

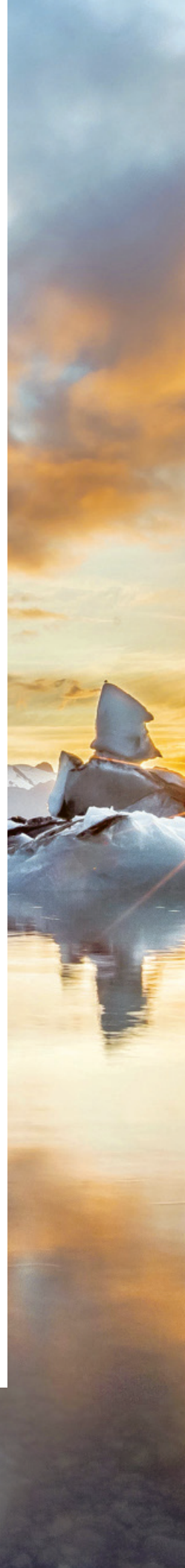
Vulnerability

The Missing Piece in the Climate Risk Puzzle

Executive Summary

As the economic, physical and human impacts of climate change mount around the world, many investors are considering related risks throughout the investment process. Morgan Stanley's Institute for Sustainable Investing has developed a climate risk assessment framework that goes beyond the traditional focus on companies' direct operational exposure to climate-related events. By integrating climate vulnerability into the risk assessment process, investors can improve their evaluation of potential financial impacts on portfolio companies and develop more climate-resilient investment approaches. Factoring in vulnerability can also help investors more accurately weigh risks and returns, differentiate securities, build portfolios and inform shareholder engagement strategies. This paper introduces our three-dimensional climate risk assessment framework and provides examples for its practical application to investments. Our goal is to encourage investors globally to adopt systems-level approaches that promote more climate resilient companies, economies and societies.

CLIMATE RISK		
EVENT	EXPOSURE	VULNERABILITY
Natural or human-induced incidents, either acute or chronic, that may have adverse effects on vulnerable and exposed people, communities, companies or investors	Factors that determine a company's level of risk should a climate-related event occur, such as its business activities in specific geographies or under certain legal jurisdictions	The underlying weaknesses that can exacerbate the consequences of exposure to climate-related events



Introduction

As climate change intensifies, so do the potential impacts it presents to businesses, investors and the global economy. These impacts stem not only from the physical risks of climate change, but also from the risks associated with the transition to a low-carbon economy.

Developing a comprehensive understanding of these impacts becomes increasingly important as the economic costs of climate change grow and global action accelerates. The 2015 Paris Agreement emphasizes the scale of action needed to limit global temperature rise to 2 degrees Celsius above pre-industrial levels and strengthen the ability of countries to deal with the impacts of climate change. Realizing the Agreement's overarching goals also presents opportunities given the need to mobilize trillions of dollars of investment to reduce greenhouse gas (GHG) emissions and adapt to the effects of climate change already underway.

This report offers investors a series of insights and considerations to evaluate climate change-related risk and opportunity throughout the investment process. It presents a three-dimensional risk assessment framework that can inform climate-resilient investment strategies. Integrating climate vulnerability into the risk assessment process can help identify key opportunities to mobilize the financial resources necessary to make businesses and the economy more resilient.

Defining Climate Risk, Opportunity and Resilience



CLIMATE CHANGE RISKS

The Financial Stability Board's Task Force on Climate-Related Financial Disclosure (TCFD) considers climate change's direct and indirect impacts from two angles:

- **Transition risk** encompasses the policy and legal, technology, market and reputational changes to organizations stemming from the transition to a low-carbon economy.
- **Acute physical risk** refers to the harms created by single events such as extreme weather events like cyclones, wildfires and floods, while **chronic physical risk** refers to the changes in natural cycles and climate patterns over longer time periods.¹



CLIMATE CHANGE OPPORTUNITIES

Mitigating and adapting to the potential impacts from climate change creates opportunities for new products and services that help to manage transition and/or physical risks. These include, but are not limited to, increased revenue due to demand for low-carbon products and services or enhanced competitive position due to shifting consumer preferences.



