CENTER FOR CLIMATE AND ENERGY SOLUTIONS

CORPORATE CLIMATE RESILIENCE

Assessing the Landscape of Climate Risk and Supply Chain Resilience:

A Primer for Corporate Leaders and Climate Risk Professionals

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SUMMARY

Global supply chains face mounting risks from climate change, geopolitics, and economic volatility. While corporate resilience planning has grown since COVID-19, climate risk is still treated separately from supply chain management, creating gaps in preparedness. This report highlights how extreme weather events, such as floods and droughts, increasingly disrupt logistics and trade, with cascading impacts across industries. It reviews existing supply chain resilience frameworks, emphasizing visibility, flexibility, contingency, and collaboration, while noting the absence of climate-specific metrics and decision-useful disclosure tools. Barriers include data challenges, limited supplier transparency, and mismatched timelines between short-term operational planning and long-term climate assessments. The report calls for integrated approaches that align climate and supply chain practices, improved KPIs for resilience, and greater collaboration among businesses, policymakers, and researchers to safeguard continuity, competitiveness, and workforce health in a warming world.

HIGHLIGHTS

Rising Climate Threats to Supply Chains

Global supply chains are increasingly vulnerable to climate disruptions, with floods, droughts, and extreme weather events compounding geopolitical and economic risks. Businesses must integrate climate resilience into supply chain strategies to safeguard continuity, competitiveness, and long-term financial stability.

Gaps in Existing Resilience Frameworks

Current supply chain resilience frameworks emphasize visibility, flexibility, contingency, and collaboration but often overlook climate-specific risks. Companies need decision-useful metrics and tools that connect climate science with operational supply chain planning to better anticipate and withstand disruptions.

Barriers to Integration and Transparency

Barriers to integration include limited supplier transparency, poor data quality, and mismatched planning horizons—short-term logistics versus long-term climate risks. Overcoming these challenges requires new partnerships, innovative data use, and cross-disciplinary approaches that align climate and supply chain practices.

Climate as a Threat Multiplier

Climate change acts as a "threat multiplier," magnifying existing vulnerabilities in supply chains. Incorporating adaptation and resilience into corporate strategies is vital, especially as overshoot beyond 1.5 degrees C makes disruptions more frequent, severe, and costly for global businesses and communities.

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Supply chains are critical to global business

Supply chains are a crucial, yet often unappreciated lever in the global economy. In recent decades, increased globalization and macroeconomic trends like trade deals, technological progress, and growing comparative advantages between countries mean that a single Fortune 500 company can have operations and infrastructure spread out across the entire world. And while keeping a company's supply chain running smoothly is a critical business priority, the ramifications of supply chain resilience extend beyond the corporate level to humanitarian efforts and global governance.

Yet despite the profound importance of global supply chains to the overall economy, supply chain risk management today tends to operate separately from other communities of resilience practice, like climate risk. Likewise, as corporate climate risk assessment has matured over recent years, disclosure frameworks often overlook the logistics and trade networks that make up global supply chains, instead focusing only on particular metrics like asset-level risk.

To help bridge the gap between supply chain and climate risk assessment, and build better, more effective business risk management overall, this white paper is targeted at both supply chain leaders in the business community who might benefit from a deeper understanding of climate risk and climate risk practitioners who might benefit from the lessons that supply chain resilience practitioners have learned over the past decades.

Why do supply chain risk and resilience matter to business leaders?

Since the COVID-19 pandemic, which disrupted manufacturing and sent the costs of many critical goods skyrocketing, supply chain resilience has risen to the forefront of corporate strategy, planning, and operations. Because supply chains are global, a single disruption can spread across logistics networks and impact multiple companies in the same sector, or it could affect multiple suppliers for a single company.

Today's business leaders must be attuned to multiple drivers of supply chain risk, from geopolitics to climate or terrorism. One recent study found that supply chain disruptions lasting a month or longer will occur every four years, and large companies can, averaging across sectors, expect to lose ~45 percent of a year's profits to supply chain disruptions cumulatively over a decade.[1] Looking into the future for U.S.supply chains, recent policy efforts like the United States-Mexico-Canada Agreement (USMCA), CHIPS and Science Act, remaining provisions of the Inflation Reduction Act, and other policies have the potential to restructure supply chains for future industries like semiconductors and clean energy. And while the industrial climate and technology policies championed by the Biden Administration were challenged and amended by Congress in July 2025, the Trump Administration has introduced new priorities regarding shipbuilding and maritime power. Globally, recent geopolitical shifts and conflicts like Russia-Ukraine and Israel-Iran, coupled with changing U.S. tariff policy, introduce profound uncertainty into logistics and supply chain networks for global companies.

Climate risk is an increasingly visible threat to supply chains

Further complicating the picture for global businesses and their supply chains is the growing threat of climate change. While the intersection of supply chain and climate has tended to focus on decarbonization, measuring Scope 3 emissions, and disclosures; recent events, including growing drought in crucial waterways like the Panama Canal and the impact of Hurricanes Helene and Milton on Gulf Coast logistics networks, have driven home how resilience to physical climate hazards is critical for the future of supply chain management. For instance, in 2021, extreme rainfall and flooding in Vancouver disrupted port operations and caused $500 million a day in losses.[2] These single discrete extreme weather events stack on top of existing trade tensions, only increasing volatility in business planning.

The increasing frequency and impact of these disruption events mean that incorporating climate risk into existing supply chain resilience frameworks is an urgent imperative for policy, advocacy, and business communities. Additionally, as emissions pathways begin to orient toward a 2-to-3 degree world, and if overshoot past 1.5 degrees C continues, robust climate resilience and adaptation efforts that touch on all aspects of a business's activities are critical.

