunities in decision-making but are not yet confident how to address all climate risk issues. Climate risk and opportunity considerations and environmental costs are embedded into decision-making processes across the company.</p>	<p>(Operational Integration)  Climate risk strategy objectives and targets are identified, quantifiable, and measured. They are aligned with core business objectives and targets.</p>		<p>(Risk Framework)  Climate risk approach includes preventative and post-event measures.</p>		<p>(Data Access &amp; Resources)  Company has access to a range of data sources and data types that are appropriate for the industry. This may include data on supply chain, areas of operations, and historical company sustainability and risk data (e.g. CO2 emissions, management response to previous risks).</p>
	<p>(Climate Risk Management Decision Making Capacity)  KPIs for 4-5 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are used regularly and consistently by leadership bodies to inform decision-making and monitor progress on climate risk</p>	<p>(Strategic Planning)  Company's strategic plan includes considerations for short- and medium-term climate risk implications and scenarios, but not long-term implications.</p>		<p>(Inclusion of Physical and Transition Risks)  Company assesses a majority of actual and potential physical and transition risks and opportunities, but blind spots exist for some climate risks or opportunities. For example, company may have robust physical risk climate risk management approach but not be looking at transition risk as closely, or vice versa. Or a company may be focusing exclusively</p>		<p>(Technological Resources)  Company has access (either internally or through a partnership) to technical resources (AI capability, CAT modeling capability, etc) to address CRM.</p>

	management.			on risks and not opportunities, or vice versa.	
	(Management) (Incentive System) Management and employees across departments are professionally incentivized to consider climate risks and opportunities in decision-making, but not financially incentivized. Employee incentives incorporate climate risk management and efforts to influence employee behaviors, education, and communication have been established.			(Financial Impact Analysis) Company has some understanding of how material climate-related risks and opportunities impact its future financial position, as reflected in its income statement, cash flow statement, and balance sheet. However, company encounters difficulty in determining actual and potential financial impacts on revenues, expenditures, assets and liabilities, and capital and financing. Company is in the process of developing a system to quantify all material climate-related risks and opportunities to understand impact to bottom line.	(Network/Ecosystem) Company has an established industry network that allows it to tap into lessons learned and best practices for climate risk management. Company actively discusses best practices with industry peers in an effort to create a community of practice.
	(Communication) Company has established communication processes and channels by which management and employees are informed about climate-related issues. However, informal channels also exist, leading to some discrepancies in			(Timeframe) Climate risk management strategy incorporates short-term and medium-term climate-related risks and opportunities into management practices but there is less or no emphasis on the long-term.	

	execution of climate risk management across departments and functional units.					
	<p>(Mission/Vision/Values) Climate risk issues are integrated into the mission, vision and values of the company in some way, but are viewed as a secondary component of business decision-making. Certain Board members and managers view climate risk management as a way to build competitive advantage and promote business prosperity, but this sentiment is not company-wide.</p>			<p>(Scenario Analysis) Company uses scenario analysis techniques to consider broader range of assumptions, uncertainties, and potential future states to develop forward-looking climate risk management strategy. Both qualitative and quantitative information is used to illustrate potential pathways and outcomes. The analysis is applied to the whole value chain (inputs, operations and markets). A significant number of physical and transition risks is considered across scenario analyses but there are notable gaps.</p>		

	<p>(Industry Leadership) The company supports the development of partner organizations' climate risk management plans. Partners may include regulators, competitors, business partners, community partners. However, plans aren't fully aligned, integrated, and connected with regional, national, and international management guidelines.</p>			<p>(Risk Response Strategy) Climate risk approach accounts for regional, but not necessarily location- or asset-specific, impacts of physical climate risks. The approach prioritizes the company's "critical" regions.</p>		