CLIMATE RESILIENCE

Climate resilience incorporates both mitigation and adaptation: mitigating the impacts of climate change that can be avoided and adapting to those that can't. The Intergovernmental Panel on Climate Change (IPCC) defines resilience as "the capacity of social, economic and environmental systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation."²

Climate Risk and Economic Impacts

Climate change-related events are growing more severe and causing greater economic damage than ever before. From 2016 through 2018, weather and climate disasters have caused over \$630 billion worth of economic damage worldwide (Figure 1).³ In 2019 alone, the United States experienced 14 weather and climate disasters with losses greater than \$1 billion, totaling \$45 billion in costs to the economy.⁴

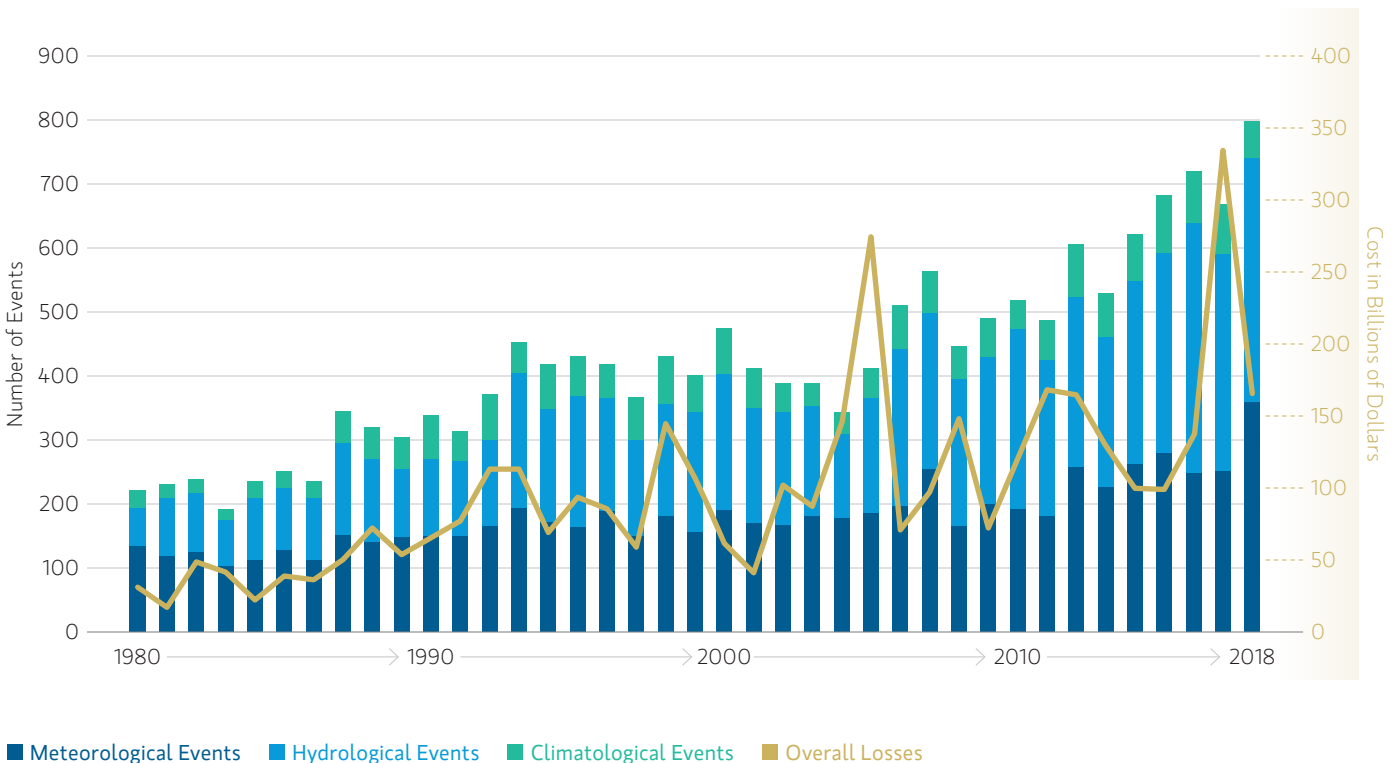
Looking to the future, models point to a range of significant costs associated with climate change. Analysis by Mercer estimates the cumulative global cost of climate change-related impact on the environment, health and food security will reach between \$2 trillion and \$4 trillion by 2030.⁵ More recent assessments published in the journal *Nature* suggest costs to the market value of global financial assets could be as high as \$24.2 trillion under worst-case scenarios.⁶ Recent activity from financial regulators signals greater appreciation of climate change as a systemic financial risk. In April 2019, the Bank of England’s Prudential Regulation Authority (PRA) issued a

supervisory statement calling for banks and insurers to enhance their approaches to managing the financial risks from climate change.⁷ In its 2019 report, “A Call for Action: Climate Change as a Source of Financial Risk,” the Network of Central Banks and Supervisors for Greening the Financial System (NGFS)—a group of Central Banks and Supervisors with more than 50 members from around the world—identified climate change as a unique source of structural change affecting the financial system. The report concluded that asset valuations do not fully reflect climate-related risks.⁸