To support this broader goal, below we provide an overview of three foundational concepts that business and supply chain leaders and climate risk practitioners (the broadly defined community of practice that encompasses climate scientists, advocates and policymakers focused on risk and resilience assessment) will encounter when tackling the intersection of climate and supply chain resilience.

- **First**, what is supply chain resilience, and how is it currently practiced?
- **Second**, how does supply chain resilience as a discipline intersect with climate change and physical climate risk?
- **Finally**, where might opportunities for better collaboration and decision-making frameworks be developed?

Supply chain resilience: in concept and in practice

What is supply chain resilience?

Definitions of resilience can vary, particularly between industries, as resilience is an emerging, multidisciplinary field of practice.[3] For instance: many climate stakeholders take a broad view, and refer to resilience as: "the ability of interconnected social, economic and ecological systems to prepare for threats and hazards, adapt to changing conditions, and withstand and recover rapidly from adverse conditions and disruptions."[4] In supply chain risk management, resilience can be a narrower concept focused on the ability of a particular network to "anticipate, adapt, and respond to a disruption in order to gain a competitive advantage."[5] In general, resilience prioritizes foresight, flexibility, speed of recovery, and ideally, building toward a better position after a disruption has occurred.

Supply chains are typically thought of as the core inputs and processes that go into a company producing its products or services. These inputs and processes span multiple domains, but can be broken down into three key steps.

1. **Procurement**: First, a company procures, or sources, raw materials or components from producers or suppliers. For instance, a clothing retailer needs to buy cotton to produce textiles.
2. **Manufacture**: Then, a company's manufacturers take the raw material and produce finished goods or products—the cotton is turned into a shirt or a pair of pants.
3. **Distribution**: Finally, once the raw materials have been converted into a finished product, these products must be distributed to customers. This can take place via "last mile" delivery (e.g. Amazon dropping a package at a customer's door) or via retailers located in brick and mortar stores.

Crucially, at any of these steps, the company's *logistics network*—roads, bridges, vessels, and distribution facilities—brings the products from the raw material to the customer.

As global businesses have become more complex and densely networked, their supply chains can vary based on the level of "Tiers" that make up a product's production process. A company might work with a single direct supplier (T1) or have multiple upstream suppliers involved in its production process (T4 or T5). These suppliers are often engaged in complex contracting relationships that can make tracking a full supply chain difficult, even to the parent company that owns and sells the finished product. In recent years, as supply chain disruptions have become more common and corporate sustainability disclosure efforts have increased, "supply chain mapping" has become a niche field in and of itself, dedicated to the process of locating and identifying a company's full supply chain.

Disruptions to any of these core supply chain processes can cause operational disruptions and lead to lost revenue and other business

impacts. Today, the inherent complexity of multi-tier supply chains can increase the overall likelihood of disruptions from an increased "surface area" of risk.[6] For instance, a fire at a crucial factory might shut down production for multiple days, and research shows that disruptions to shared logistics networks, like port congestion, can triple overall losses.[7]

To address risks and mitigate potential damage, businesses focus on developing supply chain resilience, or the ability to withstand, adapt, and thrive after a disruption or other unforeseen event occurs. In recent years, but particularly since the COVID-19 pandemic, supply chain resilience has become a robust community of practice, with multiple existing frameworks for how best to conceptualize and operationalize supply chain resilience. Below, we summarize several existing frameworks focused on private sector supply chain resilience. While high-level, these frameworks provide best practices that can be tailored for a corporation seeking to build supply chain resilience. Framework providers emphasize that there is no one-size-fits-all approach to supply chain resilience, but by understanding fundamental components of a resilient supply chain and good outcomes, businesses can improve performance before, during, and after a disruption.

Corporate resilience frameworks

Framework 1: Pillars of Supply Chain Resilience

Visibility, Flexibility, Collaboration, Contingency, and Control

This type of framework focuses on core "pillars" or capabilities that make a company's supply chain resilient across its organization, processes, and technology.[8] The most important pillars for supply chain resilience include:

- **Visibility**: the ability to understand and see across the entire supply chain in order to support risk identification
- **Flexibility**: the ability to adapt quickly without increasing operational costs
- **Collaboration**: the ability to develop trustful cross-functional relationships internally and with the broader supply chain network
- **Contingency**: the planning structures that establish backups or options in case of disruption (e.g. extra inventory) that can maintain business continuity
- **Control**: the ability to implement policies that increase a company's control over its overall end-to-end supply chain

While pillar-based frameworks emphasize the importance of understanding a company's unique culture and context, these capabilities can be achieved through a variety of strategies. For instance, transitioning suppliers from single-sourcing to multi-sourcing can reduce the chance of a catastrophic failure. Synchronized production planning can help build contingency buffers that are cost-effective but built to maintain basic services.[9] Likewise, investing in cross-functional collaboration and visibility tools like data infrastructure can build overall organizational capacity while deepening supply chain resilience.

Framework 2: Supply Chain Resilience Across Time

Another key supply chain resilience framework focuses on resilience as a function of how an organization responds to disruption throughout time.[10] At each stage in the disruption process described below (anticipation, resistance, recovery, and response), this framework describes how organizations can benchmark themselves using different indicators.

