Navigating the Sustainability-Resilience Nexus

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FIGURES AND TABLES

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Executive Summary

Future human well-being depends on both sustainability and resilience at every scale, from the local to the global. However, sustainability and resilience historically have been pursued as separate endeavors, with each tending to treat the other as secondary or even subordinate. This separation is evident at the global policy level in many nations, including the United States, and in many corporations. Sustainability practices tend to focus on long-term well-being, while resilience practices tend to focus on coping with unexpected crises. However, this separation is limiting, because, in reality, sustainability and resilience have a complex, multi-faceted relationship. They may reinforce each other, or they may conflict. Pursuing them separately may emphasize one at the expense of the other, or may fail to capitalize on synergies.

It is important that disaster risk planning, preparedness, prevention, and recovery focus on resilience, so that people, ecosystems, and infrastructure can better withstand extreme events. Infrastructure that has been destroyed by such an event needs to be "built back better" to avoid repeated destruction. Data have shown that up-front investments in disaster risk management, prevention, and resilience result in savings that are multiple times greater than these initial costs.

This publication uses the term "sustainability-resilience nexus" to capture the complex relationship between sustainability and resilience. Global policy instruments such as the Sendai Framework for Disaster Risk Reduction 2015-2030 and the Sustainable Development Goals attempt to capture the synergies between these two concepts, yet do not explain *how* this nexus is to be implemented.

In the corporate context, sustainability tends to be managed by a Chief Sustainability Officer or similar position, while resilience tends to be managed by a Chief Risk Officer or Chief Financial Officer. These functions may exist in silos that have not engaged with each other as effectively as possible, despite the potential tradeoffs and synergies in areas such as facilities and supply chain management.

The sustainability-resilience nexus recently is coming into sharper focus. Examples include:

- The United Nations (UN) Office of Disaster Risk Reduction (UNDRR) has identified pathways to better align resilience with the Sustainable Development Goals (SDGs), and is the primary UN agency managing disaster risk and resilience. The European Union's (EU) recent Corporate Social Reporting Directive (CSRD) firmly ensconces the connections between sustainability and resilience in law, and will over several years affect about 50,000 companies globally. The Task Force for Climate-Related Financial Disclosures (TCFD) invites corporations to consider risks and opportunities related both to sustainability and to resilience. TCFD is referenced in the rubric that underpins the European CSRD.[1]
- A growing range of civil society organizations, such as the Resilient Cities Network, the C40 Cities Initiative, and others, explicitly or implicitly are connecting the different elements of this nexus, as are a growing number of companies.

This report suggests that public and private sector decision makers can take a number of actions to better account for the sustainability-resilience nexus, including the following:

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[1] United Nations Environment Programme (UNEP) Finance Initiative. "European Sustainability Reporting Standards." https://www.unepfi.org/impact/interoperability/european-sustainability-reporting-standards-esrs/. ESRD will govern implementation of the environmental sections of the CSRD and explicitly calls for disclosures of climate related physical risks. In addition to the EU, Brazil, Hong Kong, Japan, New Zealand, Singapore, and Canada have all adopted the TCFD's Framework to some degree. See, for example: https://www.onetrust.com/blog/getting-to-know-the-task-force-on-climate-related-financial-disclosures-tcfd/#.

    - Adopt clear definitions of sustainability and resilience and steer the organization towards an integrated approach for strategy development and implementation.
- Identify a key point person, team, or department to better manage, integrate, and align sustainability and resilience efforts across organizational departments or silos (for example, the Chief Risk Officer).
    - Recognize the interconnections between businesses and their surrounding communities (for example infrastructure usage, where workers reside), and engage key stakeholders in relevant decision-making processes.
    - Anticipate future trajectories of markets and supply chains, and seek competitive advantage by leveraging an understanding of sustainability and resilience opportunities (for example, alternative supplies, suppliers, and supply routes).
- Deploy metrics to evaluate progress toward mastering the sustainability-resilience nexus.

Additional steps that companies can pursue to enhance their sustainability and resilience, separately and in conjunction with one another, include the following:

- Strive to embed resilience and sustainability into core business processes, including planning, design, procurement, manufacturing, marketing, and supply chain management. Companies should consider a variety of strategies to improve their *inherent* supply chain resilience.
- Align risk management with sustainability and resilience efforts, given that risk is the underlying factor common to the sustainability-resilience nexus. Doing so likely will capture the co-benefits and opportunities that might be missed when focusing on a narrow set of risks.
- Reconcile corporate financial goals and decision-making, which tend to focus on the near-term (e.g., quarterly, annual), with sustainability and resilience goals over longer time horizons.
- Leverage federal, state, and local financial incentives, such as tax credits, to help achieve the sustainability-resilience nexus, and encourage business partners to follow suit.
- Encourage an anticipatory approach throughout corporate cultures and workforce capacity building efforts, including educating cross-functional teams on how resilience and sustainability initiatives can yield measurable returns on investment.
- Considering a variety of strategies to improve inherent supply chain resilience, given the particular vulnerability of supply chains to sudden disruptions, such as the following:
    - Improve surge and back-up capacity;
    - Create greater flexibility in sourcing and manufacturing;
    - Build agility and adaptability in responding to challenges;
    - Develop an ability to anticipate and detect signals of change;
    - Distribute assets and resources in a geographically diverse manner; and,
    - Improve supply chain visibility through information technology.
- Adopt existing tools and methodologies that help to characterize the sustainability and resilience implications of corporate strategies and practices, as well as decision methods that help to analyze the implications of alternatives, including unexpected consequences.

Finally, to support effective management of risks and opportunities, industry associations should continue working with their members to develop new metrics, tools, and scientific protocols for quantifying business goals and trade-offs in an increasingly complex decision space.

1. Introduction

The global economy is experiencing increasing turbulence, including changes in national leadership across the globe, with associated policy changes and economic repercussions, as well as extreme weather events, and resource and supply chain shortages. Businesses, governments, and non-governmental organizations (NGOs) have responded with a growing emphasis on two strategic imperatives: sustainability—ensuring the continued well-being of humans and the planet; and resilience—building the capacity to anticipate, prepare for, mitigate, and recover from crises, and to continually adapt to turbulent change.

Historically, pursuit of these two imperatives has proceeded along different, often uncoordinated paths. Sustainability has been largely addressed as an environmental and social management challenge, focused on improving human and ecological well-being. Resilience has been largely addressed as a risk management challenge, focused on assessing potential vulnerabilities, anticipating and preparing for disruptions, and responding effectively to them.

Within businesses and governments, these two imperatives are frequently overseen in different departmental silos. Sustainability typically is managed within the Environmental, Social and Governance (ESG) function, often by a Chief Sustainability Officer (CSO), with resilience responsibilities typically being in the purview of a Finance or Risk Management function under a Chief Financial or Chief Risk Officer. These functions might or might not communicate effectively with one another, so coordination on decision-making tends to be sporadic.

This disparateness is problematic because, although sustainability and resilience are distinct, they are intertwined. Together, they encompass the characteristics and operations of multiple systems, and should be addressed in an integrated manner.[2]

On one hand, there are causal interactions between sustainability and resilience, and “cascading effects” that result. For example, global climate change exacerbates the potential for more frequent and severe weather events, while increasing urbanization likely will concentrate growing numbers of people and assets in harm's way. These implications are increasingly reflected in evolving policies, standards, practices, tools, and methods. Yet the authors of this paper are aware, based on research and professional experience, that many companies are still wrestling with new levels of internal coordination needed to address this nexus.

Being aware of potential trade-offs between sustainability and resilience is vital. Examples of potential trade-offs include instances in which hardening assets may require more concrete or steel, which typically are considered less sustainable materials; or, in which supply chain resilience might require redundancies of operations, processes, or component parts. Yet many companies are discovering a "sweet spot" through actions that optimize both sustainability and resilience in profitable and productive manners. An example is the introduction of “circularity” approaches, whereby industrial wastes can be converted to byproducts that are used either internally or externally, thus reducing dependence on long supply chains while avoiding environmental burdens.

ARISE-US uses the term "sustainability-resilience nexus" to refer to this “sweet spot.” To invest wisely in appropriate innovations and solutions for navigating this nexus, and to meet various standards and

[2] A systems approach is needed to mitigate global risks due to interactions among multiple stresses and shocks. See Fiksel, J. and B.R. Bakshi. “Designing for Resilience and Sustainability: An Integrated Systems Approach” (Ch. 21) in B.R. Bakshi (ed.). *Engineering & Ecosystems: Seeking Synergies Toward a Nature-Positive World*. Springer. 2023.

evolving reporting requirements, companies need to understand and account for these interactions, and the implications for successful outcomes in both the short- and long-term.

Recognizing the opportunity to better integrate sustainability and resilience, a team of ARISE-US[3] experts researched and analyzed current gaps, barriers, and opportunities associated with the sustainability-resilience nexus from the local to the global scales. In doing so, the team conducted interviews with several businesses, including both members of ARISE-US and non-members. This report reflects the results of these efforts, and is intended to serve as guidance to help both the public and private sectors understand and address the sustainability-resilience nexus.

The report is intended for two major audiences:

- Those in companies and governments seeking to understand how sustainability and resilience interact and how they can better address this interface; and,
- Those in the policy-making arena seeking to create a workable synthesis of the many "partial" policies on sustainability and resilience.

The remainder of this report is structured as follows:

- Section 2, *Essentials for Human Progress*, portrays the dimensions of the complex systemic relationship between sustainability and resilience.
- Section 3, *Global Policies and Principles*, highlights relevant local, national, and trans-national sustainability and resilience policies and practices. It also contains recommendations that can help the public and private sectors better plan, prepare for, prevent, and recover from disasters, by more holistically addressing sustainability and resilience.
- *Section 4, Corporate Frameworks and Case Studies,* describes leadership in the private sector aimed at managing and harmonizing sustainability and resilience, and offers some relevant resources and recommendations.
- Section 5, *Available Tools and Methods*, surveys selected tools and techniques that organizations may use to assess and coordinate sustainability and resilience.
- Section 6, the *Conclusion*, summarizes the implications of the previous Sections and provides recommendations for paths forward.
- *Appendices A and B* elaborate on the policies and tools identified in Sections 3 and 5, respectively.

[3] ARISE-US is the US Network of ARISE, the Private Sector Alliance for Disaster Resilient Societies, established globally, and led by, the United Nations Office of Disaster Risk Reduction (UNDRR) in 2015 to build public-private collaboration in disaster risk reduction (DRR). ARISE seeks to energize the private sector in collaboration with the public sector to achieve disaster risk reduction in a transparent and inclusive way that delivers local and measurable impacts.

2. Essentials for Human Progress

This ARISE-US initiative began with the premise that future human well-being is dependent on both sustainability and resilience at every scale, from local to global. The authors of this report have not attempted to reconcile the many existing definitions of sustainability and resilience, but offer this common understanding, in brief:

- "Sustainability" is a widely used term, connoting simultaneous pursuit of environmental protection, economic development, and social well-being. While climate change is an important concern, there are many other interwoven stresses, such as habitat loss, ecosystem and human health, and food insecurity. Corporate sustainability practices range from reductions in energy use and waste, to socially responsible outreach, to innovations and redesign of existing businesses and technologies.

> *Many companies in our research do not specifically define sustainability, and even fewer define resilience.*
>
> *Some company interviewees characterized resilience as a quality of the finances of the business – with the physical resilience of locations and supply chains as components of financial fitness. Others include cybersecurity as part of resilience.*

- "Resilience" is a more ambiguous term, often confused with sustainability. It connotes the capacity to anticipate, prepare for, avoid, absorb, adapt to, and/or recover from potential stresses and shocks. Corporate resilience initiatives range from enterprise risk management to business continuity planning and adaptive redesign of buildings, business processes, and supply chains. One important point in this context is that resilience is not just about mitigating risks. It also requires foresight, adaptation and agility. In this sense, resilience is as much about "bouncing forward" as it is about "bouncing back."

In an ideal state, there is a reciprocal flow of value between companies and communities. Companies provide goods, services, jobs, and economic prosperity within the community, while communities provide infrastructure, human resources, and financial investment. In addition to natural resources and raw materials, the environment provides a variety of ecosystem services and associated benefits.