Ratings agencies are also incorporating climate related-risks into their analysis. S&P Global Ratings found that between July 2015 and August 2017, environmental and climate change factors resulted in a change of rating, outlook or action by their analysts in 106 cases.⁹ In 2019, Moody’s issued a draft scoring framework for assessing transition risk as a distinct subset of climate risks.¹⁰

Weather and Climate Disasters, and Related Financial Losses, Have Risen Sharply Over 40 Years

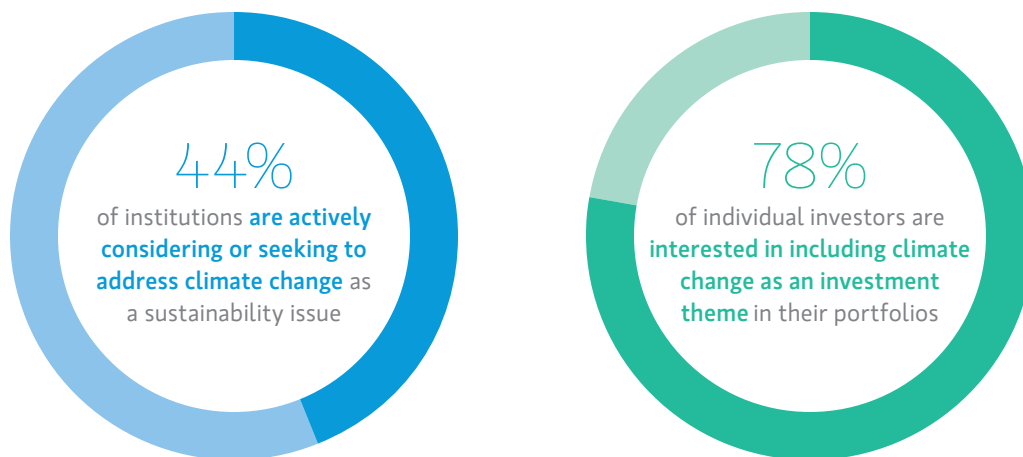
FIGURE 1



Source: NatCatSERVICE, Munich Re

Individual and Institutional Investors Increasingly Seek to Address Climate Change

FIGURE 2



Climate Change Opportunities and Resilience

Soaring investor interest in climate change provides an additional proof point that the market is actively taking climate change impacts more seriously. The Morgan Stanley Institute for Sustainable Investing's recent investor surveys show that asset owners and individual investors are doing more to integrate climate change into their investment decision making (Figure 2).

With these trends in mind, it is our view that the time for investors to develop a more comprehensive understanding of climate-related risk—and by extension, an understanding of opportunities to support climate resilience—has arrived. Building climate resilience by enhancing the ability of corporations to adapt to climate change can bolster the long term value of investor portfolios while yielding a broad range of economic benefits.

Resilient companies will be better able to anticipate, avoid, accommodate and recover from climate-related risks internally and across their value chains. They can help mitigate financial losses by being prepared for climate change impacts and support greater business continuity and customer retention through climate-resilient infrastructure and practices. They can also maintain supply chain integrity by building the adaptive capacity of upstream resources including their workforce, and therefore retain profitability when less prepared competitors suffer from such events. These benefits may accrue to investors in the form of less volatile investment performance.

When pursued at scale, the actions of climate-resilient businesses can contribute to a more resilient global economy, moderating harm to socio-ecological systems from disruptive climate impacts and driving improved development outcomes.¹¹

For example, in “Weathering the Storm: Integrating Climate Resilience into Real Assets Investing,” Morgan Stanley Real Assets Research & Investing and the Morgan Stanley Institute for Sustainable Investing demonstrated how resilience has emerged as an important consideration for investing in real assets. The report notes the opportunities that investing in resilience provides for achieving high returns through “cost reductions (lower operating costs and averted damage), revenue growth (enhanced reputation, increased occupancy rates) and higher asset value.”¹²

Across the many sectors impacted by climate change, enhancing climate resilience presents investors with significant opportunity. Demand for products and services that mitigate GHG emissions or support greater adaptation to a warmer world is expected to rise as the transition to a low-carbon economy accelerates. Investors will play an important role in mobilizing the capital markets to help scale innovative solutions, and persuading companies to adapt their businesses to succeed in a carbon-constrained future.