- **Anticipation**: pre-occurrence stage, where a resilient supply chain's likelihood of disruption and impact should be understood ahead of time
- **Resistance**: if and when a novel disruption occurs, the resilient supply chain should be able to disable its negative effects quickly
- **Recovery**: after a disruption occurs, the resilient supply chain should be able to regain its original position.
- **Response**: ideally, a resilient supply chain is able to restore itself to a higher competitive advantage post-disruption

Framework 3: Supply Chain Resilience As A Function of Capacity

Additional supply chain resilience frameworks focus on the impacts on an organization's capacity and continuity planning.[11] In these frameworks, regardless of the type of risk, overall resilience is a function of how limited the impacts are on crucial dimensions of corporate capacity:

- The capacity to acquire materials (maintain supply).
- The capacity to ship and/or transport products.
- The capacity to communicate.
- The capacity to convert (internal manufacturing operations).
- The human resources (personnel) capacity.
- The capacity to maintain financial flows.
- The capacity to distribute products to customers including consumers.

By focusing on the capacity outcomes regardless of type of risk, this framework can build a more robust, diversified approach to overall resilience.

Public sector supply chain resilience: resources, stakeholders, and frameworks

Along with supply chain resilience efforts focused on corporations and the private sector, governments and NGO are important stakeholders that invest resources into developing their own supply chain resilience frameworks. This is particularly important in humanitarian and disaster response—a multi-stakeholder domain where supply chains play a critical role. While private sector entities are often key players in response and recovery, these efforts are often coordinated, funded, and managed by state and federal agencies. As such, the Federal Agency for Emergency Management (FEMA) offers several guides, resources, and frameworks that touch on community-level supply chain resilience.[12] Other federal

agencies focused on trade and commerce, like the General Services Agency, International Trade Administration (ITA) and the Office of the United States Trade Representative (USTR) publish resources and hold events focused on supply chain resilience.[13]

Additionally, NGOs and research organizations working on overall organizational resilience have developed important initiatives that cover aspects of supply chain resilience. *The World Business Council for Sustainable Development (WBCSD)* is prioritizing supply chain resilience in recent C-Suite level mobilization efforts. ResilienceFirst, a UK-based research group, has developed a cross-cutting model for organizational resilience that identifies supply chain as a key aspect of infrastructure resilience.[14] Multi-national institutions like the World Bank convene stakeholder groups to develop global supply chain resilience and also keep important indicators and data sets focused on supply chain resilience.[15] Trade groups like the Institute for Supply Chain Management (ISM), Association for Supply Chain Management (ASCM) and Council of Supply Chain Management Professionals (CSCMP) all offer convenings and thought leadership on current supply chain issues as well.

How is supply chain resilience currently measured?

While all of the frameworks and public and private sector efforts discussed here take different approaches to developing and supporting supply chain resilience, their core purpose can be boiled down to simple principles: maintaining the flow of goods and services before, during, and after a disruption.

To that end, supply chain resilience measurement is a crucial consideration. That's because developing metrics and key performance indicators (KPIs) that are organization-specific and trackable over time are a fundamental way to assess how resilient a supply chain is, and whether efforts to improve supply chain resilience are working. Below, we provide a summary of key supply chain resilience metrics and concepts that are in practice today. These metrics do not necessarily pertain to specific frameworks, though additional work to develop such a consistent mapping would be helpful—but instead these offer general metrics that companies can use to start to quantify supply chain resilience.

- **Business continuity:** the ability of a corporation to maintain critical business functions during and after an incident occurs. Critical business functions can be organization-specific, but focus on production, manufacturing, and delivery of goods to customers.
- **Time to Survive (TTS):** measures how long a supply chain can operate before failure
- **Time to Recover (TTR):** time required to recreate a company's lost capacity
- **Resilience (TTR < TTS):** Under this metric, an organization can be considered resilient if its supply chain's time to recover is shorter than its time to survive, since it can make up lost capacity before a customer is impacted.[16] We note that this is just one definition of supply chain resilience, and definitions can vary both qualitatively and quantitatively.

- **Time to Thrive (TTT):** measures how quickly a supply chain can implement changes that lead to competitive advantages after a disruption.[17]

As discussed, corporations can use these frameworks and metrics to track and build supply chain resilience by utilizing a variety of methods. Best practices methods may typically include supplier diversification, increased working capital to provide inventory buffers, better data integration and mapping to support supply chain visibility, to increasing end-to-end supply chain control through contracting and stakeholder engagement. To help companies in these efforts, service providers offer sub-tier supplier mapping, asset-level resilience scores, digital twin development to model disruption, and real-time visibility insights like container tracking.[18]

Examples of how supply chain resilience measures can reduce the impacts of disruption on businesses:

Sub-tier supplier visibility and mapping in response to geopolitical tensions:[19] large importers like auto parts suppliers can have highly regionally concentrated supply chains. For instance, a single supplier can import 70% of its parts from China. This creates strategic vulnerability as trade tensions rise between the US and China. An importer conducted supply chain vulnerability assessments and mapping exercises that balanced traditional metrics like cost and supplier reliability with novel risk exposure like geopolitics. As a result, the company identified opportunities to move 25% of their sourcing from China to other regions.[20] These strategic mapping exercises, coupled with scenario modeling and proactive relationship building with potential suppliers, increase resilience in the face of continued geopolitical tension.

Workforce planning changes in the aftermath of COVID:[21] While many lessons regarding supply chain resilience can be learned from the COVID-19 pandemic, one of the most relevant to future disruptions, including climate, is proactive workforce planning. Quicker transitions from in-person to remote work, or bringing in new automation technology, have been identified by business leaders as a post-pandemic opportunity to build supply chain resilience going forward. However, reviews of supply chain responses note that these transitions must balance effective management and employee well-being to be most effective.