Well-chosen interventions can increase sustainability and resilience, while delivering positive returns on investment. For example, it is possible to reduce water and waste management costs by utilizing "green infrastructure"[4] or by adopting "circular economy" practices[5] that recover value through waste conversion. Some may require capital investment, while others – such as improved collaboration with

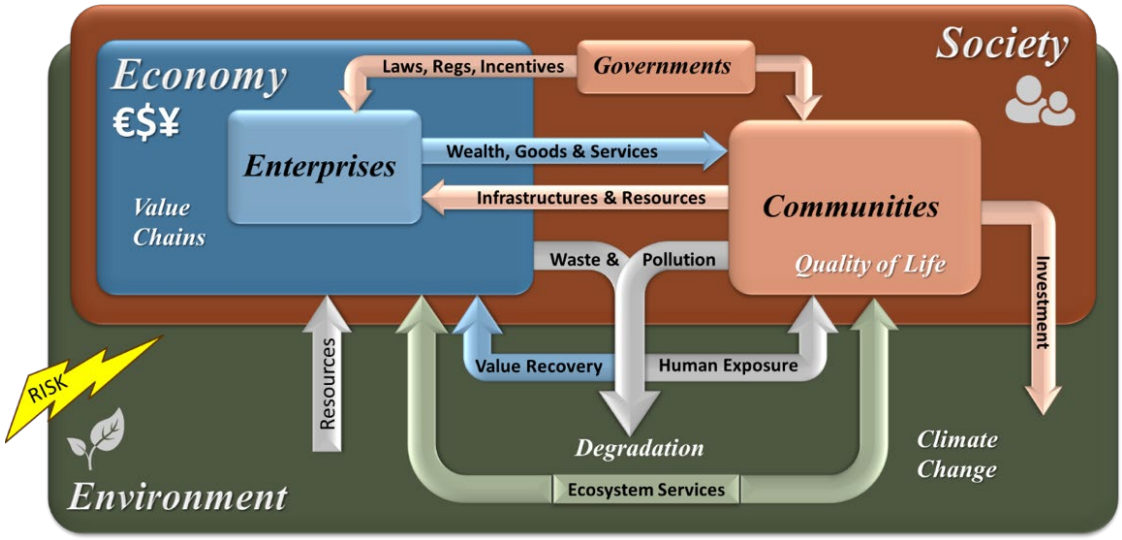
[4] See for example: U.S. Environmental Protection Agency (EPA). "Benefits of Green Infrastructure." https://www.epa.gov/green-infrastructure/benefits-green-infrastructure.
[5] See for example: World Resources Institute (WRI). "5 Opportunities of a Circular Economy." https://www.wri.org/insights/5-opportunities-circular-economy.

suppliers –may generate substantial benefits. Ideally, companies can strive for "inherent" resilience by redesigning products and processes in ways that both improve profitability and increase resilience.

Sustainability and resilience, although different, are mutually dependent—resilience is a necessary condition for long-term sustainability, and sustainability is an important foundation for ongoing resilience to enhance disaster risk management. Of course, trade-offs between the two can arise—increased resilience may demand additional resources—but through careful analysis, companies can maximize the synergies and balance the trade-offs (see Section 5).

To provide insights into the sustainability-resilience nexus, Figure 2.1 below provides a comprehensive systems view that illustrates the flows of value among society, the economy, and the environment. This paradigm, known as the Triple Value Framework, was developed by the Center for Resilience at The Ohio State University, and has been utilized by private sector firms as well as the U.S. EPA.[6]

Figure 2.1: Systems View of Value Flows: The Triple Value Framework[7]



One engineering company interviewee suggested that climate mitigation is the focus of sustainability and climate adaptation is the focus of resilience.

In another case, different functions within a single company chose to define, or view, resilience as a characteristic of supply chains (sometimes almost to the exclusion of the parent company and its overarching policies), as well as addressing climate adaptation, fire-proofing, business continuity, disaster recovery, or product stewardship.

Many organizations, including several interviewees, have found it helpful to adopt a systems approach that accounts for the full life cycle of the assets, products, and services in question. Understandably, companies with complex supply chains are often among the first to use systems thinking to map and plan for both the sustainability and the resilience of their

[6] U.S. Environmental Protection Agency. Sustainability and the Report on the Environment (ROE). 2024. https://www.epa.gov/report-environment/sustainability-and-roe.

[7] Adapted from: Fiksel, J. *Resilient by Design: Creating Businesses That Adapt and Flourish in a Changing World.* Island Press. 2015.

businesses. ARISE-US found this to be the case; for example, one food ingredient company is integrating its small-holder farmer sustainability efforts to integrate resilience tactics as appropriate, thus improving overall outcomes.

The dynamic equilibrium depicted in Figure 2.1 can be disrupted by sudden, unexpected events, such as regional conflicts, pandemics, supply chain failures, or natural disasters. Improving the resilience of critical assets and resources can offset these risks and protect value flows. Unexpected events or consequences can yield opportunities. Proactive sustainability and resilience actions often are expected to lead to cost-effectiveness, substantial savings, and co-benefits. For example, improving a product's sustainability also can improve its performance; and "hardening" an asset may improve its reliability and thereby lower its operating costs.

3. Global Policies and Principles

This Section provides an overview of select global and United States-based entities and agreements, highlighting policies, principles, and examples that are relevant to the sustainability-resilience nexus. These entities include international bodies, such as the United Nations (UN) system and international financial institutions (IFIs), as well as national and local governments, the private sector, and civil society entities. A recent global trend has evolved toward a more closely coordinated and holistic approach to addressing sustainability and resilience, as reflected in this analysis. Companies interviewed for this report referred to the power of policies to drive change in their organizations and along their supply chains. Comprehensive, systems-oriented policies often lead to the development of models, tools, and mechanisms that influence strategic direction regarding sustainability and resilience, help establish standards and protocols, and improve decision-making. Appendix A elaborates on the key agreements and entities highlighted herein, and explores how these agreements link sustainability and resilience.

3.1. Relevant United Nations Organizations and Frameworks

To increase the likelihood of meeting the United Nations' (UN) sustainability, climate change, disaster risk reduction, and resilience 2030 goals, the UN system and its agencies are directing their strategic policy frameworks, programs, actions, and stakeholder engagement, as well as tools, methods, metrics, and scenarios, in a manner that more intentionally fosters cross-coordination and integration of sustainability and resilience. As 2030 targets loom, these steps are essential to prevent the worst anticipated extreme weather events and climate impacts (including potential "tipping points"), including related losses of water, food, and energy resources, human lives, and ecosystem services.[8] These deadlines, events, and impacts also serve as catalysts for UN agencies individually and collectively to play important roles in engaging governments, non-governmental organizations (NGOs), businesses, and other stakeholders, including underrepresented groups, to improve their disaster risk management in ways that maximize opportunities to more fully align and integrate sustainability and resilience.[9]

This Section focuses on the United Nations Office of Disaster Risk Reduction (UNDRR)[10] as the primary UN agency responsible for disaster risk management and resilience. The UNDRR also aligns with the UN's 2030 Agenda for Sustainable Development (2030 Agenda)[11] and associated 17 major SDGs,[12] as well as the UN Framework Convention on Climate Change (UNFCCC)[13] and its Paris Agreement on Climate Change (Paris Agreement),[14] which are the primary UN entities and frameworks involved in further enhancing disaster risk management and in fostering the sustainability-resilience nexus. This Section also highlights some major policy mechanisms that stem from these key entities and agreements.

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[8] Lenton, T.M., et. al. *The Global Tipping Points Report 2023.* https://report-2023.global-tipping-points.org/.

[9] "From the earliest days of the corporate responsibility movement, stakeholder engagement has been emphasised as a necessary part of any good corporate sustainability strategy and practice."
Global Compact Network Germany. *Stakeholder Engagement in Human Rights Due Diligence*. United Nations Global Compact, twenty fifty. 2014.
https://www.globalcompact.de/migrated_files/wAssets/docs/Menschenrechte/stakeholder_engagement_in_humanrights_due_diligence.pdf.

[10] United Nations Office of Disaster Risk Reduction (UNDRR). https://www.undrr.org/our-work/our-impact.

[11] UN Department of Economic and Social Affairs (UN DESA) – Sustainable Development. "Transforming our world: the 2030 Agenda for Sustainable Development." https://sdgs.un.org/2030agenda.

[12] UN DESA – Sustainable Development. "The 17 Goals." https://sdgs.un.org/goals.

[13] UN Climate Change. "What is the UN Framework Convention on Climate Change?" https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change.

[14] UN Climate Change. "The Paris Agreement." https://unfccc.int/process-and-meetings/the-paris-agreement.

3.1.1. The UN Office of Disaster Risk Reduction, Sendai Framework, and Related Mechanisms

UNDRR promotes resilience strengthening through "multi-hazard disaster risk management."[15] As such, it supports the Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework), which highlights disaster risk reduction and ways to enhance resilience and sustainability. It grew from the UNDRR's recognition of the "convergence between disaster risk reduction, sustainable development, financing for development, and climate change mitigation and adaptation."[16] It also highlights the importance of the consequent incorporation into the global policy agenda of a "common message: understanding hazards, how they interact and [how] managing exposure and vulnerability are imperative for development to be sustainable."[17] This confluence "presents a unique opportunity for increased coherence and global impact,"[18] serving as a guide for the private sector, civil society, and other stakeholders. The Sendai Framework further helps to draw connections between sustainability, risk reduction, and built resilience, because, as it states, "a better understanding of risk, strengthened risk governance, increased investment and better preparedness creates a foundation for the resilience of people, communities, governments and businesses."[19] It consists of four priorities, seven targets, principles, and several dozen monitoring indicators (see Appendix A).[20] The Sendai Framework is not the only global agreement that seeks to achieve these goals, as this Section and publication also reflect.

An operational mechanism to accelerate the Sendai Framework's implementation at the local level is the "Ten Essentials for Making Cities Resilient" (Ten Essentials).[21] The Ten Essentials are meant to include all sectors and elements of a community, including planning and organizing for disaster prevention, preparedness, and response, community engagement, protection of ecosystem and essential services, and building back better (see Figure 4.1). The Ten Essentials map directly to the Sendai Framework's priorities for action and its indicators for monitoring actions on disaster risk reduction. These essentials – along with later addenda on public health, food supply, cultural artifacts, and persons with disabilities – are the critical and independent action areas that need to be addressed to build and maintain resilience. They represent a key construct for guidance[22] and are deployed by the ARISE Global Network and Making Cities Resilient 2030 (MCR 2030),[23] among other entities.

The UNDRR-led MCR 2030 works with over 1,000 cities globally, in partnership with ARISE, UN-Habitat, UNDP, the Resilient Cities Network (RCN; formerly known as the Rockefeller Foundation's 100 Resilient Cities Initiative),[24] the C40 Cities Initiative (C40), and others.[25] MCR 2030 aims to help cities become

[15] UNDRR. "Our impact." https://www.undrr.org/our-work/our-impact.
[16] Ibid.
[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] UNDRR. "What is the Sendai Framework for Disaster Risk Reduction?" https://www.undrr.org/implementing-sendai-framework/what-sendai-framework.
[21] UNDRR. Making Cities Resilient 2030 (MCR 2030). "The Ten Essentials for Making Cities Resilient." https://mcr2030.undrr.org/ten-essentials-making-cities-resilient.
[22] Genser, Ebru. *How to make cities more resilient: a handbook for local government leaders.* UNDRR, MCR 2030. 2017. Page 32. https://www.undrr.org/publication/how-make-cities-more-resilient-handbook-local-government-leaders-2017.
[23] MCR 2030. https://mcr2030.undrr.org/who-we-are.
[24] Resilient Cities Network (RCN). https://resilientcitiesnetwork.org.
[25] C40 Cities. "Our History." https://www.c40.org/about-c40/our-history/.

more sustainable, resilient, and safe by 2030, in line with the goals of the Sendai Framework, the SDGs, the New Urban Agenda (NUA),[26] and the Paris Agreement. Alignment of MCR 2030 with global agreements, especially the SDGs, provides communities with insights and pathways to achieve the sustainability-resilience nexus.