The nonprofit CDP examines climate-related opportunities in their 2019 report “Major Risk or Rosy Opportunity: Are companies ready for climate change?” Responses to CDP’s 2018 Climate Change Questionnaire from 225 of the world’s 500 largest companies indicate that these opportunities represent over \$2.1 trillion in potential financial impacts.¹³

While a majority of companies reporting to the CDP framework also identified potentially significant climate-related risks, these assessments remain particularly narrow in scope. Most companies only identified potential risks to their direct operations and not to their customers or supply chains.¹⁴ Accounting for such indirect risk exposure can help companies and investors identify key climate change-related vulnerabilities.

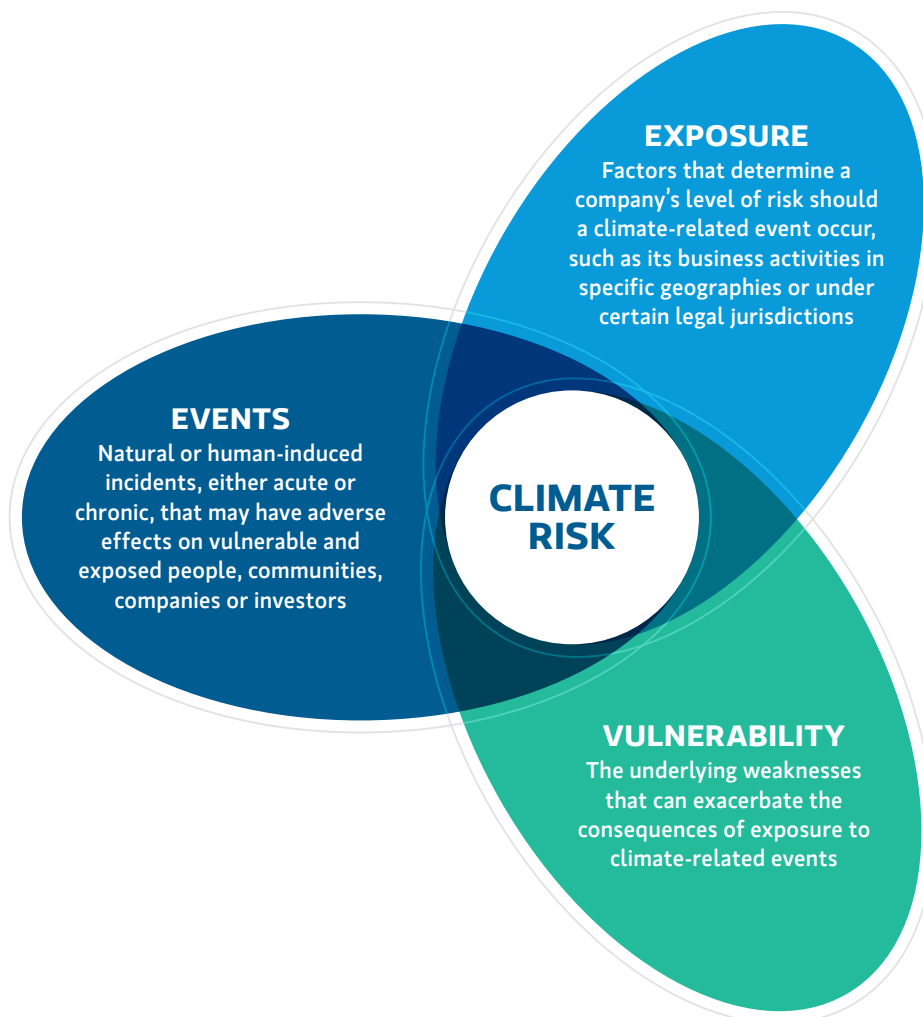
The Morgan Stanley Institute for Sustainable Investing’s 3D climate risk assessment framework, described on the following pages, is designed to help companies and investors bridge this gap and broaden their understanding and estimation of climate change risks overall.