The past decade of supply chain management research and practice has seen a clear focus on developing methods, frameworks, and resources for building supply chain resilience. Spurred by the pandemic, corporations now have a clear imperative to focus on supply chain resilience in their operations and strategy. At the same time, climate risk is emerging as a fundamental risk to businesses around the world, as recent disruptions like Hurricane Helene and Milton, and drought in crucial trade waterways, raise the salience of future climate risk.

How does supply chain resilience intersect with climate risk?

In addition to infrastructure vulnerabilities, pandemics, and geopolitics, climate risk is a fundamental driver of disruption to global supply chains. While weather events, like hurricanes, droughts, and extreme rainfall, have long been a core disruptor of maritime trade routes and commodity supply chains, the fundamental changes in the severity and frequency

of these events that climate change brings are an urgent challenge for supply chain managers. Below, we provide an overview of how supply chain is considered in current climate risk assessment efforts, including frameworks, key stakeholders, and metrics.

What are climate risks to supply chains?

Climate risks to supply chains take the form of *co-occurring* and *complex* physical and transition risks. They can be either chronic risks, like drought or extreme heat, or acute risks like floods, hurricanes, and fires. For instance, a wildfire in one manufacturing location can occur during the same time as a drought in a key transport waterway, all amid pressure to decrease emissions in line with local and international policy mandates.[22]

- **Physical Risks:** Risks from water—too much, in the form of rainfall and floods, and too little, in the form of drought—are particularly damaging to commodity supply chains and trade infrastructure like ports and railways. In addition, businesses with operations that depend heavily on water to generate materials and/or cool their critical infrastructure are heavily exposed to water related risks.[23] Other physical risks that impact a company's labor force, from extreme heat and wildfire smoke, mean that stress will fall on the production, manufacturing, and logistics functions of supply chains without better adaptation measures.
- **Transition Risks:** In addition to physical risks, supply chains face transition risks across shipping, logistics, and manufacturing, and procurement. For instance, recent policy efforts at the International Maritime Organization (IMO) and the inclusion of shipping in the European Union's carbon pricing mechanism threaten business models that do not transition to green fuels or reduce carbon emissions.[24]

For these reasons, climate risk presents an additional, long-term challenge for corporations in an already volatile macroenvironment. In addition, physical climate risk in particular is a "threat multiplier" that magnifies existing organizational weaknesses and vulnerabilities[25]—from security to changing disease patterns,[26] factors that all present unique threats to global supply chains. These threats and their associated costs are large and growing. Research consistently indicates that the intersection of climate risk and supply chains will drive billions, even trillions of dollars in losses to aggregate GDP.[27]

In addition to the current global context of risk, prioritizing future climate threats to supply chains is crucial as greenhouse gas reduction targets become harder to reach. In general, given overshoot of the 1.5 C degree goal of the Paris Agreement, climate risk assessments that envision 2–3 degree worlds and that focus on adaptation and resilience in addition to mitigation are critical for corporations to consider, alongside efforts to continue to advance decarbonization. C2ES recognizes the need to prioritize a both/and approach that aims for 1.5 C policy targets while being realistic about a warming world.

Understanding and measuring climate risks to supply chains

In recent years, understanding climate risk has become a core strategic business activity for many global corporations. Driven first by pressure from investors and civil society groups, such as the Task Force on Climate-Related Financial Disclosures—which has now been subsumed into International Financial Reporting Standards (IFRS) S1 and S2– and more recently codified into policy at the state and international level, like California's Senate Bill 261 (SB261) and the European Union's (EU) Corporate Sustainability Reporting Directive (CSRD), climate risk assessments that inform corporate sustainability disclosures are often the first step for a company trying to understand climate risk to its supply chain.

Climate disclosure frameworks and legislation typically identify supply chain risks as an area of focus.[28] Yet details and guidance from these disclosure entities, including methods to assess these risks, key performance indicators (KPIs) and definitions of supply chain resilience, remain vague. Instead, these disclosure frameworks tend to focus on how risks like floods, wildfires, and droughts impact a company's physical assets. These asset-level risks touch on supply chain issues, as they affect manufacturing locations and production facilities, but they can ignore the critical infrastructure upon which companies depend for business continuity as well as the logistics and transportation networks that also typify supply chains. In general, comprehensive, practice-oriented disclosure frameworks for assessing supply chain risk and resilience in the context of climate change appear yet to be developed, though early examples of companies taking action on climate risks to their supply chains do exist.

Examples of supply chain and climate risk assessment in practice

- **Protecting workers from heat risk:** The supply chain workforce is exposed to extreme heat and rising temperatures across the globe. This touches all aspects of supply chains, from production and agricultural labor to dock workers. Initiatives like the Health Action Alliance focus on protecting workers from extreme heat and have developed new tools that can help businesses quantify the future risk of heat stress on their labor force.[29]

- **Comprehensive supply chain risk mapping:** Agri-business, pharmaceutical, and food and beverage companies' supply chains are deeply exposed to changing weather patterns resulting in climate risk. Nestle, Coca-Cola, and Mercer International have all undertaken comprehensive supply chain risk assessment using both qualitative and quantitative methods to map future exposure to changing yields for key supply chain inputs like cocoa or timber.[30] Likewise, in partnership with Oxford Economics, a major pharmaceutical manufacturer developed a comprehensive materiality assessment for its global supply chain.[31]