Figure 3.1: Overview of the "Ten Essentials for Making Cities Resilient[27]

UNDRR's "Global Assessment Report on Disaster Risk Reduction" (GAR)[28] notes that measuring and addressing current "resilience deficits" in a holistic manner can help build resilience as a foundation to accelerating progress toward achieving the UN's SDGs. The GAR maps various threats, such as natural, slow-onset, and technological ones, to the associated SDGs. It also discusses the importance of investing in early warning systems, which have a proven ability to yield triple benefits in reducing damaging impacts, especially for vulnerable populations.

UNDRR also operates a "Stakeholder Engagement Mechanism" (SEM),[29] which leverages the Sendai Framework and engages state and "non-state" stakeholders (of which ARISE is one), to ensure that all of society, including underrepresented populations, plays a greater role in decision-making, knowledge sharing, and helping shape policy processes to more effectively reduce disaster risks. The SEM aims to better integrate disaster risk reduction into the broader 2030 Agenda.

ARISE-US created, with support from UNDRR, MCR 2030, and other entities, a "Disaster Resilience Scorecard for Cities"[30] (Scorecard) as another means to facilitate urban resilience. The Scorecard is used by over 400 cities and variants have been or are being developed for specific risks, such as wildfires and coastal hazards. Relatedly, the Santiago Network, hosted by UNDRR and the UN Office for Project

[26] UN Habitat. "New Urban Agenda." https://unhabitat.org/about-us/new-urban-agenda.
[27] ARISE-US/CrowdDoing. Catastrophic Wildfire Prevention & Consortium. "Community Wildfire Resilience Scorecard." https://wildfirescorecard.onrender.com.
[28] UNDRR. Global Assessment Report on Disaster Risk Reduction (GAR). https://www.undrr.org/gar.
[29] UNDRR. "Stakeholder Engagement Mechanism." https://www.undrr.org/implementing-sendai-framework/partners-and-stakeholders/stakeholder-engagement-mechanism.
[30] UNDRR. MCR 2030. https://mcr2030.undrr.org/disaster-resilience-scorecard-cities.

Services (UNOPS), facilitates technical assistance from public- and private-sector organizations for recovery from loss and damage.[31]

3.1.2. UN Sustainable Development Goals and Relate Frameworks

On the sustainability side of the nexus, the UN Department of Economic and Social Affairs (UN DESA) is working to improve coordination and advance synergies across development and climate actions, particularly via the 2030 Agenda, which established 17 major, interconnected, global Sustainable Development Goals (SDGs – see Figure 3.2).[32] The SDGs aim to address various social, economic, and environmental challenges, while ensuring the ability of future generations to meet their own needs. They seek to promote more cross-sectoral and holistic sustainable development, and often highlight the linkages between sustainability and resilience.

Figure 3.2: UN Sustainable Development Goals

The following frameworks support the execution of the SDGs.

- The *Addis Ababa Action Agenda of the Third International Conference on Financing for Development* (Addis Ababa Action Agenda)[33] provides a financing framework that seeks to align financing and policy priorities in support of the 2030 Agenda and its SDGs. Companies may be aware of this Agenda but, until recently, have not fully considered it in their risk assessments.
- The High-Level Political Forum on Sustainable Development[34] (HLPF) serves as the "central global platform" for implementation, follow-on, and review of the 2030 Agenda and its SDGs. This is the mechanism that national governments use to report on their respective voluntary progress toward achieving the SDGs. The HLPF also involves local governments, NGOs, and private sector stakeholders.

[31] UNDRR. "The Santiago Network." https://www.undrr.org/what-we-do/santiago-network.
[32] UN DESA – Sustainable Development. "The 17 Goals." https://sdgs.un.org/goals.
[33] UN. *Addis Ababa Action Agenda of the Third International Conference on Financing for Development.* (Addis Ababa Action Agenda). 2015. https://sdgs.un.org/sites/default/files/publications/2051AAAA_Outcome.pdf.
[34] UN Human Rights. Office of the High Commissioner. High-Level Political Forum on Sustainable Development. https://www.ohchr.org/en/sdgs/high-level-political-forum-sustainable-development.

- The non-binding UN Global Compact (Global Compact),[35] which consists of Ten Principles[36] to help businesses worldwide adopt more sustainable, resilient, and socially-responsible policies and principles, particularly the SDGs. Members of ARISE commit to these Ten Principles; ARISE is considered a sister alliance of the Global Compact.

- The UN Habitat's NUA focuses on helping cities achieve a better, more equitable and sustainable future, in which urban spaces are viewed as solutions rather than solely as challenges. See Appendix A for more details.

The UNDRR, the Global Compact, the 2030 Agenda and its SDGs, and the NUA can help guide companies – and the non-profit and public sectors – to achieve their sustainability and resilience agendas and evolve toward a more sustainable and inclusive future. For example, the SDGs relating to resilient infrastructure (Goal 9),[37] and sustainable cities and settlements (Goal 11)[38] facilitate the integration of sustainability, climate adaptation, and resilience. These goals incorporate social and environmental metrics, such as lives saved, impacts on livelihoods, and reductions in infrastructure and service damages and losses. Goal 11 also incorporates disaster risk reduction and building back better (See Appendix A for further details).

3.1.3. Global Climate Agreements and Synergies with Sustainability and Disaster Risk Reduction

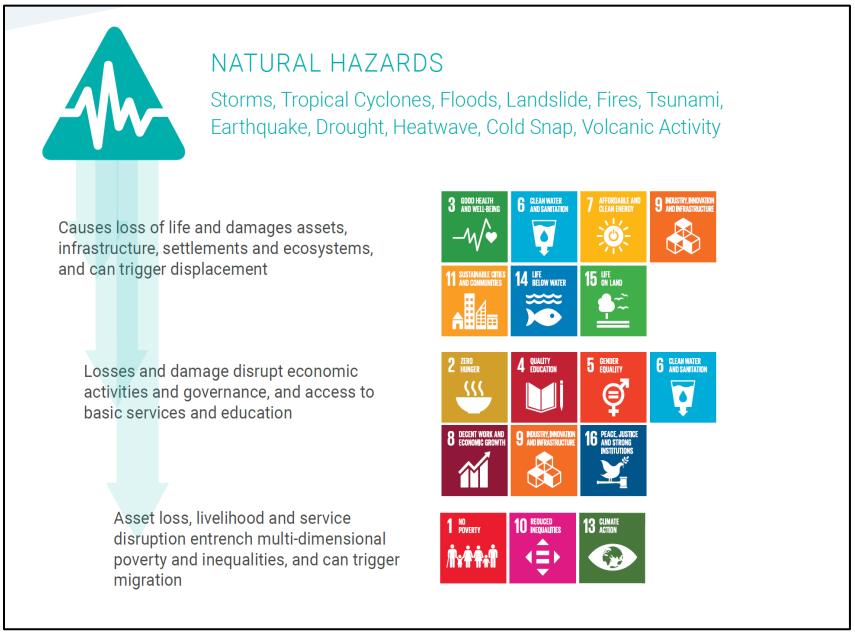
Climate action by the private and public sectors, including both mitigation and adaptation, can help achieve many of the SDGs, including those related to poverty (or food security),[39] access to safe drinking water (Goal 6),[40] healthy terrestrial ecosystems (Goal 15),[41] and resilient agriculture. Additional climate and SDG synergies[42] have been identified, e.g., via the 2030 Agenda and the Paris Agreement, the latter of which stems from the UNFCCC – that itself arose out of the 1992 UN Conference on Environment and Sustainable Development (Rio Earth Summit).[43]

UNDRR is fostering greater integration and coordination of the Sendai Framework with other global agreements, such as the UNFCCC, the Paris Agreement, and the SDGs, thereby enhancing management of climate- and disaster-related risks, and strengthening the sustainability-resilience nexus. For example,

[35] UN Global Compact. https://www.unglobalcompact.org.
[36] The "Ten Principles of the UN Global Compact" are specified in the Appendix A. *Source:* UN Global Compact. "The Ten Principles of the UN Global Compact." https://unglobalcompact.org/what-is-gc/mission/principles.
[37] UN DESA. SDG 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation." https://sdgs.un.org/goals/goal9.
[38] UN DESA. SDG 11: "Make cities and human settlements inclusive, safe, resilient and sustainable." https://sdgs.un.org/goals/goal11.
[39] UN DESA. SDG 1: "End poverty in all its forms everywhere." https://sdgs.un.org/goals/goal1.
[40] UN DESA. SDG 6: "Ensure availability and sustainable management of water and sanitation for all." https://sdgs.un.org/goals/goal6.
[41] UN DESA. SDG 15: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss." https://sdgs.un.org/goals/goal15.
[42] UN DESA. "Harnessing Climate and SDGs Synergies." https://sdgs.un.org/climate-sdgs-synergies.
[43] UN. UN Conference on Environment and Sustainable Development (Rio Earth Summit). 1992. https://www.un.org/en/conferences/environment/rio1992.

the UNDRR has issued *Guidance*[44] to better integrate natural, biological, technological, and slow-onset, climate-related hazards with sustainability, including specific SDGs, as well as disaster risk management, and resilience. Figure 3.3 illustrates some of the connections identified in the UNDRR *Guidance* between natural hazards and associated SDGs. It also provides a roadmap and list of recommended actions to enhance these linkages. (However, politically- and socially-induced incidents are not included.)

Figure 3.3: Connections Between Different Types of Natural Hazards and Associated SDGs



3.2. U.S. Federal Agencies, Frameworks, and Initiatives

U.S. federal policies and actions, of course, are subject to changes in leadership, as is the case at the state and local levels. At the time of this writing, whether or how the Trump Administration will change aspects of U.S. federal policies and approaches remains uncertain, although select sustainability, disaster risk management, and resilience-related, efforts are expected to survive in some form.

Regardless, previous U.S. policies merit attention for their important holistic approach. For example, one recent overarching policy framework, the *U.S. Framework for Climate Resilience and Security,*[45] recognized that "climate hazards are threatening the long-term stability of our governments, our economies, and our global security." Consequently, it sought to implement a "whole-of-government" and "all-of-society" approach to address climate and disaster risks, and enhance the nexus with sustainability.

[44] UNDRR. Disaster Risk Reduction and Climate Change Adaptation in the UN Sustainable Development Cooperation Framework: Guidance Note on Using Climate and Risk Management to Help Build Resilient Societies. July 2020. https://unsdg.un.org/sites/default/files/2020-08/Integrating-DRR-CCA-in-CFs-web.pdf.

[45] The White House. *U.S. Framework for Climate Resilience and Security.* Press Briefing. September 20, 2024. This *Framework* recognizes the United States' prioritization of the need for mitigation, sustainability, and resilience efforts for the entire country. It notes that: "increasing the resilience of our own investments . . . advances national security objectives and yields economic results." Such investments "not only protect lives, and livelihoods, but avoid or lessen future humanitarian and economic assistance needs."

This overarching approach almost certainly arose from leadership established at the U.S. Department of Defense (DOD) stretching back nearly two decades. Since that time, DOD has recognized the national security threats posed by disaster-related impacts to food, water, and energy resources, especially in fragile nations facing economic or political instability. It also recognized that U.S. troops and military facilities at home and abroad face similar risks. Thus, the Honorable Sherri Goodman, former Deputy Undersecretary of Defense (Environmental Security), coined the phrase that climate is a "threat multiplier."[46] She was instrumental in laying the groundwork for DOD to integrate climate mitigation, adaptation, and related risk management into virtually every aspect of military training and readiness, including by continuing to dramatically increase installation and base resilience as well as that of surrounding communities.