A Three Dimensional Approach to Assessing Climate Risk

Developing a thorough understanding of climate change risk will help investors make more informed investment decisions. Evaluating vulnerability is critical to understanding a company’s climate risk because it helps identify how exposure to climate-related events will manifest as financial impacts. Two companies with similar exposure to a climate-related event may not face the same level of risk and financial impact; the differentiation is driven by their respective vulnerabilities, which may or may not extend beyond their direct operations. Current assessment approaches often narrowly focus on firms’ direct operations and fail to consider indirect impacts to their employees, local communities, customers and supply chains. This can lead companies and investors to underestimate their climate-related vulnerabilities and exposure to systemic risks that are costly to the economy.¹⁵

In 2012, the Intergovernmental Panel on Climate Change (IPCC) introduced a new approach to managing physical climate risk. Adopted by the climate science and policy communities, it defines physical climate risk in terms of hazards, exposure and vulnerability. Most companies and investors, however, have not adopted this comprehensive approach to assessing climate

risk. To facilitate its uptake, the Morgan Stanley Institute for Sustainable Investing has adapted and expanded the IPCC’s three-dimensional assessment framework so that it can be more readily used by investors and applied to both transition risk and physical risk. Our approach defines climate-related risk in terms of events, exposure and vulnerability.



CLIMATE RISK			
	EVENT	EXPOSURE	VULNERABILITY
Definition	Natural or human-induced incidents, either acute or chronic, that may have adverse effects on vulnerable and exposed people, communities, companies or investors	Factors that determine a company's level of risk should a climate-related event occur, such as its business activities in specific geographies or under certain legal jurisdictions	The underlying weaknesses that can exacerbate the consequences of exposure to climate-related events
Transition Risk (Examples)	Implementation of a price on GHG emissions (acute)	Portion of a company's business operations or supply chain covered by GHG emissions regulations	GHG emissions intensity
	Falling cost of energy storage technologies (chronic)	Portion of a company's product portfolio at risk of substitution	Lack of capital investments made or planned to mitigate technological disruption and displacement
Physical Risk (Examples)	Hurricanes (acute)	Location of a firm's key manufacturing facilities	Poorly maintained municipal transportation infrastructure limiting access to/from facilities
	Drought (chronic)	Key agricultural commodity suppliers located within drought prone areas	Seniority of suppliers' surface water and groundwater rights

Value of the Three-Dimensional Assessment Framework for Investors

The three-dimensional climate risk assessment framework encourages the application of systems-level thinking when considering climate change from an investment perspective. While climate change is a systemic issue affecting 93% of the capital markets or \$27.5 trillion,¹⁶ climate-related risk assessment approaches tend to be operations-centric and narrowly focused on exposure to a limited set of transition and/or physical events. Given the interrelated nature of companies, their supply chains, the communities they operate in and infrastructure they rely on, these approaches can lead investors to underestimate or misunderstand climate-related risks.

Our three-dimensional assessment framework helps illuminate the multi-faceted, and often unexpected, vulnerabilities companies face based on the systems they are exposed to, are a part of, or operate within. This perspective encourages deeper scrutiny of climate risk and a broadening of the scope of climate-related considerations, such as indirect risks and opportunities across supply chains.

Applying the framework can help investors differentiate between companies that may have comparable levels of exposure to similar climate events. Including vulnerability as a key climate risk consideration can help investors select securities, build portfolios and inform shareholder engagement strategies.