	<p>(Timeframe) Decision-making on climate risk management issues considers short-, medium-, and long-term implications and scenarios.</p>			<p>(Risk Response Strategy) Climate risk approach includes an on-site assessment of the reliability and effectiveness of emergency response and business continuity plans, any peril-specific protection measures (e.g., mobile flood protection elements, etc.), and quality of structures, infrastructure and utilities but not necessarily at the most critical locations.</p>		

				<p>(Adaptive Capacity)  The company adaptively manages its climate risk management approach but focuses only on the existing climate risks already covered, with gaps persisting for other climate risks. Company conducts periodic reviews of current climate risk approach and its effectiveness in mitigating climate risk impacts. This includes evaluating executed climate risk responses after specific events as well as incorporating new scientific data. Lessons learned and new data inform updates to the climate risk management approach.</p>		
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<p><b>Maturity Level V: Mature: Strategy delivered for physical &amp; interconnected risks by 2030</b></p>	<p>(Governance Structure) Internal organizational structure has climate risk management issues strategically embedded and distributed across relevant internal stakeholders.</p>	<p>(Strategic Planning) Climate risk management is embedded into the company's strategic planning processes, and into the strategic plan itself. Climate risk management initiatives are embedded into short-, medium- and long-term strategic planning exercises. KPI: Climate risk management priorities are present in organizational strategic planning commitments and documents (Y/N).</p>	<p>(TCFD Climate-Related Metrics Categories) All relevant data related to climate risk are collected or analyzed. All 6 of TCFD's 6 climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are measured and analyzed. KPI: Number of TCFD climate-related metrics regularly collected, measured and analyzed (#).</p>	<p>(Risk Framework) Climate risk management approach and process is embedded into overall company risk management framework. The process is standardized, well-defined, repeatable, measured, and in alignment with other core processes. KPI: Climate risk management is embedded into risk management function. (Y/N)</p>	<p>(Standardized Frameworks) Company publicly discloses on all 6 TCFD climate-related metrics categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) using TCFD framework. Disclosure includes metrics and is robust and comprehensive. KPI: Number of TCFD climate-related metrics disclosed (#).</p>	<p>(Financial Resources) Company has appropriately allocated financial resources to manage climate risk management issues, and has established financial allocation that aligns with objectives. This may include necessary capex for new technology, human capacity, or facilities and/or R&amp;D. KPI: Amount of money allocated to climate risk management issues. (#) KPI: Percent budget allocated to climate risk management issues. (%)</p>
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	<p>(Governance Structure) Climate risk management is part of overarching risk management (or oversight) team. KPI: Climate risk management issues present in formalized Risk Management mandate or charter (Y/N).</p>	<p>(Commitments) Company has external-facing evidence of climate risk management as an organizational strategic priority. It has been published into company-wide documents.  KPI: Climate risk management objectives and topics are published in external-facing organizational commitments and documents (Y/N).</p>	<p>(Targets &amp; Metrics) Company has established climate risk management objectives, and a set of metrics and KPIs to measure progress towards these objectives for all 6 of TCFD's 6 climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation). KPI: Number of objectives set, based on TCFD climate-related metrics (#).</p>	<p>(Risk Framework) Climate risk management framework analyzes how climate risks and opportunities impact the organization's businesses, strategy, and financial planning. It looks at impacts on the company's supply chain, operations, distribution, physical assets, existing and new customers and markets, demand for goods/services, ability to do business, product offerings, and returns in investment portfolios.</p>	<p>(Oversight) Company uses regulatory oversight to ensure disclosed information is externally verified.</p>	<p>(Human Resources) Company has the appropriate team structures and internal expertise working on climate risk management issues.</p>