- **Developing better climate risk decision-support:** Recent academic research has begun to tackle existing gaps in supply chain and climate risk assessment by proposing frameworks that look across perils to develop "climate report cards" for a company's key assets and logistics hubs.[32]

Key stakeholders in climate risk and supply chain resilience

Like other areas of climate risk practice, business organizations and NGOs play a crucial role in developing resources and organizing multi-stakeholder efforts to better understand climate and supply chain risk and resilience. This includes the Business Sustainability Roundtable (BSR), World Business Council for Sustainable Development (WBCSD), World Bank, and Business Continuity Institute (BCI), who collectively publish case studies, host events, and serve as a convening forum for ongoing supply chain and climate change issues (though as one component of a broader research and practice agenda).[33]

In addition, governmental efforts like the National Climate Assessment (NCA) have, to date, provided a deep dive into how different climate risks impact the United States, including supply chains. While these resources are not directly targeted at the business community, they have provided a fundamental source of knowledge on how climate risks impact sectors of the economy. The most recent NCA includes a thorough overview of climate-related supply chain impacts, particularly to the food supply.[34]Recent action to reduce financial and administrative support for the next NCA (in tandem with efforts to reduce public climate and weather data access to the National Oceanic and Atmospheric Administration (NOAA)) may limit the availability of important climate insights that can inform companies' supply chain strategies.[35]

Despite all these important efforts, the relative lack of benchmarks, disclosure frameworks, or focused stakeholder efforts indicates that more work is needed to build out decision-useful climate-related risk assessment in the context of supply chain resilience. Such efforts are critically needed, as investing in supply chain and overall business resilience strengthens business models, increases competitive advantage, protects workforce health, and can improve overall financial performance.[36]

Opportunities for better collaboration and decision-useful frameworks

Existing barriers

Climate risk is an urgent priority for global business leaders, while supply chain risk and resilience have also risen to the top of boardroom agendas. Yet despite the impact of these twin challenges to overall business resilience, barriers remain in terms of integrating climate risk into supply chain planning and vice versa. This can be seen in the relative lack of specific framework, metrics, and KPIs for tracking supply chain resilience to climate threats in disclosure frameworks, despite the growth in climate disclosure as a practice in the past decade.

Below, we identify three of the key barriers to better integration of supply chain and climate risk assessment and practice:

Problem Scope: Supply chain practitioners are long accustomed to navigating weather. As such, they tend to treat "every disruption as a disruption," including weather events like hurricanes and floods. The frameworks described above, particularly those that focus on supply chain outcomes like capacity, are agnostic to the underlying disruption, whether a labor strike or a hurricane. Climate as a discrete area of risk that must be understood and quantified is, therefore, a relatively novel concept to the discipline of supply chain management. This is reflected in the relative dearth of supply chain resilience tools that include long-term climate risk assessment modules. Likewise, climate risk practitioners are accustomed to working with models and tooling that address asset-level risks, but might be less familiar with logistics and transportation networks that require thinking about risk as a function of both space (location) and time.

Lack of Partnership Between Companies and Suppliers: In many cases, there are distinct barriers in communication and partnership between companies and their suppliers that impact overall supply chain risk management. For instance, suppliers often lack time and resources, and companies are wary of overburdening suppliers with questions and surveys. This general lack of transparency and partnership limits the ability of companies to understand their residual risk from climate change across their supply chain.

Timelines: Supply chain resilience focuses on improving operational decision making, often over short-term timelines (one week to one month) to undertake labor planning, asset allocation, rapid response etc. In contrast, climate risk assessments are seen as strategic planning tools that can look out over 30-year horizons to set better infrastructure standards or assess long-term risks to financing.

Data and Analysis: In addition to higher-order barriers around problem scope and timeline, core challenges remain with regard to both climate and supply chain data and analytics. Supply chains are characterized by a high degree of complexity, spanning multiple geographies and stakeholders. Methods for quantifying this complexity are improving, but harmonizing

new supply chain innovations in digitization and visibility with climate data and building frameworks for bridging temporal gaps remain to be solved. In addition, understanding the different components of risk can be challenging across a complex supply chain—for instance, companies may understand facility hazard and exposure from a heatmap, but not have insight into the suppliers' actual adaptive capacity.

- *Supply chain data challenges:* Data quality—particularly supply chain visibility and basic shipment tracking data—remains an issue in supply chain independent of climate variables.[37] While progress has been on asset-level supply chain mapping (including the tools mentioned above), sub-tier mapping is also still a challenge, even for large organizations.[38] Supply chain and climate risk assessments that have been done require multiple sources of data, from supplier location to shipment information, to climate hazard information.[39] Accessing and harmonizing all of this data requires a high degree of technical sophistication, computing infrastructure, and internal buy-in. Triangulating across data sources—for instance, using GHG value chain reporting data to identify factory locations—can be a helpful tool for also assessing and identifying physical risk.

- *Climate data challenges:* Using climate data to inform business decisions remains an ongoing area of work for practitioners and scientists. The market for decision-useful climate data continues to grow, but core challenges remain with quantifying uncertainty, making data accessible, and communicating the limitations of what climate science can, and can not, tell us with confidence.[40] For instance, while climate risk fits into the existing categories of what can disrupt supply chains (i.e. weather extremes), understanding future disruptions requires assessing location, likelihood, duration, and magnitude of a climate event. Existing climate risk models can provide directional information, but are designed to provide granular information at a resolution that might make sense to a business operator. Likewise, quantifying the "network effects" from a single asset-level disruption to second and third-order risk cascades that are fundamental components of supply chain risk assessment remains challenging.