Event

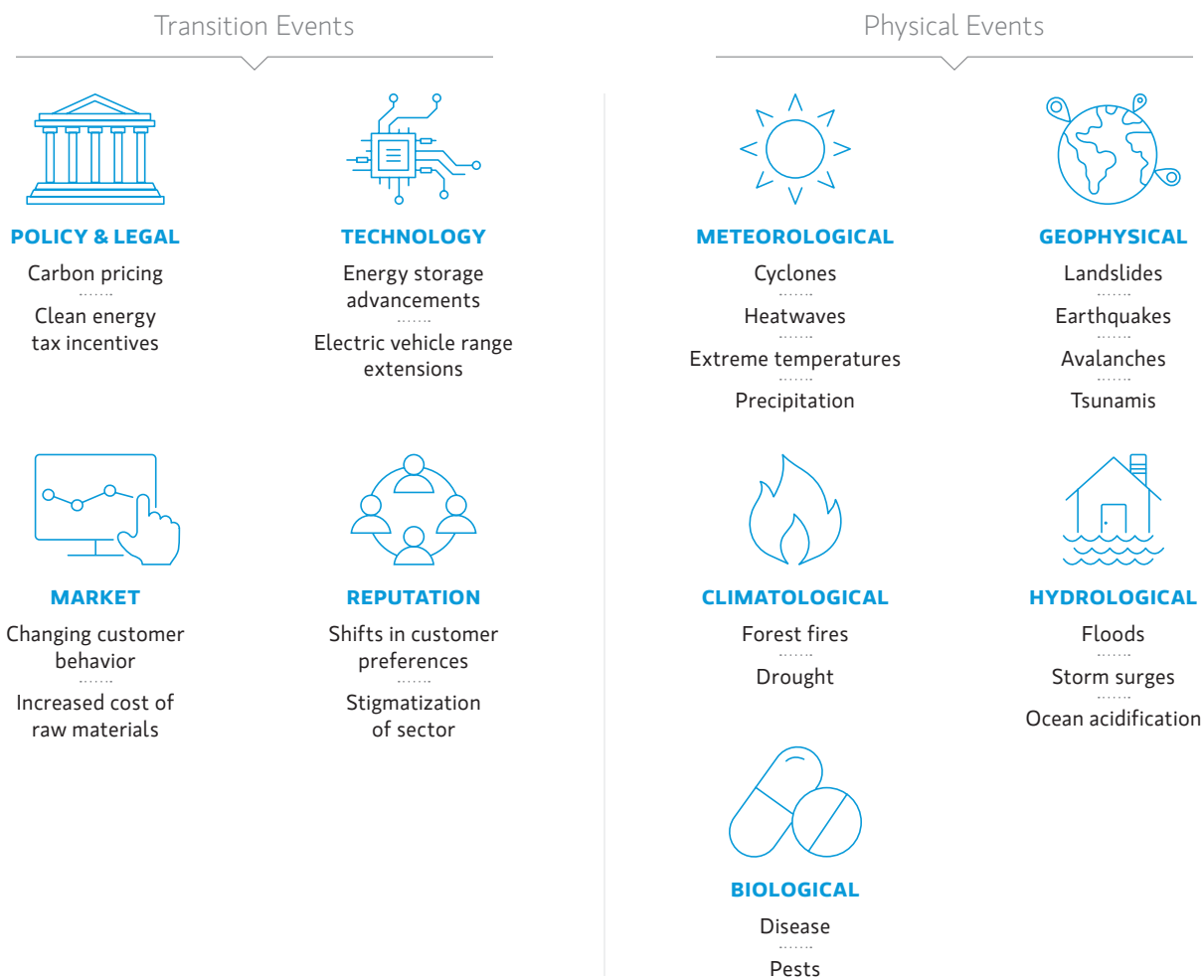
In the climate change context, ‘events’ that can impact portfolio companies cover a wide range of potential acute or chronic incidents, both natural and human-induced (Figure 3).¹⁷

Transition events are closely associated with reducing GHG emissions ushering in a low-carbon economy. Acute transition events, like the implementation of a GHG emissions pricing policy, occur at distinct points in time, whereas chronic transition events, such as the commercialization of next-generation energy storage technology, take place gradually over decades. Similarly, physical events encompass both acute weather hazards such as cyclones and floods, and chronic climate change impacts such as sea level rise or drought.

Determining the types of climate-related events that can occur and their likelihood, are important first steps for investors conducting thorough assessments of climate-related risks in their portfolios. Is it likely for a price to be imposed on GHG emissions within a certain country or region over the next three to five years? Would it take the form of an economy-wide tax or a sector-specific emissions trading scheme? Do cyclones or forest fires occur within a certain region? What is the likelihood in a given year? Are they expected to occur more frequently as the climate changes?

Thorough Assessments of Climate Risk Starts with Understanding Climate-related Events

FIGURE 3



Source: Adapted from *City Climate Hazard Taxonomy: C40's classification of city-specific climate hazards*, C40 Cities

Exposure

'Exposure' refers to the factors that determine whether or not a company will be impacted should a climate-related event occur. For transition risk, these factors may include direct (scope 1) or indirect (scope 2 and 3) GHG emissions, the sector or industry in which a company operates, and the legal jurisdiction of its operations and supply chains.

In the context of physical risk, exposure generally refers to the inventory of company-relevant elements in a geographical area prone to physical climate-related events. The presence of people, livelihoods, environmental resources and infrastructure, as well as economic, social or cultural assets helps determine physical risk exposure.²³

Vulnerability

'Vulnerability' describes the likelihood of adverse effects on companies due to the impact of climate-related events on people, ecosystems, biodiversity, economic sectors, cities, regions, and supply chains. Assessing vulnerability is a process of identifying and evaluating the underlying weaknesses that can exacerbate the consequences of exposure to climate-related events.²⁴

In the context of a transition event such as a GHG emissions pricing policy, factors affecting a company's vulnerability could include its GHG intensity or capital investments made or planned that do not align the business with science-based GHG emissions reduction targets. The financial impact of a GHG emissions pricing policy can vary significantly across companies in the same industry depending on the emissions intensity of their direct and indirect operations.