The Federal Emergency Management Agency (FEMA) is the primary agency for disaster risk management, helping entities, communities, and individual citizens to mitigate their disaster risks, recover from disasters, and improve their sustainability and resilience. The 2018 "Disaster Recovery Reform Act" (DRRA)[47] marked a major policy milestone by prioritizing the concept of "building back better" to enhance infrastructure resilience. The DRRA promotes and encourages public and private sector stakeholders to adopt strategic proactive and preventive approaches to disaster risk planning, preparedness, and prevention, as well as more sustainable and resilient measures to recover following disasters. By integrating these principles into planning, funding, and implementation processes, the DRRA aims to foster sustainable communities and entities that are capable of withstanding and recovering from future disasters more effectively. Building on these policies, FEMA encourages communities and companies to enhance the resilience of built and natural environments by addressing threats and hazards comprehensively, and integrating systems-oriented, adaptive, sustainable, and people-centered principles to the greatest extent practicable. These are reflected, for instance, in FEMA 2023 "National Resilience Guidance,"[48] aimed at helping corporations and communities further reduce their disaster risks and recover from extreme events.

3.3. Community Networks

Local engagement is critical to enhance sustainability and resilience to better plan, prepare for, and recover from, and adapt to disaster-related risks. Every dollar spent up front on "resilience and preparedness saves communities 13 [dollars] in damages, cleanup costs and economic impact," according to one source,[49] and the UNDRR projects as much as fifteen dollars in post-disaster recovery savings for every dollar invested proactively.[50]

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[46] CNA Corporation. *National Security and the Threat of Climate Change*. 2007. https://www.cna.org/archive/CNA_Files/pdf/national%20security%20and%20the%20threat%20of%20climate%20change.pdf.

[47] Public Law 115-254. *Federal Aviation Administration Reauthorization Act of 2018,* Division D. October 5, 2018. https://www.congress.gov/bill/115th-congress/house-bill/302/text?q=%7B%22search%22%3A%5B%22HR+302%22%5D%7D&r=1.

[48] Federal Emergency Management Agency (FEMA). "National Resilience Guidance: Background and Key Concepts." March 2023. https://www.fema.gov/sites/default/files/documents/fema_national-resilience-guidance-project-background_2023.pdf.

[49] The U.S. Chamber of Commerce, Allstate, and the U.S. Chamber of Commerce Foundation. *The Preparedness Payoff: The Economic Benefits of Investing in Climate Resilience. 2024 Climate Resiliency Report.* June 25, 2024. https://www.uschamber.com/assets/documents/USCC_2024_Allstate_Climate_Resiliency_Report.pdf.

[50] UNDRR. "Our impact." https://www.undrr.org/our-work/our-impact.

Many cities have designated resilience officers and have created plans for early warning systems, evacuation routes, and financing for loss and damage, due to increased disaster risk. Cities also are implementing more nature-based solutions to better protect citizens from damages and losses, for example, due to flooding. Local input "is critical to [communities'] successful recovery and requires long-term investment in local capacity for resilience planning," according to one expert.[51] As an example of enhancing community resilience, distributed, solar-powered, small water systems can help protect human health, by keeping "basic pumps and services up and running."[52] Similarly, localized microgrids that can isolate from the electric grid typically can maintain functionality in the event of power outages.

Communities, local, state, and national governments, and the private sector need to engage closely with one another to further enhance coordination, collaboration, and planning regarding sustainability and resilience to make sure respective and collective needs can be met. Some companies are educating their workforces about disaster readiness with help from local governments or other umbrella business or resilience organizations, including through apps, such as "Perci."[53] Given that companies are inextricably linked with their communities, because the latter is where employees, services, and markets often are based, the impacts of extreme events increasingly affect these populations, resources, and operations. For example, roads might become impassable and thereby prevent employees or supplies from entering or leaving a company. Therefore, more companies, like communities, are coming to realize the importance of investing in resilience, as elaborated in Section 5. At the moment, there is little evidence that such activities are occurring on the required scale, and much more needs to be done.

Civil society organizations are among the stakeholders that have engaged in UN and other processes to enhance resilience and restore livelihoods in the face of disasters. For example, the Global Network of Civil Society Organizations for Disaster Reduction (GNDR)[54] is the largest global civil society network focused on community disaster resilience. It consists of over 129 countries, 161 regional representatives, 1,850 civil society organizations, and other stakeholders and partners seeking to achieve these goals.

The independent Resilient Cities Network (RCN)[55] serves as an excellent resource to help cities and other entities enhance their disaster risk preparedness and response, and resilience (see Appendix A for further details). The aforementioned MCR 2030 and the Disaster Resilience Scorecard , which are used by over 400 cities, complement and support the Sendai Framework's goals. A new Scorecard "Disaster Displacement Addendum" can help local governments and stakeholders better assess the "integration of measures addressing disaster displacement within wider [disaster risk reduction] policies, management, and planning process[es] at the sub-national government level."[56]

[51] Campaigne, Alys. "Lessons from Helene." October 19, 2024. https://www.linkedin.com/pulse/lessons-from-helene-alys-campaigne-13cuc?utm_source=share&utm_medium=member_android&utm_campaign=share_via.
[52] Ibid.
[53] Perci. 2025. https://perci.us/employers/. The creators of Perci are ARISE-US members.
[54] Global Network of Civil Society Organizations for Disaster Reduction (GNDR). https://www.gndr.org/.
[55] Resilient Cities Network (RCN). https://resilientcitiesnetwork.org.
[56] UNDRR. MCR 2030. "Disaster Resilience Scorecard for Cities: Disaster Displacement Addendum." https://mcr2030.undrr.org/disaster-displacement-scorecard. This Addendum was developed collaboratively by the International Organization for Migration (IOM), the Platform on Disaster Displacement (PDD), UNDRR, the Internal Displacement Monitoring Centre (IDMC) and the Norwegian Refugee Council, with support from a wide range of stakeholders and partners.

3.4. Policy Recommendations

International, national, and local governments, civil society organizations, and the private sector could leverage the policies and principles herein and beyond to undertake strategic planning, management, and policy development and implementation efforts that are aligned with global sustainable development, climate change, and disaster risk reduction and resilience goals. These include:

- ***Definitions:*** Entities are encouraged to adopt definitions of sustainability and resilience, such as those provided in this report, to foster a common understanding and organizing principles around which to develop and implement strategic policies, management, and operational activities and practices to benefit from the sustainability-resilience nexus.
- ***Financial Capacity:*** Entities are encouraged to manage, access, and utilize financial resources effectively. Doing so involves improving financial literacy, providing access to capital, and supporting initiatives that enable communities to generate and manage their own income, savings, and investments. The goal is to empower communities to become more resilient, sustainable, and economically self-sufficient, thus reducing dependency on external aid or resources, per the third of the Ten Essentials referenced earlier. This can include:
    - financial education
    - access to financial services, including credit, savings accounts, and insurance
    - support for local businesses to access funding, markets, and resources for growth
    - creating systems or institutions (such as community savings groups or cooperatives) to help communities pool resources and invest in local projects.
- ***Governance/Leadership:*** While some municipalities, cities, states, companies, and NGOs have created leadership-level sustainability and/or resilience roles within their organizations, those that have not yet done so are encouraged to identify a key point person, team, or department to manage their sustainability and resilience efforts. These leaders should strive to align their efforts and coordinate them across organizational departments or silos to better understand, communicate, and achieve the sustainability-resilience nexus.

- ***Policies and Practices:*** Key policies and practices that merit consideration include the following:
    - Use scientific- and multi-hazards-based approaches to identify solutions to development, sustainability, disaster risk management, and resilience.
    - Promote pre-disaster urban and infrastructure resilience and disaster risk reduction, including, as applicable:
        - Deployment of early warning systems, including supply chain monitoring and more sophisticated, granular weather forecasting.
        - Development and implementation of building codes and standards that exceed minimum requirements. While “building back better” to meet the most recent building codes will generally require additional up-front investment, evidence has shown that this is far more cost effective and sustainable in the long run (see Section 4.3).
        - Related, development of assets and physical infrastructure in ways that: (a) minimize or avoid adverse environmental impacts, particularly in areas that have high ecosystem service or biodiversity value; and (b) prioritize *nature-based solutions,* where possible, such as by purifying water supplies and controlling floods via wetlands.

- Ensure safe and equal access to physical and social infrastructure and basic services, as well as adequate, accessible, and affordable housing.

- ***Metrics and Targets****:* Entities are encouraged to measure, manage, report, monitor, and evaluate implementation goals and targets, and demonstrate achievement. This can drive a culture of success and collaboration.

- ***Loss and Damage Solutions****:* Developed countries are encouraged to contribute their fair share to the global World Bank's Fund for Responding to Loss and Damage[57] to provide financing, so developing nations can "build back better" following disasters.

In the United States, some much-needed reforms have been made to FEMA's National Flood Insurance Program (NFIP) over time,[58] though more are needed. Communities, property developers, and asset owners should meet or exceed the latest building codes and relevant zoning requirements. In instances where destruction nevertheless occurs, property owners are encouraged to prioritize "building back better" following a disaster, for example, in keeping with the DRRA. Property developers and owners may be required to avoid risky rebuilding, and the future availability and extent of insurance coverage for rebuilding in known hazard zones may drive developers and owners in this direction in any case.

3.5. Conclusion

The Sendai Framework, UN SDGs, and a range of other global, domestic, and local frameworks are recognizing the sustainability-resilience nexus to a greater extent to help public, civil society, and private sector stakeholders navigate it successfully. Doing so will help address the urgent needs associated with managing climate-related disaster risks and meeting global to local 2030 goals. To this end, International Organizations, national and local governments, and private and non-governmental stakeholders are making progress in advancing sustainability and resilience policies, principles, and actions—each in their own manner. Challenges remain in implementing sustainability and resilience measures, and they increase when working to combine and overlay these efforts. Nevertheless, working to achieve this combination in an intentional, planned, and cohesive manner should be viewed as an opportunity and will dramatically improve disaster risk planning, preparedness, response, adaptation, and recovery efforts, while also improving sustainability.

UN *Guidance*, as well as the High-Level Political Forum on Sustainable Development, are further helping to draw the connections between a range of hazards and policy recommendations and methodologies, so that public and private entities can more closely apply and integrate the concepts of sustainability and resilience, and measure and evaluate progress. Additional efforts are emerging that complement and leverage existing ones. ARISE-US, with its technical assistance, can continue to help coordinate and contribute to local and non-governmental efforts. Public-private partnerships can continue to leverage and advance such objectives. Many more global and national policy frameworks and principles undoubtedly exist that are geared toward navigating the sustainability-resilience nexus in the public and private sectors in a coordinated, inclusive manner. The subsequent Sections supplement the aforementioned policies with tools, methodologies, and recommendations to expedite the overarching goal of integrating sustainability and resilience.

[57] World Bank Group. "Fund for Responding to Loss and Damage." https://www.worldbank.org/en/programs/funding-for-loss-and-damage.
[58] FEMA. "Flood Insurance Rules and Regulations." https://www.fema.gov/flood-insurance/rules-legislation#reform. Indicates the last major NFIP reforms occurred in 2014.

4. Corporate Efforts to Integrate Sustainability and Resilience

This Section focuses on private sector entities, including companies interviewed by ARISE-US, and their strategic development and implementation of sustainability and resilience policies and principles. It concludes with several recommendations for corporations and other entities to consider.

Policies and principles can help stimulate the development of strategic and better-integrated corporate frameworks, tools, business processes, and technological innovations that foster the synergies between sustainability and resilience. Moreover, adoption of these approaches by the private sector can also increase market certainty and investor confidence.

As described below, numerous U.S., multi-national, and global companies have demonstrated leadership by implementing sustainability policies and practices that help mitigate their operational and supply chain risks and thereby enhance their resilience. These include systems-oriented approaches to product or service life cycles, including management of supply chains and promotion of circularity.

4.1. Resources to Enhance Sustainability and Resilience

Numerous resources exist to help companies enhance and integrate their sustainability and resilience planning and implementation efforts. For example, the Institutional Investors Group on Climate Change (IIGCC)[59] has a Physical Climate Risk Assessment Methodology (PCRAM)[60] that can help companies better assess the costs and benefits of incorporating resilience into building and other infrastructure projects that they finance. However, companies are encouraged to be even more intentional and ambitious about addressing both sustainability and resilience as part of their overall risk management and disaster risk reduction efforts. The following organizations are among those that have promulgated principles and guidelines to help companies enhance their sustainability and resilience:

- Industry associations, such as the World Business Council for Sustainable Development (WBCSD),[61] Business for Social Responsibility (BSR),[62] and the Global Environmental Management Initiative (GEMI);[63]
- International Organizations (IOs), including the UN, the World Bank, the International Organization for Standardization (ISO),[64] and the International Red Cross and Red Crescent Movement (the latter also is a member of the UNDRR SEM);[65] and,
- Consulting firms, such as McKinsey & Company, Bain & Company, Miyamoto International, and Deloitte.