Opportunities for improvement

Perhaps due to the perception that climate resilience requires a longer-term strategic focus or is primarily the domain of disclosure or voluntary efforts, while supply chain operations are a day-to-day component of business activity, these practice areas have been largely siloed from each other. Going forward, there are multiple areas where collaboration could help both disciplines build stronger businesses and communities overall. In general, there is a clear need to identify where within an organization climate and supply chain risk assessment, monitoring, and mitigation should sit, whether it's within Enterprise Risk Management (ERM), with a Chief Risk Officer, finance office with a Chief Financial Officer, legal department with a Chief Compliance Officer, etc. As the world gets riskier, companies need more innovative thinking around organizational governance and structure. Below, we identify three key areas for improvement and a high-level research agenda to begin to facilitate these improvements.

First, identifying where the practice areas and disciplines of supply chain and climate risk and resilience can learn from each other. For example, supply chain practitioners should be aware that, in contrast to other risks like terrorism or tariff policy that cannot be predicted with any degree of reliability, climate models can provide directional information regarding changing frequencies and magnitudes of known hazards like rainfall and extreme heat.

Likewise, climate risk professionals might benefit from the more operational outcome-focused frameworks that are well-developed in supply chain management. Core pillars like visibility, flexibility, and control are broadly applicable and valuable to business resilience regardless of the specific risk that is being assessed. Opportunities to advance these cross-disciplinary learnings include stakeholder gatherings and co-developed research.

Second, identifying strategies to overcome analysis gaps. For example, data limitations might be endemic in both supply chain and climate risk assessment, but creative methodologies can help organizations overcome data gaps and build better strategies. Mixed qualitative and quantitative approaches, like narrative-based scenario analysis or simulations using alternative data sources, can fill existing gaps without making a decision based on a particular data source or outcome. Better education between data practitioners on both sides will be helpful to encourage fundamental understanding of what we know with a high degree of likelihood, and where caution is warranted with overinterpreting results. Flexible pilot projects that test out some of these mixed-method strategies and offer interpretative guidance can be publicly shared to advance the state of knowledge.

Finally, there is a clear need for better KPIs and metrics that focus on building supply chain resilience to climate threats. Disclosure frameworks and now legislation like the EU's CSRD offer important guidance and high-level structures for physical risk assessment, but they can lack decision-useful information that helps businesses accomplish the fundamental goals of supply chain resilience—namely maintaining business continuity in the face of climate change. The leading stakeholder groups identified in this paper, which span science, practice, and business leadership, could focus on developing KPIs and metrics that are quantifiable and can scale toward market adoption.

Example research agenda to improve climate and supply chain risk assessment

1. **Targeted, topical stakeholder dialogues balanced across supply chain and climate risk experts.** These dialogues can start by presenting frameworks, methodologies, metrics, and case studies from each domain and then identifying existing gaps and challenges in data quality, analysis, strategy, etc, from both climate and supply chain risk perspectives.

2. **Facilitated deep dives into analysis challenges using indicative case studies.** Convening and research groups could then conduct collaborative deep dives into key issue areas. This could include strategies to invest in workforce protections, developing contracts to support supplier flexibility and diversification, and implementing responsive cross-organizational supply chain disruption monitoring. These deep dives could focus on leveraging different methods to overcome analysis barriers and using insights from both supply chain and climate risk experts.

3. **Reporting back learnings to inform the development of pilot KPIs and metrics that companies can test, deploy, and iterate on.** Learnings from such research can help answer key gaps in current practice. For example, there is a clear need for consensus on (1) climate risk metrics that scale across strategic and operational supply chain risk assessment, (2) business continuity KPIs that can be tracked over time, and (3) the extent to which KPIs need to be tailored to sectors or are generalizable.

Integrating supply chain and climate risk with resilience planning

For corporate leaders, building resilience, regardless of the underlying driver of risk, is now a core priority for business success. Changes in the macroeconomic environment such as trade policy, the rise of new technologies, and shifting geopolitical alliances and tensions, mean that the overall business environment is less stable than it was in recent decades. Climate risk, particularly given current rising emissions pathways, stacks on top of existing stressors and magnifies them. And global supply chains, whether procurement, manufacturing, distribution, or customer relationships, are all key areas where disruptions from these risks drive billions of dollars in business losses.

As such, building corporate resilience requires new frameworks, tools, and methodologies that bridge the gap between traditionally siloed domains like climate risk and supply chain management. In this paper, we've identified at a high level how the domains of supply chain resilience and climate risk assessment currently operate, where gaps arise, and opportunities for bridging these gaps. Both disciplines could benefit from lessons learned from the other.

In future work, C2ES will continue to leverage its policy expertise and business community leadership to help build more resilient businesses and communities, including through the development of supply chain and climate risk assessment frameworks and toolkits.

Endnotes

1 McKinsey & Company, *What is Supply Chain?* (New York: McKinsey & Company, 2021), *https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-supply-chain*; McKinsey & Company, *Risk, Resilience, and Rebalancing in Global Value Chains* (New York: McKinsey & Company, 2020), *https://www.mckinsey.com/capabilities/operations/our-insights/risk-resilience-and-rebalancing-in-global-value-chains*.

2 "Port of Vancouver Flooding Supply Chain Disruption Logistics," *Fortune*, December 1, 2021, *https://fortune.com/2021/12/01/port-of-vancouver-flooding-supply-chain-disruption-logistics/*.