GHG-intensive companies will be more heavily affected by such policies and could potentially lose their competitive advantage over more GHG-efficient peers.

For physical events such as hurricanes or flooding, these factors could include whether a flood-zone located asset is raised or not, or the condition of the municipality's transportation infrastructure. While a company might harden the infrastructure of a key facility to weather a severe storm, if its workers cannot commute to work due to road damage or lack of power, it may still be forced to curtail production.

Developing a thorough understanding of climate vulnerability can also help identify investment opportunities where more resilient, better-prepared companies have the potential to outperform their peers as climate change risks grow.

Assessing Exposure: Hurricanes and the U.S. Atlantic and Gulf Coasts

While the frequency and severity of North Atlantic hurricanes over the last 30 years has increased,¹⁸ the number that have made landfall in the Continental U.S. has remained mostly stable since 1900.¹⁹ Their economic impacts, however, have risen significantly in recent decades due to increases in exposure along the U.S. Atlantic and Gulf Coasts. These areas have experienced increases in population, housing and wealth at rates faster than the national average. Economic damage during the 2017 storm season "was among the costliest ever recorded on a nominal, inflation-adjusted and normalized basis."²⁰

As climate change continues and coastal waters warm, these areas are likely to experience more severe, energy-charged hurricanes in the future.²¹ But even if these changes in frequency and intensity do not materialize, "losses from future hurricanes have the potential to dwarf those of the past based on societal changes alone."²²

Investors evaluating their exposure to hurricanes could start by understanding the value of their portfolio holdings' physical assets in hurricane-prone areas and whether these assets have appropriate insurance coverage. How critical are these assets to the direct and indirect business operations of holding companies? Are they covered by multi-peril policies? Do the policies include business interruption insurance? Determining exposure is a prerequisite to understanding vulnerability and gaining a comprehensive view of climate-related risk in order to inform portfolio decision making.

Assessing Vulnerability: Hurricanes and the U.S. Atlantic and Gulf Coasts

Two distinct vulnerabilities can exacerbate the economic consequences of increased hurricane exposure along the U.S. Atlantic and Gulf coasts:

CONSTRUCTION QUALITY AND EFFICIENCY OF BUILDING CODES

Following hurricanes Harvey, Irma and Maria in 2017, damage assessments found structures built in accordance with the latest standards and at proper elevations sustained less damage than older structures. “In Texas, the worst flood damage from Harvey often occurred to older-built structures constructed at ground level; while in Florida, structures built prior to current stringent codes developed after Hurricane Andrew (1992) performed much more poorly in areas where Irma’s radius of maximum winds occurred.”²⁵

INSURANCE COVERAGE

When Hurricane Harvey made landfall in Texas in August 2017, there were only 5.1 million active National Flood Insurance Program (NFIP) policies in the U.S, the fewest since 2005. This decline in insurance coverage, coupled with increased exposure along the Gulf coast, helps explain why only 30 percent of the category 4 hurricane’s huge economic impacts (approximately \$100 billion) were covered by insurance.²⁶

While insurance can help reduce climate vulnerabilities, an over reliance on insurance can become its own vulnerability. As the climate continues to change, access to cost-effective coverage can vary significantly year to year. Homeowners exposed to wildfire risk in California are experiencing this firsthand as insurance companies increase insurance premiums or refuse to renew policies altogether.²⁷

Assessing a company’s vulnerabilities to climate-related events can help investors determine how disruptive they would be to direct and indirect business operations, and whether the company maintains an advantage over its peers. It also provides an opportunity for thoughtful dialogue with company leaders on methods to improve climate-related risk management.

Investing in Climate Resilience

Climate vulnerability and resilience can serve as differentiating factors across a spectrum of sustainable and impact investing approaches, including restriction screening, environmental, social and governance (ESG) integration, thematic and impact investing, and shareholder engagement. As the availability of companies' climate-related risk and resilience data continues to improve, so too will investors' ability to fully act on the insights from their portfolio climate assessments.

Our three-dimensional climate risk assessment framework can provide investors with decision-useful information across a spectrum of sustainable investment approaches. By integrating

these climate-related risk and resilience insights, investors can develop a more nuanced understanding of risks and inform climate resilient investment strategies.