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	<p>(Board) (Climate Risk Management Decision-Making Capacity)  Board has been trained on how to consider climate risks and opportunities in decision-making and is confident in doing so across physical and interconnected risks. Board is updated regularly on climate-related issues, and considers climate risks and opportunities in decision-making.  KPI: Board has received formal training on climate risk management issues (Y/N).  KPI: Climate Risk Management topics are included on at least 2 meeting agendas per year (#).</p>	<p>(Operational Integration)  Company ensures that external consulting agencies tasked with strategy projects include a climate risk management lens in their scope. This is a company-wide policy.</p>	<p>(Science Based Targets)  Company uses Science Based Targets Initiative guidelines, or similar frameworks, to set greenhouse gas emissions reductions target.  KPI: Science Based Targets are used in GHG reduction target (Y/N).</p>	<p>(Risk Framework)  Climate risk management is integrated into operational areas of the company. Operational processes and climate risk management processes are streamlined.</p>	<p>(Reporting Consistency)  Climate risks and opportunities using TCFD framework are updated and disclosed each fiscal year.  KPI: Disclosure updated annually (Y/N).</p>	<p>(Knowledge Management)  Company provides education and training for its leadership and employees at all levels to learn how to incorporate climate risk and opportunity lens into decision-making processes. Capacity building resources exist to aid professional development related to climate risk issues. Employees across all departments and management levels have basic familiarity with climate-related issues, with core group of subject matter experts.  KPI: Annual or bi-annual trainings on climate risk management are held by each department. (Y/N)  KPI: Onboarding process for new staff includes climate risk management overview. (Y/N)</p>
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	<p>(Management) (Climate Risk Management Decision Making Capacity)  Management and employees across departments are trained on how to consider climate risks and opportunities in decision-making. Climate risk and opportunity considerations and environmental costs are embedded into decision-making processes across the company.  KPI: Executive-suite has received formal training on climate risk management issues (Y/N).  KPI: Climate Risk Management topics are included on at least 2 executive meeting agendas per year (#).</p>	<p>(Operational Integration)  Climate risk strategy objectives and targets are identified, quantifiable, and measured. They are aligned with core business objectives and targets.  KPI: Objectives and targets are quantifiable and measured (Y/N).  KPI: Objectives align with at least 2 core business objectives or targets (#).</p>		<p>(Risk Framework)  Climate risk management approach includes preventative and post-event measures.  KPI: Climate risk management approach includes preventative and post-event measures. (Y/N)</p>		<p>(Data Access &amp; Resources)  Company has access to a range of data sources and data types that are appropriate for the industry. This may include data on supply chain, areas of operations, and historical company sustainability and risk data (e.g. CO2 emissions, management response to previous risks).</p>
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	<p>(Climate Risk Management Decision Making Capacity)  KPIs for all 6 of TCFD's climate-related metric categories (Greenhouse Gas Emissions, Energy/Fuel, Water, Land Use, Location, Risk Adaptation &amp; Mitigation) are used regularly and consistently by leadership bodies to inform decision-making and monitor progress on climate risk management.  KPI: Number of climate-related metric categories are integrated into leadership decision-making processes (#).</p>	<p>(Strategic Planning)  Company's strategic plan includes considerations for short-, medium-, and long-term climate risk implications and scenarios.  KPI: Short-, medium- and long-term scenarios are analyzed and embedded into strategic planning.</p>		<p>(Inclusion of Physical and Transition Risks)  Company assesses full range of actual and potential physical and transition risks and opportunities.  KPI: Company assesses full range of actual and potential physical and transition risks and opportunities.  (Y/N)</p>		<p>(Technological Resources)  Company has access (either internally or through a partnership) to technical resources (AI capability, CAT modeling capability, etc) to address CRM.</p>