3 Systemiq. *The Case for Resilience: A Growth, Stability & Competitiveness Agenda for COP30* (London: Systemiq, 2024), *https://www.systemiq.earth/the-case-for-resilience-a-growth-stability-and-competitiveness-agenda-for-cop30/*.

4 Center for Climate and Energy Solutions, *Corporate Climate Resilience Pathways* (Arlington, VA: Center for Climate and Energy Solutions, 2024), *https://www.c2es.org/corporate-climate-resilience-pathways/*.

5 Association for Supply Chain Management, "The ABCs of Supply Chain Resilience," *ASCM Insights*, 2024, *https://www.ascm.org/ascm-insights/the-abcs-of-supply-chain-resilience/*.

6 McKinsey & Company, *Risk, Resilience, and Rebalancing in Global Value Chains*

7 Jasper Verschuur, Elco E. Koks, and Jim W. Hall, "Systemic Risks from Climate-Related Disruptions at Ports," Nature Climate Change (published online September 2023), *https://doi.org/10.1038/s41558-023-01754-w*.

8 IBM, *Supply Chain Resiliency* (Armonk, NY: IBM Corporation, 2023), *https://www.ibm.com/think/topics/supply-chain-resiliency*; Deloitte, *Resilience Report – Marts 2023* (Copenhagen: Deloitte, 2023), *https://www.deloitte.com/content/dam/assets-zone2/dk/en/docs/services/consulting/2024/Resilience-Report-Marts-2023.pdf*.

9 SAP, "What is a Resilient Supply Chain?" *SAP* (blog), 2023, *https://www.sap.com/products/scm/integrated-business-planning/what-is-a-resilient-supply-chain.html*.

10 Chandra Shekhar Singh, Gunjan Soni, and Gaurav Kumar Badhotiya, "Performance Indicators for Supply Chain Resilience: Review and Conceptual Framework," Journal of Industrial Engineering International 15, Suppl 1 (2019): S105–S117, *https://doi.org/10.1007/s40092-019-00322-2*.

11 Supply Chain Management Review, "The Seven Core Capacities of Supply Chain Resilience," *SCMR*, 2024, *https://www.scmr.com/article/the_seven_core_capacities_of_supply_chain_resilience*.

12 12. Federal Emergency Management Agency, *Supply Chain Resilience Guide* (Washington, DC: U.S. Department of Homeland Security, 2020), *https://www.fema.gov/sites/default/files/2020-07/supply-chain-resilience-guide.pdf*; Federal Emergency Management Agency, "Resilience Analysis Planning Tool," accessed July 2024, *https://www.fema.gov/about/reports-and-data/resilience-analysis-planning-tool*.

13 Office of the United States Trade Representative, "USTR Publishes Policy Paper Series: Supply Chain Resilience," *USTR Press Release*, January 2025, *https://ustr.gov/about-us/policy-offices/press-office/press-releases/2025/january/ustr-publishes-policy-paper-series-supply-chain-resilience-0*; International Trade Administration, "Supply Chain Center Resources," *Trade.gov*, 2024, *https://www.trade.gov/supply-chain-center-resources*; General Services Administration, 2024 *Climate Adaptation Plan* (Washington, DC: GSA, 2024), *https://www.sustainability.gov/pdfs/gsa-2024-cap.pdf*.

14 Resilience First, "How to Make Your Business Resilient to Supply Chain Challenges in 2023," *Resilience First*, 2023, *https://resiliencefirst.org/news/how-to-make-your-business-resilient-to-supply-chain-challenges-in-2023/*; Resilience First, "What We Do: Organisational Resilience," *Resilience First*, 2024, *https://resiliencefirst.org/what-we-do/organisational-resilience/*.

15 World Bank, "Power BI: Global Supply Chain Resilience Dashboard," *World Bank*, 2024, *https://app.powerbi.com/view?r=eyJrIjoiZmQ5*...; World Bank, "Resilient and Inclusive Supply Chain Enhancement," *World Bank*, 2024, *https://www.worldbank.org/en/programs/egps/brief/resilient-and-inclusive-supply-chain-enhancement*.

16 Supply Chain Management Review, "Supply Chain Resilience Core Capacities Part 2: Lessons from Comparing Disruptions," *SCMR*, 2023, *https://www.scmr.com/article/supply_chain_resilience_core_capacities_part_2_lessons_from_comparing_disru*.

17 Association for Supply Chain Management, "What is Supply Chain Resilience?" *ASCM Topics*, 2024, *https://www.ascm.org/topics/what-is-supply-chain-resilience/*.

18 Resilinc; Everstream Analytics; Vizion (cited as referenced in report for commercial product information).

19 Boston Consulting Group, "Building Resilience: Strategies to Improve Supply Chain Resilience," *Boston Consulting Group*, 2021, *https://www.bcg.com/publications/2021/building-resilience-strategies-to-improve-supply-chain-resilience*.

20 Ibid.

21 World Economic Forum, "Supply Chain Resilience Lessons from COVID-19," *WEF*, 2021, *https://www.weforum.org/stories/2021/12/supply-chain-resilience-lessons-from-covid-19/*.

22 International Maritime Organization, "IMO Approves Net Zero Regulations," *IMO*, Press Briefings, 2023, *https://www.imo.org/en/MediaCentre/PressBriefings/pages/IMO-approves-netzero-regulations.aspx*.

23 World Business Council for Sustainable Development, *Business Leaders Guide to Climate Adaptation and Resilience* (Geneva: WBCSD, 2024), *https://www.wbcsd.org/wp-content/uploads/2024/04/Business-Leaders-Guide-to-Climate-Adaptation-and-Resilience.pdf*.