[59] Institutional Investors Group on Climate Change (IIGCC). https://www.iigcc.org/.
[60] IIGCC. "PCRAM in Practice: Outputs and insights from climate resilience in action." https://www.iigcc.org/resources/pcram-in-practice-climate-resilience-risk-assessment-case-studies.
[61] World Business Council for Sustainable Development (WBCSD). https://www.wbcsd.org/.
[62] Business for Social Responsibility (BSR). https://www.bsr.org/en/about/story.
[63] Global Environmental Management Initiative (GEMI). https://gemi.org/.
[64] International Organization for Standardization (ISO). https://www.iso.org/standards.html.
[65] International Committee of the Red Cross (ICRC). "About the International Red Cross and Red Crescent Movement." https://www.icrc.org/en/about-international-red-cross-and-red-crescent-movement. The International Red Cross and Red Crescent Movement consists of the ICRC, International Federation of Red Cross and Red Crescent Societies (IFRC), and National Red Cross and Red Crescent Societies.

UNDRR has convened a network of Corporate Chief Resilience Officers (CCROs) to help businesses enhance their resilience and better protect themselves from disasters[66]. This network facilitates public-private collaboration and the sharing of best practices to help businesses prepare for, and manage, disaster risks. It consists of Chief Resilience Officers and resilience leads from businesses operating across all sectors and in over 100 countries, with Cartier SA, Holcim Group, Honeywell International Inc., Hyatt Hotels & Resorts, Marsh McLennan, Nestlé, Syngenta Group, Swiss International Air Lines Ltd., and Sky at the forefront, and University College London as an academic advisor.

UNDRR also has developed a maturity model called the Resilience Maturity Assessment (REMA) Tool to help businesses assess their resilience.[67] It focuses on six operational elements, or pillars, that will help a business become more resilient that also are reflected in this report's recommendations: establishing a leadership culture of resilience; ensuring senior leadership resilience roles exist in the organization; providing a corporate policy and governance structure on resilience; developing the requisite financial and human capacity; incorporating disaster risk management and resilience into business operations; and enhancing supply chain resilience, including through redundancies in transportation systems.

The U.S. Chamber of Commerce Foundation also offers a range of online resources to help businesses improve their disaster preparedness and resilience. For example, with support from the UPS Foundation, it offers a Small Business Resilience Hub[68] that includes a "Resilience in a Box" checklist to help businesses undertake resilience efforts in relatively simple, digestible steps. These resources are especially important, because research by the Foundation, conducted with FedEx, and supported by Allstate, has found that one in four small businesses is one step away from not re-opening following a disaster.[69] Thus, these entities also have established a "Readiness for Resiliency" (R4R) Program[70] to offer multi-year assistance to small businesses that have been impacted by disasters.

The American Institute of Architects (AIA) has recognized that resilient design is crucial for establishing secure, healthy, sustainable communities and is incorporating it across its scope. AIA provides educational resources, certificate programs, and best practices to help industry and communities enhance the resilience of the built environment. For example, it has created a "Resilience Design Toolkit" for architects and designers.[71]

The National Institute of Building Science (NIBS)[72] is a Congressionally-established organization that works across every element of the built environment, including the formulation of consensus-based

[66] UNDRR. Corporate Chief Resilience Officers. https://www.undrr.org/implementing-sendai-framework/catalyze-investment-in-resilience/corporate-chief-resilience-officers-network.
[67] UNDRR. "UNDRR Resilience Maturity Assessment Tool." https://c2hbu193.caspio.com/dp/967AD000254bc2865563442e90a5.
[68] U.S. Chamber of Commerce Foundation. https://www.uschamberfoundation.org/solutions/disaster-response-and-resiliency/small-business-resilience-hub.
[69] U.S. Chamber of Commerce Foundation, et. al. *Readiness for Resiliency Program (RFR) 2023 Impact Report*. January 22, 2024. https://www.uschamberfoundation.org/disasters/small-business-readiness-for-resiliency-2023-impact-report.
[70] U.S. Chamber of Commerce Foundation. "Small Business Readiness for Resiliency Program: How It Works." May 1, 2022. https://www.uschamberfoundation.org/disasters/small-business-readiness-for-resiliency-program-how-it-works.
[71] American Institute of Architects. "Resilience." https://www.aia.org/design-excellence/climate-action/resilience.
[72] National Institute of Buildings Science (NIBS). "About NIBS – Our Story." https://www.nibs.org/about.

solutions and standards. In 2023, NIBS and Fannie Mae issued a *Resilience Incentivization Roadmap 2.0* [73] on "mitigation investment" to help the building sector and citizens prepare for and respond to natural hazards. Infrastructure developers, building managers, and other stakeholders are encouraged to undertake systems-level infrastructure planning, and to build in flexibility and resilience. A NIBS Study[74] found that natural hazard mitigation can save four to eleven dollars in avoided future losses[75] for each dollar invested up front in infrastructure resilience, with adoption of the latest building codes[76] yielding the higher savings, reflecting similar findings of this type highlighted in the prior Section. In the building and other infrastructure sectors, transformational change involves managing and resolving trade-offs, (e.g., between built and natural assets, referred to as green, blue, and gray infrastructure), recognizing that building for sustainability can diminish resilience and vice versa. The challenges of the sustainability-resilience nexus can be addressed strategically by prioritizing the types of policies and best practices recommended here and in the prior Section.

ASTM International (ASTM)[77] establishes voluntary, consensus-based global standards, including those related to health, safety, and resilience, to improve corporate performance, technical quality, and infrastructure adaptability. It recently released a new Standard for Property Resilience Assessments, E3429-24.[78] ASTM partners with the Global ARISE Network to champion resilient infrastructure.

Ceres[79] is an example of a U.S.-based non-profit organization that works with institutional investors and corporations to develop assessments, roadmaps, action plans, and other resources to help companies enhance their sustainability and resilience, and reduce and adapt to climate change impacts, including policy development assistance. More specifically, such resources can help companies address operational, reputational, and financial risks, as well as more equitable, sustainable, and resilient solutions. For example, Ceres' resources include a "Roadmap 2030,"[80] and a "Blueprint for Implementing a Leading Climate Transition Action Plan" (Blueprint).[81] The types of approaches and resources highlighted here are among those that could help companies more fully integrate sustainability and resilience into their strategic planning, operations, and products.

4.2. Insights from Corporate Interviews

ARISE-US conducted a series of interviews with select companies representing diverse sectors to explore whether and how they are balancing the twin imperatives of resilience and sustainability. Some companies noted that they are, in fact, integrating sustainability and resilience, including across business

[73] NIBS. "NIBS and Fannie Mae Release Disaster Mitigation Roadmap." News. September 20, 2023. https://www.nibs.org/news/national-institute-building-sciences-and-fannie-mae-release-disaster-mitigation-roadmap.
[74] Ibid. References a *NIBS Natural Hazard Mitigation Saves Study.*
[75] Ibid.
[76] NIBS. "Mitigation Saves: Mitigation Saves up to $13 per $1 Invested." https://www.nibs.org/files/pdfs/ms_v4_overview.pdf.
[77] ASTM International (ASTM). "About Us." https://www.astm.org/about/overview.html.
[78] ASTM. ASTM E3429-24. "Standard Guide for Property Resilience Assessments." https://www.astm.org/e3429-24.html.
[79] Ceres. https://www.ceres.org/.
[80] Ceres. "Ceres Roadmap 2030." October 6, 2020. https://www.ceres.org/resources/reports/ceres-roadmap-2030.
[81] Ceres. "Blueprint for Implementing a Leading Climate Transition Action Plan" (Blueprint). June 10, 2024. https://www.ceres.org/resources/reports/blueprint-for-implementing-a-leading-climate-transition-action-plan.

units, and generally have found that comprehensive, cross-sectoral policies and principles can help drive beneficial changes, both within their organizations and along their supply chains.

The interviews further revealed that one way in which companies are better integrating sustainability and resilience is by restructuring the way they prioritize and operationalize these activities among all employees and leadership, including with Boards of Directors. For example, one company discussed its eight-year journey to develop cross-functional committees to focus on sustainability and now also to identify ways to define and include resilience. Such efforts can shift organizational dynamics, including leadership and management roles and structures, toward greater responsibility and accountability for sustainability and resilience efforts sometimes occurring at Board or committee levels, while landing lower in the management structure, at other times.

Another interviewee said that achieving greater participation and "buy-in" at all levels through such changes has accelerated and matured the organization's sustainability efforts and likely will help integrate resilience to a greater extent, too. Often, corporate sustainability and resilience roles are lacking or, where they exist, are not coordinated or integrated across silos or departments. Thus far, a company's headquarters and operating locations may not have synchronized their sustainability and resilience priorities. Having a single point of coordination is important, as elaborated in the recommendations below.

On the other hand, some interviewees indicated that they still distinguish and distribute sustainability and resilience assignments across different internal business units or departments, such as engineering, real estate, and risk management. Currently, many companies include disaster resilience as part of risk management, which is typically located within the finance department, and linkages with sustainability management tend to be informal, to the extent they exist at all. Some companies might be substantially contributing to sustainability and/or resilience, but might not be fully aware that they are addressing either or both aspects. Several companies tend to refer to their sustainability and resilience efforts, using these terms interchangeably.

Several of the companies surveyed increase their competitive edge (or are starting to do so) by leveraging their sustainability efforts. At least one company uses its supply chain redundancies and resilience as sources of competitive strength.

Some companies interviewed for this study have been reporting on these goals, yet are recognizing the importance of defining resilience for themselves as well as for their suppliers. This recognition moves companies beyond climate mitigation (i.e., GHG emissions reductions), toward climate adaptation and business resilience. This evolution has been especially true for companies whose value chains rely on forests, land, and agriculture.

4.3. Additional Corporate Leadership Examples

Major companies around the world are demonstrating leadership by establishing and integrating sustainability and resilience policies and practices across their operations, including their supply chains and beyond. The following industrial and consumer-facing companies, namely, Dow Chemical, Levi Strauss & Co., and Starbucks Corporation are just a few representative companies among those that exemplify leadership in these regards. While not interviewed by ARISE-US, some of the applicable policies and best practices of these three companies are highlighted here.

Dow Chemical

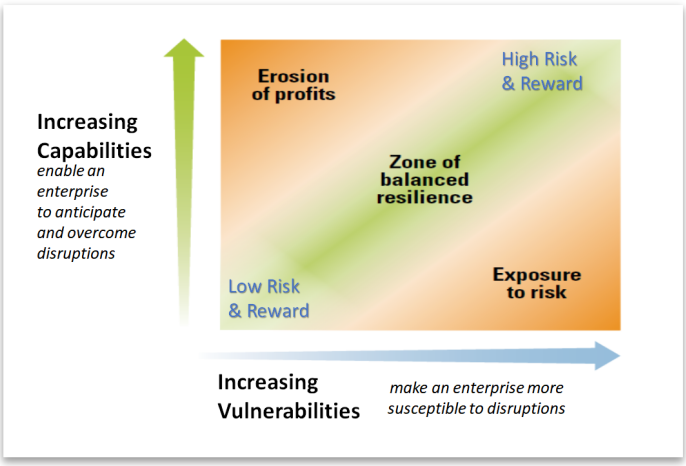
Beginning in 2005, a multidisciplinary research team at The Ohio State University collaborated with a number of companies in diverse industries, including Dow Chemical, to develop a comprehensive process for Supply Chain Resilience Assessment and Management (SCRAM™).[82] This process engages a cross-functional team to develop a resilience profile based on qualitative judgments. The underlying concept is illustrated in Figure 4.1 below: as a company's *vulnerabilities* increase, the company is *exposed to more risk*. To counteract those exposures, companies can develop a variety of resilience *capabilities* that mitigate those risks. By identifying key business vulnerabilities and building appropriate capabilities, companies can prevent significant disruptions and achieve an acceptable level of risk.