MITIGATE CLIMATE-RELATED RISKS —————> **LEVERAGE CLIMATE OPPORTUNITIES**

RESTRICTION SCREENING	ESG INTEGRATION	THEMATIC AND IMPACT INVESTING
<p>As the availability of climate-related risk and resilience data improves, opportunities for investors to develop restriction screens will increase. Investors might consider limiting portfolio exposure to companies that have significant transition and/or physical climate vulnerabilities. This approach can help minimize exposure to climate-related risks and align investments with an investor's core values or environmental goals, but can limit one's investable universe and may not be appropriate for investors interested in more proactive climate adaptation or mitigation solutions.</p>	<p>Improved data availability will also increase climate resilience-focused ESG integration opportunities. Investors may be interested in using resilience metrics to identify companies with strong mitigation and adaptation efforts. Key indicators for leadership on climate resilience can include:</p> <ul style="list-style-type: none"> • Capital investments made or planned to align business models with science-based GHG emissions reduction targets • Research and development investment in low emissions products and services 	<p>Investors interested in taking a more proactive approach to climate resilience can explore specific mitigation- or adaptation-focused themes or solutions:</p> <ul style="list-style-type: none"> • Clean energy and/or energy efficiency themed funds that can help mitigate GHG emissions through the products and services of the underlying fund holdings • Municipal green bonds with climate adaptation-focused use of proceeds • Sustainable infrastructure funds targeting mitigation and adaptation opportunities across infrastructure subsectors, including utilities, communication, energy and transportation

SHAREHOLDER ENGAGEMENT

Shareholder engagement can provide investors the opportunity to discuss and influence corporate strategies to manage climate-related risk and resilience. Active dialogue with senior leadership can help companies conduct their own three-dimensional climate change assessments, set GHG emissions reduction targets and make investments that take advantage of opportunities to reduce climate vulnerabilities and enhance resilience.

Data Availability and Its Impact on Climate-Resilient Investing

Efforts by organizations including the TCFD, SASB, the Climate Disclosure Standards Boards (CDSB), CDP and many others are helping to improve the quality and coverage of corporate climate-related risk and resilience data. These initiatives continue to advance environmental disclosure practices, drive collective understanding of climate-related risks and identify opportunities for investments in climate

resilience. Despite these efforts, access to certain climate change risk data continues to be a challenge. While the application of the three-dimensional assessment framework can be difficult with incomplete data, it can still provide investors with decision-useful information. Further, identifying these data gaps provides investors with important topics of conversation when engaging with company management.

Example Questions for Engaging Companies on Climate Risk and Resilience

GOVERNANCE

- Who is the most senior employee at your firm responsible for conducting climate risk assessments?
- What tools and resources does your firm provide employees to conduct assessments?

ASSESSMENT

- Does your firm conduct regular climate risk assessments? How? At what frequency?
- How does your firm measure exposure to transition and physical climate events?
- How does your firm evaluate climate vulnerabilities?

RESILIENCE

- How do company leaders use climate-related risk assessments to inform the firm's business continuity program, risk management systems and overall business strategy?
- Have climate-related risk assessments contributed to the way the firm considers business opportunities?

DISCLOSURE

- Does your firm disclose the findings of its climate risk assessments to investors? If so, how? If not, what are the obstacles to doing so?

Conclusion

Developing a thorough understanding of climate-related risk and resilience is increasingly important as the economic impacts of climate change grow and global action to address it accelerates. The three-dimensional climate risk assessment framework presented here offers one way for investors to improve their understanding of climate-related risks and identify opportunities to mitigate their exposure and vulnerabilities through investments in climate resilience.

Mounting economic impacts, recent actions from financial regulators around the world and growing interest from institutional and retail investors are but a few factors motivating investment professionals to consider and act on the investment implications of climate change.

Our climate risk assessment framework is the latest effort by Morgan Stanley's Institute for Sustainable Investing to provide actionable tools and analysis for investors seeking to mitigate climate risk and promote a low-carbon future. Where traditional approaches for assessing climate-related risk have often been limited in scope, the three-dimensional assessment framework

encourages the application of systems-level thinking. It is designed to help improve investors' understanding of climate-related risks and the estimation of its economic impacts and identify opportunities to build climate resilience through investments in mitigation and adaptation.

Morgan Stanley's Institute for Sustainable Investing is committed to exploring the various facets of climate-related risk and resilience in ways that advance collective understanding throughout the investment and business communities.

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