24 International Maritime Organization, "IMO Approves Net Zero Regulations,"; Carbon Market Watch, "FAQ: The EU ETS for Shipping Explained," *Carbon Market Watch*, December 6, 2023, *https://carbonmarketwatch.org/2023/12/06/faq-the-eu-ets-for-shipping-explained/*.

25 U.S. Department of Defense, "Hagel to Address 'Threat Multiplier' of Climate Change," *DoD Press*, May 2014, *https://www.defense.gov/News/News-Stories/Article/Article/603440/hagel-to-address-threat-multiplier-of-climate-change/*.

26 Marcia C. Phillips, Regina C. LaRocque, and George R. Thompson, "Infectious Diseases in a Changing Climate," JAMA 331, no. 15 (2024): 1318–1319, *https://doi.org/10.1001/jama.2023.27724*; UC Davis Health, "Experts Warn Climate Change Will Fuel Spread of Infectious Diseases," *UC Davis Health*, 2024, *https://health.ucdavis.edu/news/headlines/experts-warn-climate-change-will-fuel-spread-of-infectious-diseases-/2024/03*.

27 King's College London, "Climate Disruption to Global Supply Chains Could Lead to $25 Trillion Net Losses by Mid-Century," *Kings College London News*, 2024, *https://www.kcl.ac.uk/news/climate-disruption-to-global-supply-chains-could-lead-to-25-trillion-net-losses-by-mid-century*.

28 Task Force on Climate-related Financial Disclosures, *Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures* (TCFD, 2017), *https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf*.

29 Health Action Alliance, "Climate Health Cost Forecaster," *Health Action Alliance*, 2024, *https://www.healthaction.org/whatsnew/climate-health-cost-forecaster-press-release*.

30 World Business Council for Sustainable Development, *Business Leaders Guide to Climate Adaptation and Resilience*; Business for Social Responsibility, "Mercer International: Conducting a Climate Risk Assessment Using Scenario Analysis," *BSR*, 2024, *https://www.bsr.org/en/case-studies/mercer-international-conducting-a-climate-risk-assessment-using-scenario-analysis*; Business for Social Responsibility, "The Coca-Cola Company: Climate Resilience," *BSR*, 2024, *https://www.bsr.org/en/case-studies/the-coca-cola-company-climate-resilience*.

31 Oxford Economics, "Assessment of Physical Climate Risk in the Supply Chain," *Oxford Economics*, 2024, *https://www.oxfordeconomics.com/case-study/assessment-of-physical-climate-risk-in-the-supply-chain/*.

32 Jean-Louis Bertrand, Miia Chabot, Xavier Brusset, and Valentin Courquin, "Identifying Assets Exposed to Physical Climate Risk: A Decision-Support Methodology," International Journal of Production Economics 276 (2024): 109355, *https://doi.org/10.1016/j.ijpe.2024.109355*.

33 Business for Social Responsibility, *Climate and Supply Chain Management* (San Francisco: BSR, 2024), *https://www.bsr.org/reports/BSR_Climate_and_Supply_Chain_Management.pdf*; World Business Council for Sustainable Development, *Business Leaders Guide to Climate Adaptation and Resilience*; World Bank, "Resilient and Inclusive Supply Chain Enhancement," *World Bank*, 2024, *https://openknowledge.worldbank.org/entities/publication/aadc928d-e0f9-42fa-8280-36ed4b222429*; Business Continuity Institute, "Supply Chain Disruptions Drive Increased Tier Mapping and Insurance Uptake," *The BCI*, 2024, *https://www.thebci.org/news/supply-chain-disruptions-drive-increased-tier-mapping-and-insurance-uptake.html*.

34 U.S. Global Change Research Program, "Focus on: Supply Chains," in *Fifth National Climate Assessment* (Washington, DC: USGCRP, 2023), *https://nca2023.globalchange.gov/chapter/focus-on-4/*.

35 Oliver Milman, "US Scientific Societies Warn of Major Threats if Climate Assessment Downscaled," *The Guardian*, May 3, 2025, *https://www.theguardian.com/us-news/2025/may/03/us-scientific-societies-climate-report*; Steven Mufson and Maxine Joselow, "Trump Curtails Next Climate Assessment Even as Warming Accelerates," *Washington Post*, April 29, 2025, *https://www.washingtonpost.com/climate-environment/2025/04/29/trump-nca-climate-change/*.

36 Systemiq, *The Case for Resilience: A Growth, Stability & Competitiveness Agenda for COP30*.

37 Supply Chain Digital, "Tive Supply Chain Visibility Report 2025," *Supply Chain Digital*, 2025, *https://supplychaindigital.com/supply-chain-risk-management/tive-supply-chain-visibility-report-2025*.

38 Sustainability Magazine, "Sphera CPO & CSO Survey," *Sustainability Magazine*, 2025, *https://sustainabilitymag.com/articles/sphera-cpo-cso-survey*.

39 S&P Global, "An Apparel Company Assesses Climate Risks to its Supply Chain," *S&P Global*, 2025, *https://www.spglobal.com/market-intelligence/en/news-insights/research/an-apparel-company-assesses-climate-risks-to-its-supply-chain*.

40 A. J. Pitman, E. Saribatir, C. Greenhill, S. Green, S. J. Pitman, and T. Fiedler, "Linking Physical Climate Risk with Mandatory Business Risk Disclosure Requirements," Environmental Research Letters 19, no. 5 (2024): 054056, *https://doi.org/10.1088/1748-9326/ad4377.*