The Ohio State team research team identified six major categories of enterprise *vulnerabilities*:

- *Turbulence* – this can range from currency fluctuations to major natural disasters.
- *Deliberate threats*, including lawsuits, strikes, and industrial espionage.
- *External pressures*, including regulatory changes, social movements, and competition.
- *Resource limits*, including availability of raw materials, energy, water, or infrastructure.
- *Connectivity* – this refers to the complexity of the supply and distribution networks.
- *Sensitivity* of products or processes that require highly controlled environments.

Similarly, the team identified sixteen major categories of capabilities. These are listed in Table 4.1 below, along with associated indicators of resilience in terms of either quantitative, measurable factors or qualitative, subjective ones. As shown, there is a *zone of balanced resilience,* where a company has deployed the appropriate portfolio of capabilities to offset its specific vulnerabilities. The typical result of the SCRAM™ process is a set of strategic recommendations for improving key resilience capabilities (see Section 5.3 below). These recommendations then can be investigated through a more detailed quantitative analysis to develop a business case for action. Dow implemented the SCRAM™ process for more than 20 of its global business units, achieving significant business benefits. For example, the Glycol Ethers business achieved a savings of over $1 million, yielding a 500-percent return on investment.[83]

Figure 4.1: The SCRAM™ Approach – Balancing Vulnerabilities and Capabilities



[82] Fiksel, J., M. Polyviou, T. Pettit, and K. Croxton. "From Risk to Resilience: Learning to Deal with Disruption." *Sloan Management Review.* Winter 2015.

[83] Supply Chain Brain. "Dow Chemical Co. Adopts a New Model for Supply-Chain Resilience." Dec. 15, 2011.

Table 4.1: Supply Chain Capabilities and Corresponding Resilience Indicators

CAPABILITIES	Measurable Factors	Qualitative Factors
Flexibility: Sourcing	• Supplier agility, alternate sources	• Contractual options
Flexibility: Manufactg	• Modularity, versatility, scalability	
Flexibility: Fulfillment	• Distribution & service agility	
Capacity	• Reserves, back-up resources	
Efficiency	• Productivity, asset utilization	• Quality, standards, maintenance
Visibility		• Status monitoring, info exchange
Adaptability	• Order re-routing ability	• Gaming, innovation, learning
Anticipation	• Forecasting effectiveness	• Risk management, preparedness
Recovery	• Equipment downtime	• Crisis management, mitigation
Dispersion	• Decentralized assets, markets	• Distributed leadership, authority
Collaboration	• Postponement of orders	• Coordination, partnerships
Organization	• Workforce flexibility	• Adaptive, resourceful culture
Market position	• Market share	• Brand strength, customer loyalty
Security		• Systems & procedures
Financial strength		• Reserves, insurance, diversity
Product stewardship		• Design, auditing, communciation

Levi Strauss & Co.

Levi Strauss & Co. (Levi's®) traditionally has manufactured its jeans using cotton, largely from low-lying island nations. These cotton crops are water-intensive and are susceptible to impacts from sea level rise, storm surge, and extreme weather events. Thus, Levi's has established ambitious sustainability goals to ensure its manufacturing facilities, production materials, and inputs will last far into the future. For example, in 2023, it had already reduced its freshwater consumption by 27 percent.[84,85] It is manufacturing some of its jeans with quality alternatives, such as cottonized hemp, which grows faster and uses much less water,[86] or recycled materials.[87] It also deployed Water<Less® techniques[88] to dramatically reduce its water consumption. These types of efforts help the Company increase the

[84] Levi Strauss & Co. (Levi's®). *2022 Sustainability Goals and Progress Update.* September 2023. https://www.levistrauss.com/wp-content/uploads/2023/09/2022-LSCo.-Sustainability-Goals-Progress-Update.pdf.
[85] Trellis (formerly GreenBiz). "Levi's lesson for fashion is a net-zero strategy that's all in the details." November 4, 2024. https://trellis.net/article/levis-lesson-for-fashion-is-a-net-zero-strategy-thats-all-in-the-details/.
[86] Levi's®. "Sustainability is in Our Jeans: This is Cottonized Hemp." January 2021. https://www.levi.com/US/en_US/blog/article/this-is-cottonized-hemp?srsltid=AfmBOopBy2N5LtOcgRoF9oTQpUfaphs8oOXMXy5Be6qFZVImjcseiGPr.
[87] Levi's®. "Building a Better, More Sustainable Future." https://www.levi.com/US/en_US/features/sustainability.
[88] Levi's®. "How We Make Jeans with Less Water." March 2018. https://www.levi.com/US/en_US/blog/article/how-we-make-jeans-with-less-water?srsltid=AfmBOop6C6FZT4i2nxkccYXsVr8LcMQWSK-2IOVhvLlqIw66BlOmHm89.

sustainability and life cycle circularity[89] of its products, as well as its resilience, by reducing the risks that could occur if or when cotton crops were damaged or destroyed.

Starbucks Corporation

Starbucks Corporation (Starbucks) recognized that its coffee crops could be at risk from drought or extreme weather events. So, it is working to develop more innovative, sustainable, and resilient soil and crop management practices. One example involves deploying new types[90] of coffee crops (e.g., hybrid crops) that can better withstand shifting weather patterns, beginning in Guatemala and Costa Rica. These activities also help raise local farm productivity and protect local farmers' livelihoods. Starbucks is sharing its research and best practices globally with farmers.

In summary, companies often motivate their corporate shareholders, suppliers, and customers to adopt similar leadership positions and systems-oriented perspectives. These companies recognize the market and reputational value of leading through excellence in sustainability and resilience and thereby meeting consumer demand. They also foster employee and customer engagement by encouraging and incentivizing employees and consumers to set their own goals along these lines (e.g., commuting via mass transit, biking, or walking; reducing water consumption; and, better managing plastic use). Section 4.5 offers specific recommendations to enhance corporate sustainability and resilience.

4.4. Corporate Financial Risk Management

Companies can manage and reduce their risks through a range of strategies, including voluntary and mandatory climate-related financial disclosures. The global Task Force on Climate-Related Financial Disclosures (TCFD), now the International Financial Reporting Standards Foundation (IFRS Foundation or IFRS),[91] was created to help companies disclose climate-related financial risks and opportunities, and thereby facilitate integration of sustainability and resilience. It has issued climate disclosure-related guidelines to help corporations with: "governance, strategy, risk management, and metrics [and targets] to address climate-related financial risk" in a consistent and comparable manner. Incorporating nature-based approaches is also important, because doing so reduces the amount of concrete, steel, and associated greenhouse gas emissions (GHGs) required to deliver a given level of resilience. Interestingly, some *nature-focused* recommendations have been issued by a Task Force on Nature-Related Financial Disclosures (TNFD).[92] Appendix B describes the TCFD and related mechanisms in greater detail.

Ceres' aforementioned Blueprint notes that "companies that have been voluntarily disclosing meaningful and useful climate-related information and using it to influence and drive action in their value chains are better prepared for evolving business, stakeholder, and regulatory requirements"[93] and to leverage such

[89] Levi's®. "Building a Better, More Sustainable Future." https://www.levi.com/US/en_US/features/sustainability.
[90] Starbucks. "Starbucks Expands Global Effort to Protect Future of Coffee with Two New Coffee Farms." October 3, 2024. https://about.starbucks.com/press/2024/starbucks-expands-global-effort-to-protect-future-of-coffee-with-two-new-coffee-farms/.
[91] International Financial Reporting Standards Foundation: https://www.ifrs.org/sustainability/tcfd/.
The TCFD recommendations are also incorporated into an EU "Corporate Sustainability Reporting Directive" (CSRD), available at: https://eur-lex.europa.eu/eli/reg_del/2023/2772/oj.
[92] Task Force on Nature-Related Financial Disclosures (TNFD). https://tnfd.global.
[93] Ceres. Blueprint. June 10, 2024. https://www.ceres.org/resources/reports/blueprint-for-implementing-a-leading-climate-transition-action-plan.

activity into a business strategy. Doing so would help them better assess, plan, prepare for, and manage their disaster risk, and enhance sustainability and resilience in an integrated manner.

In the United States, California has enacted two mandatory climate disclosure laws, based on the TCFD and the Greenhouse Gas (GHG) Protocol.[94] The United States' Securities and Exchange Commission (SEC) also issued federal climate-related financial risk disclosure regulations in March 2024."[95] However, this rule already has been challenged by multiple states and others, so it currently on hold.[96] Nevertheless, thousands of companies globally [97] will be subject to the European Union's (EU) Corporate Sustainability Reporting Directive (CSRD), despite the recent EU decision to slow down the pace of adoption.

4.5. Strategic Recommendations

The following recommendations stem from ARISE-US interviews, the prior Section, and beyond to help those in the private sector seeking to integrate sustainability and resilience to a greater extent. Above all, companies are encouraged to be even more intentional and ambitious about addressing both sustainability and resilience as part of their overall risk management and disaster risk reduction efforts.

- ***Definitions****:* Companies could adopt definitions for sustainability and resilience, such as those provided herein. Doing so will help "up-skill" organizations, and enable them not only to facilitate balancing the sustainability-resilience nexus, but also to optimize beneficial opportunities.
- ***Coordinated Governance****:* A corporate senior leadership role that focuses on managing sustainability and resilience in an integrated and cross-organizational manner, such as a Chief Sustainability Officer, Chief Resilience Officer, or a combined sustainability-resilience officer role or team, could be instrumental to achieving the goals and recommendations here and throughout this report.
- ***Strategic Planning****:* Companies are encouraged to proactively make near- and long-term strategic plans to mitigate and adapt to local-to-global threats and to "build back better" after disasters, recognizing budgetary limitations. They are also encouraged to weigh decisions through a risk-informed lens to determine whether they are decreasing or accumulating risks over time.

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[94] Marten Law. "California Adopts Sweeping Climate Disclosure Laws." January 8, 2024. https://martenlaw.com/news/california-adopts-sweeping-climate-disclosure-laws. The California laws consist of: the "Climate Corporate Data Accountability Act" (Data Act). Senate Bill 253. 2023-2024. Reg. Sess., ch. 382, 2023 Cal. Stat. October 7, 2023. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB253; and, the "Climate-Related Financial Risk Act" (Risk Act). Senate Bill 261. 2023-2024. Reg. Sess., ch. 383, 2023 Cal. Stat. October 7, 2023. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240SB261.

[95] SEC. "SEC Adopts Rules to Enhance and Standardize Climate-Related Disclosures for Investors." Press Release. March 6, 2024. https://www.sec.gov/newsroom/press-releases/2024-31; and SEC. "The Enhancement and Standardization of Climate-Related Disclosures for Investors." Final Rule. 89 *Fed. Reg.* 21668. March 28, 2024. https://www.govinfo.gov/content/pkg/FR-2024-03-28/pdf/2024-05137.pdf.

[96] SEC. "SEC Stays Its Climate Rule; But Do Not Put Your Pencils Down." April 16, 2024. https://www.cov.com/en/news-and-insights/insights/2024/04/sec-stays-its-climate-rule-but-do-not-put-your-pencils-down#layout=card&numberOfResults=12.

[97] Persefoni. "CSRD: A Guide to the Corporate Sustainability Reporting Directive." Updated July 8, 2024. https://www.persefoni.com/blog/what-is-csrd#:~:text=An%20estimated%2010%2C000%20non%2DEU,3%2C000%20of%20which%20are%20American.

- These efforts should include a comprehensive assessment of operations and supply chains. Companies could consider redesigning, revamping, and sourcing or identifying alternate products, processes, and services to improve both sustainability and resilience against unexpected disruptions. Examples include avoiding hazard-prone and low-lying areas and identifying alternate transportation routes.
- Companies can promote pre-disaster urban and infrastructure resilience and disaster risk reduction by deploying early warning systems with more sophisticated and granular weather forecasting, designing infrastructure to exceed the latest building codes and standards, and implementing nature-based solutions.
- As "business as usual" becomes less viable due to increased risks, companies should encourage an anticipatory approach throughout their corporate cultures and workforce capacity building efforts. Specifically, companies could educate cross-functional teams on how resilience and sustainability initiatives can yield measurable returns on investment over time.
- The above efforts should include engagement of customers, communities, and partners.