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	<p>(Incentive System)  Management and employees across departments are financially incentivized to consider climate risks and opportunities in decision-making. Employee incentives are aligned with climate risk management and efforts to influence employee behaviors, education, and communication have been established.  KPI: Professional Assessment toolkits &amp; processes include climate risk issues as an assessment area, and are used annually to support employees at all levels (Y/N).  KPI: Financial Incentives includes climate risk issues as an assessment area (Y/N).</p>			<p>(Financial Impact Analysis)  Company has clear understanding of how material climate-related risks and opportunities impact its future financial position, as reflected in its income statement, cash flow statement, and balance sheet. Company is able to determine actual and potential financial impacts on revenues, expenditures, assets and liabilities, and capital and financing. Company has developed a system to quantify all material climate-related risks and opportunities and understand impact to bottom line.  KPI: Company has system to financially quantify all material climate-related risks and opportunities. (Y/N)  KPI: Financial losses from climate risks (# amount in local currency)  KPI: Revenues/savings from climate risk mitigation initiatives and investments, and climate-related products and services (# amount in local currency)</p>		<p>(Network/Ecosystem)  Company has an established industry network that allows it to tap into lessons learned and best practices for climate risk management. Company actively discusses best practices with industry peers in an effort to create a community of practice.  KPI: Company is member of climate risk management communities of practice. (Y/N)  KPI: Company personnel attend climate risk management conferences/meetings annually. (Y/N)</p>
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	<p>(Communication)  Company has established standardized communication processes and channels by which management and employees are informed about climate-related issues. Information disseminated through these channels ensure climate risk management actions are standardized and repeatable across departments and functional units.</p>			<p>(Timeframe)  Climate risk management strategy incorporates short-term, medium-term, and long-term climate-related risks and opportunities into management practices.  KPI: Short-, medium- and long-term scenario are analyzed and embedded into decision-making.  (Y/N)</p>		
	<p>(Mission/Vision/Values)  Climate risk issues are integrated into the mission, vision and values of the company, and are viewed as a core component of business decision-making. Climate risk management is seen as a way to build competitive advantage and to promote business prosperity.  KPI: Climate risk issues are included in company's mission statement. (Y/N)</p>			<p>(Scenario Analysis)  Company uses scenario analysis techniques to consider broader range of assumptions, uncertainties, and potential future states to develop forward-looking climate risk management strategy. Both qualitative and quantitative information is used to illustrate potential pathways and outcomes. The analysis is applied to the whole value chain (inputs, operations and markets). A comprehensive suite of physical and transition risks is considered across scenario analyses.  KPI: Scenario analysis incorporates qualitative, quantitative, physical, and transition risks. (Y/N)</p>		

	<p>(Industry Leadership)  The company proactively supports the development of partner organizations' climate risk management plans. Partners may include regulators, competitors, business partners, community partners. Plans are aligned, integrated, and connected with regional, national, and international management guidelines.  KPI: Company is a member of industry and sector-specific networks around climate risk issues (Y/N).  KPI: Company is aligned with industry-specific objectives around climate risk management (Y/N).</p>			<p>(Risk Response Strategy)  Climate risk approach accounts for location- and asset-specific impacts of physical climate risks. The approach prioritizes the company's "critical" locations.  KPI: Company has identified and prioritized critical locations for climate risk management. (Y/N)</p>		
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	<p>(Timeframe) Decision-making on climate risk management issues considers short-, medium-, and long-term implications and scenarios. KPI: Short-, medium- and long-term scenarios are analyzed and embedded into decision-making. (Y/N)</p>			<p>(Risk Response Strategy) Climate risk approach includes an on-site assessment of the reliability and effectiveness of emergency response and business continuity plans, any peril-specific protection measures (e.g., mobile flood protection elements, etc.), and quality of structures, infrastructure and utilities at critical locations. (Source: Zurich, 2019) KPI: Company conducts on-site climate risk assessments for critical locations. (Y/N)</p>		
				<p>(Adaptive Capacity) The company adaptively manages its climate risk management approach. Company conducts periodic reviews of current climate risk approach and its effectiveness in mitigating climate risk impacts. This includes evaluating executed climate risk responses after specific events as well as incorporating new scientific data. Lessons learned and new data inform updates to the climate risk management approach. KPI: Company conducts annual or bi-annual reviews of climate risk management approach (Y/N).</p>		