- ***Insurance Industry Innovations****:* The insurance industry should pursue innovations that will enable it to provide or sustain policies so commercial and industrial customers and residents can survive and rebuild for themselves and their communities in a more resilient and sustainable manner following disasters. This point is especially timely given that many private insurers have stopped providing policies, for example, in California and Florida.
- ***Enhanced Alignment of Profitability and Sustainability Time Horizons****:* Recognizing that corporate financial goals are primarily near-term (e.g., quarterly, annual), primarily driven by shareholder expectations for profitable returns, and that sustainability and resilience goals tend to focus on a longer time horizon, it is important for sustainability and resilience officers to work with financial managers to strategically align these goals for the near and long term. As described in Section 5,
- ***Performance Measurement****:* Companies should establish measurable goals, metrics, and targets that address sustainability and resilience, in order to drive corporate culture and contribute to local, regional, national, and global objectives.
  - Companies should measure, manage, evaluate, and report on progress toward implementing and achieving their targets. Coordination at the highest level of a company, e.g., through a Chief Sustainability Officer, can align metrics within and across departments. In the EU, this will effectively be mandated by the CSRD.
  - Achieving such targets will be aided by involving employees, consumers, and other community stakeholders, as well as supply chain partners.
  - Verification of sustainability- and resilience-related accomplishments using data-driven metrics will help avoid any perceptions of "greenwashing."
- ***Risk & Opportunity Management****:* Given that risk is the common underlying factor of the sustainability-resilience nexus, incorporating risk management into sustainability and resilience efforts, or at least coordinating these efforts, is vital. Doing so likely will bring the co-benefits to the forefront and could help capture opportunities that might be missed when focusing solely on one or two of these factors, or on a narrow set of risks (e.g., those associated with perils). In this regard, it is important to measure the effectiveness of the risk management process, and to

account for "risk velocity", since sudden disruptions require a faster response than gradual pressures.

- ***Policy Leverage**:* Governmental policies can support private and public sustainability and resilience objectives across operations, production facilities, supply chains, and workforces.
    - Federal, state, and local financial incentives are a common way to facilitate these goals, as are targets (e.g., to achieve 50 percent renewable energy by 2030).
    - Corporations can implement internal policies to advance corporate objectives, such as adopting beneficial technologies and encouraging customers and suppliers to follow suit. These can include financial incentives and targets to facilitate or expedite deployment of:
        - Renewable energy (e.g., solar panels) for manufacturing facilities and offices;
        - Clean and efficient vehicles and transportation modes;
        - Energy efficient appliances, products, and processes, including lighting and refrigeration; and,
        - Net-zero, decarbonization, and waste elimination initiatives, e.g., circularity.
- ***Supply Chain Resilience**:* Given that a company's extended supply chains are often its most vulnerable assets, in addition to the recommendations above, the SCRAM™ methodology described earlier in this Section offers the following strategies:
    - Improve surge and back-up capacity;
    - Create greater flexibility in sourcing and manufacturing;
    - Identify alternative suppliers and available logistical resources;
    - Build agility and adaptability in responding to challenges;
    - Develop an ability to anticipate trends and detect signals of change;
    - Distribute assets and resources in a geographically diverse manner;
    - Improve supply chain visibility based on information technology;
    - Establish appropriate metrics and targets for supply chain resilience; and,
    - Educate the workforce about the importance of resilience as a competitive advantage.

4.6. Conclusion

In summary, companies are demonstrating progress toward adopting and implementing sustainability policies and practices, though experts and interviews noted that multiple challenges remain, and that adding resilience to these efforts presents additional hurdles. For example, sustainable actions can involve trade-offs that affect resilience, and vice versa, and unintended consequences can occur. Nevertheless, companies are making strides toward managing the sustainability-resilience nexus. Climate-related financial disclosure is one means by which companies can better identify the opportunities and value of integrating sustainability, climate, disaster risk mitigation, management, and resilience. Corporations can help, and many already are helping, to advance such goals and better achieve these synergies – without waiting for international organizations, governments, and institutions – by undertaking their own strategic policy efforts, including implementing and disseminating the types of recommendations reflected in this report.

5. Available Tools and Methods

5.1. Overview

To integrate the management of sustainability and resilience, considering potential impacts across societal, industrial, and natural systems, as well as multiple spatial and temporal scales, while maintaining profitability, is certainly a challenging task. This Section outlines some tools and techniques to help companies and other organizations manage the relationship between sustainability and resilience, maximizing both as opportunities allow. These methods are described below, with examples of how they have been applied by various organizations.[98] The methods are separated into two categories:

Characterization methods are used to describe a complex, dynamic system, such as a single industrial facility, a global network of company operations, or a geographic region that includes both human communities and supporting ecological systems. Conceptual or mathematical modeling of complex systems at a local, regional, or even global scale can help to characterize their current state and potential future trajectories, providing a basis for strategic decision-making. These methods include:

- Performance metrics;
- Life-cycle analysis;
- Scenario development; and,
- Influence diagrams.

Decision methods are used to analyze the implications of alternative strategies, including unexpected consequences, based upon characterization models and selected decision criteria. Such analyses enable managers to assess the potential impacts of alternative courses of action and to choose a preferred strategy, even in the presence of large uncertainties. These methods include:

- Cost/risk/benefit analysis;
- Probabilistic decision analysis;
- System dynamics simulation;
- Real options analysis; and,
- Adaptation pathways.

A general caveat must be recognized: "all models are wrong; some models are useful."[99] There is an art to finding the right scope, boundaries, and level of detail for a specific model so that it is actually useful for decision-making.

Combination of characterization and decision methods*:* As mentioned in Section 4, the TCFD's Framework offers a comprehensive approach that includes both characterization and decision methods, with a focus on climate resilience and sustainability.[100] By focusing on climate risks and opportunities, it automatically addresses resilience and sustainability together, and links to the financial success of a business. Appendix B provides additional details about the Framework.

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[98] Further technical details and methodology for practitioners are provided in Appendix B.
[99] Box, George E. P. *Science and Statistics.* Journal of the American Statistical Association. 71 (356): 791–799. 1976.
[100] TCFD. "Final Report: Recommendations of the Task Force on Climate-Related Financial Disclosures." June 2017. https://assets.bbhub.io/company/sites/60/2021/10/FINAL-2017-TCFD-Report.pdf.

5.2. Characterization Methods

5.2.1. Performance Indicators and Metrics

"What gets measured gets managed" has been a management truism for many years[101], and therefore a framework of indicators and quantifiable metrics for sustainability and resilience (accounting for the interplays between them) is essential. However, the indicators that companies use may be incomplete or inappropriate, and if the "wrong" metrics are selected for these indicators, the "wrong" things will get managed. This certainly applies to the linkage between sustainability and resilience. If separate metrics are used for sustainability and resilience, especially if developed in separate organizational functions, opportunities for synergy may be lost and hidden pitfalls may be overlooked.

Sustainability performance metrics typically fall into two major categories—environmental footprint methods (e.g., energy intensity, waste reduction) and societal value metrics (e.g., resource conservation, poverty alleviation).[102] However, resilience metrics are not yet standardized, and many possible indicators exist, as illustrated in Table 4.1. Note that these are *leading* indicators, since it is difficult to quantify resilience retrospectively if disruptions are infrequent. In many cases, resilience factors may not be quantifiable, and qualitative assessments must suffice.

Table 5.1: Resilience Indicators and Metrics[103]

Resilience Factors	Leading Indicators	Examples of Metrics
Vulnerability	Susceptibility to disruptive forces that can threaten business continuity	Country-specific political risk index
Adaptability	Capacity to rapidly modify key products, technologies, sites, or business processes	Response time to perform a modification
Efficiency	Productivity in terms of value delivered relative to resources required	Production volume per unit of energy
Diversity	Variety of markets, suppliers, facilities, and employee capabilities	Number and geographic distribution of qualified sources by part
Stability	Ability to continue normal business operations when disruptions occur	Surge capacity as a percent of output
Recoverability	Ability to overcome severe disruptions and restore business operations	Maximum tolerable damage without requiring a shutdown
Cohesion	Strength of corporate identity and loyalty of business partners	Interbrand ranking of brand value

[101] The phrase is variously attributed to Peter Drucker and Lord Kelvin.
[102] See for example: ISO 14000, ISO 26000 standards; Global Reporting Initiative.
[103] Fiksel, J. Resilient by Design: Creating Businesses That Adapt and Flourish in a Changing World. Island Press. 2015.

Appendix A.3.2 provides additional guidance for practitioners, including examples of metrics that integrate sustainability and resilience. It is particularly important to address the challenge of *supply chain resilience*, since it is outside the direct control of the firm.

5.2.2. Life-Cycle Analysis (LCA)

There are several types of LCA methods available to estimate the overall costs, impacts and benefits of company operations. Each of the methods below focuses on a different metric over the *life cycle* of a product, process, or service from "cradle to cradle." The life cycle stages generally include raw material extraction, procurement, manufacturing, distribution, and end-of-life recovery or disposal. Application of these methods augments the traditional performance metrics above, providing a more wholistic understanding. There are several categories of LCA methods:

- Life-cycle cost analysis (LCCA), similar to "full-cost accounting", estimates the costs incurred by a product, process, or service over its life cycle.[104] These may include one-time costs such as construction and decommissioning, and recurring costs that depend on factors such as sales volume and procurement operations. LCCA data can be used to evaluate expected profitability using discounted cash flow analysis.
- Life-cycle environmental assessment (LCEA) is an ISO-standardized practice that examines the non-monetary impacts of a product, process, or service upon human and ecological well-being, based on "normal" operations. Potential impacts include utilization of non-renewable resources, such as scarce minerals, energy, water, and land, as well as generation of pollution, waste, and global warming gases. More broadly, LCEA may also assess impacts upon human health and quality of life. LCEA is ideally applied at the design stage to avoid future problems.
- Life-cycle resilience assessment (LCRA) is a relatively new approach for identifying forces that may threaten business continuity or generate unexpected costs, and for building resilience to cope with these threats. Normal business operations can be disrupted due to many factors, ranging from natural disasters to legal interventions to simple human error. Some of these factors can be mitigated through risk management, but some may be unavoidable and/or unpredictable; for example, remote supply chain disruptions can occur with little or no warning. LCRA methods have been adopted by Dow Chemical and other companies to identify important vulnerabilities and develop appropriate capabilities as countermeasures.[105]

5.2.3. Scenario Development

Scenario development is a strategic approach that is frequently used to conceptualize how a business, a region, or even the world as a whole could evolve over time. This is usually a qualitative exercise based on expert opinion from a variety of disciplines and stakeholder perspectives, and is often carried out in a group setting to maximize interaction. A given scenario will postulate a set of future conditions and assess how economic, social, and environmental outcomes may change as a result.

[104] Farr, John Vail and Isaac Faber. *Engineering Economics of Life Cycle Cost Analysis.* CRC Press. 2018.
[105] Fiksel, J., M. Polyviou, T. Pettit, and K. Croxton. "From Risk to Resilience: Learning to Deal with Disruption." *Sloan Management Review.* Winter 2015.

Royal Dutch Shell has been developing and publishing possible future scenarios since the early 1970s, intended to help both the company and external organizations to consider long-term challenges and explore alternative strategies. For example, in 2021 the Shell Scenarios team launched the Energy Transformation Scenarios, based on societal trends that emerged following the COVID-19 pandemic.[106]

Shell identified the following three scenarios:

- *Wealth first:* A focus on wealth and economic recovery, but this results in a late start to the rapid transition required to reach net-zero emissions around the middle of the century. Rather, the energy required to support growth in the 2020s comes from conventional sources.
- *Security first:* National sentiment shifts inwards, and security issues prevail. The transition slows along with economic growth. Domestic energy resources prevail and while some countries proceed with a transition, the global pace of change required to meet the ambitious goals of the Paris Agreement just isn't there.
- *Health first:* The pandemic leads to structural change across society, significant green investment and a realization that the broader health and well-being of society is fundamental. In this context the goals of the Paris Agreement are met.

While these types of scenarios are qualitative in nature and meant to provoke strategic thinking, they can also serve as a foundation for predictive modeling. Appendix B provides additional guidance for scenario analysis related to climate change. Also, Section 5.3.3 below describes how dynamic simulation can be used to develop quantitative models that project future outcomes under different scenarios.

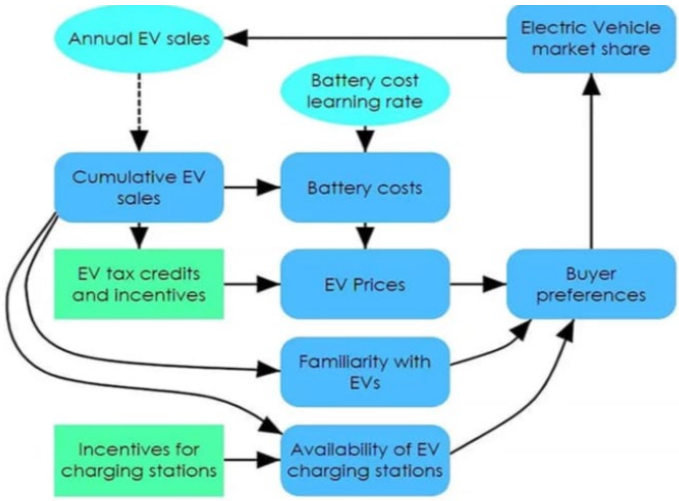
5.2.4. Influence Diagrams

Influence diagrams offer a qualitative technique that supports decision-making by identifying the known factors that drive an intended outcome. The relationships among these factors are commonly represented in graphical form, as illustrated in Figure 5.1 below. This diagram shows the factors influencing the market for electric vehicles. The light blue ovals represent key variables, the rounded blue rectangles represent cascading impacts that will affect the EV market, and the green rectangles represent external drivers. Note the inherent circularity that often occurs in this approach.

Influence diagrams are particularly useful for managing complex systems with numerous interacting factors at play that may not be well understood. The diagram can help to characterize a system by defining key elements and important relationships among them, thus providing a basis for modeling and decision-making. As discussed in Section 5.3 below, qualitative influence diagrams (also known as causal loop diagrams) are often used as a basis for formulating a quantitative decision analysis or a dynamic simulation exercise, but these approaches require extensive data collection and mathematical modeling.

[106] Shell. "The Energy Transformation Scenarios." 2021. https://www.shell.com/transformationscenarios.

Figure 5.1: Influence Diagram for the Electric Vehicle Market



5.3. Decision Methods

5.3.1. Cost/Benefit/Risk Analysis

Cost/benefit/risk analysis (CBRA) is a common technique for assessing the attractiveness of a specific investment, where the costs and benefits are uncertain. This augments the classic accounting techniques of cost/benefit analysis and discounted cash flow analysis by introducing stochastic variables to represent key assumptions. If the risks can be represented as discrete possible outcomes, then the analysis can readily calculate the range of expected return on investment. In more complex situations, a Monte Carlo technique can be applied to develop a probability distribution of possible outcomes.

In summary, a CBRA for a specific project involves the following steps:[107]

- *Cost estimation.* The costs should include both direct and indirect costs that will be incurred over time, as well as intangible (i.e., non-monetary) factors such as impact on brand reputation, employee morale or customer satisfaction. In addition, decision makers should include opportunity costs—benefits lost by choosing one option over another (e.g., potential income from an alternative investment) and potential risks—possible negative impacts or losses (e.g., lost sales if a new product introduction may alienate existing customers).
- *Benefit estimation.* Expected benefits can include both direct benefits, such as improved energy efficiency that lower costs, and indirect benefits, such as enhanced reputation due to environmentally friendly business practices. Enhanced company reputation can lead to increased customer loyalty and brand value.
- *Risk estimation.* Quantification of risk is the most challenging aspect of CBRA, since sufficient data are often unavailable, especially for rare or unpredictable events. Subjective assessment and expert judgment are frequently necessary to fill data gaps. Instead of assuming a specific

[107] Simonson, J. "How to Conduct a Cost-Benefit Analysis." *Forbes Advisor.* 2024. https://www.forbes.com/advisor/business/software/cost-benefit-analysis/.

likelihood and severity for a potential disruption, analysts often develop a range of parameters and use Monte Carlo simulation techniques to bracket the associated risks.[108]

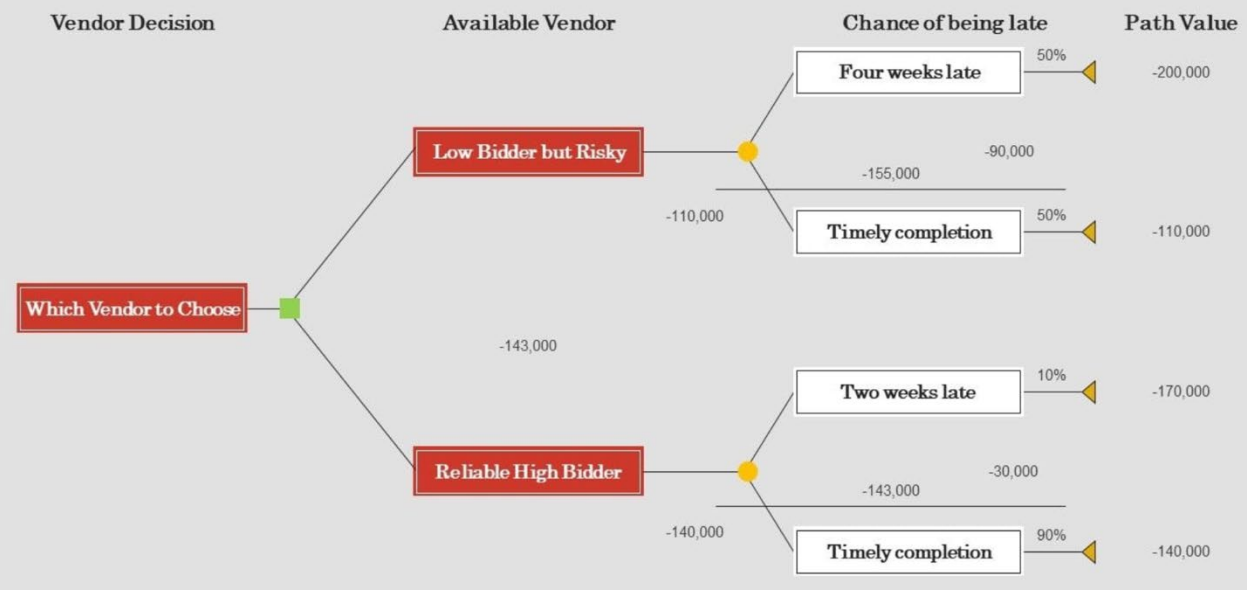
Best practices in CBRA include ensuring clarity of scope, accuracy and reliability of data, appropriate discounting of future costs and benefits, and sensitivity analysis to determine key factors that drive the ultimate results.

5.3.2. Decision Analysis

Decision analysis is a widely used methodology for analyzing decision problems under uncertainty. It accounts for the potential costs of gaining additional information to reduce uncertainty, and can represent several stages in the decision process. To perform a decision analysis, one must use relevant data or expert judgment to estimate the probabilities of various outcomes for a given decision. By estimating the value of additional information in terms of costs or other metrics, this approach can yield an optimal strategy at each stage of the process.

Decision analysis often utilizes a visual device called a *decision tree*, which represents the various possible pathways that one can follow in a multi-stage decision process. (As mentioned in Section 5.2.4, decision trees can be constructed based on influence diagrams.) For example, Figure 5.2 below shows the factors involved in deciding between two vendor bids for a time-sensitive project.[109] The least expensive bid, at $110,000, only has a 50 percent chance of timely completion, whereas the bids that incur delays result in substantial additional costs. Thus, the reliable $143,000 bid, that is neither the least nor most expensive, is optimal.

Figure 5.2: Decision Tree for Vendor Selection



[108] Science Direct. https://www.sciencedirect.com/topics/economics-econometrics-and-finance/monte-carlo-simulation.

[109] SlideGeeks. "Project Risk Management and Reduction Decision Tree Analysis to Evaluate Options Background PDF." https://www.slidegeeks.com/project-risk-management-and-reduction-decision-tree-analysis-to-evaluate-options-background-pdf.

5.3.3. System Dynamics Simulation

System Dynamics is a computer-aided approach for strategy and policy design, aimed at making better decisions for managing complex, dynamic systems. It was developed in the 1950s by Professor Jay Forrester at MIT.[110] The approach uses simulation modeling based on systems thinking approaches, and has been applied to countless problems in social, economic, and environmental contexts for both industry and government. The elements of a system dynamics model are:

- *Stocks and Flows*: Stocks represent the accumulations in the system (e.g., fuel reservoir content), while flows represent the rates of change (e.g., fuel flowing into or out of the reservoir).
- *Causal Loops*: These are circular chains of cause and effect that can either be reinforcing (positive feedback) or balancing (negative feedback). For example, in a population model, a reinforcing loop might be the birth rate, while a balancing loop might be the death rate. Causal loops are usually represented graphically, similar to influence diagrams; for example, Figure 2.1 is a generic causal loop diagram that can be applied at different scales, from local to global.
- *Embedded logic*: At any point in the model, mathematical formulae and constraints can be incorporated to simulate the behavior of stocks or flows.
- *Time delays*: These are delays between actions and their effects, which can cause oscillations and complex behaviors in the system.

Appendix B describes examples of system dynamics application, including a model developed by the U.S. EPA to explore alternative policies and interventions for reducing nutrient pollution in the Narragansett Bay area, including parts of Rhode Island and Massachusetts. This case study illustrates an application of the conceptual model shown in Figure 3.1 at a regional scale.

5.3.4. Real Options Analysis

Real options analysis (ROA) is a technique that assesses the economic benefit of the flexibility that comes from techniques such as decision analysis and adaptation pathways.[111] It can be useful for developing an optimal strategy under large uncertainties, such as the future rate of climate change or sea level. However, ROA calculations are complex and can be computationally intensive if techniques such as Monte Carlo simulation are used. Appendix B presents additional details.

ROA is often contrasted with traditional cost-benefit analysis (CBA) which discounts future cashflows, reflecting an implicit "all or nothing" assumption. ROA builds on a traditional CBA by calculating the value of opportunities ("real options") to change the investment trajectory in response to future events. Those opportunities might include strategic adaptations such as abandoning, delaying, or modifying a planned action. The benefit of this flexibility can be expressed as reduction in the risk of misapplying funds, and/or the resulting value achieved.

[110] Forrester, Jay W. "Lessons from system dynamics modeling." Wiley Online Library. Summer 1987. https://onlinelibrary.wiley.com/doi/abs/10.1002/sdr.4260030205.
[111] Liu, Jamie, and P. Krans. "An economic approach to investing in climate adaptation." ICF. September 22, 2021. https://www.icf.com/insights/environment/real-options-analysis-climate-resilience-investment.

5.3.5. Adaptation Pathways

Adaptation pathways are sequenced programs of action that can be progressively implemented in response to future changes, such as climate change impacts.[112] Pathways may include actions which can be implemented now with "no or low regrets;"[113] and they may identify specific thresholds where the "next" action would be triggered. The approach is usually applied at the societal or governmental level (or for specific pieces of infrastructure), but, particularly when linked to scenarios and combined with real options analysis, they can structure and inform corporate decision-making also. Appendix B provides additional details, as well as an example of adaptation pathways for a flood-prone industrial site.

5.4. Summary

The above tools and methods provided are commonly used to characterize and evaluate investment options and business process improvements that may be beneficial to a firm. They range from qualitative and subjective evaluations to rigorous mathematical techniques, and require implementation by qualified analysts. The key role of management is to define the goals and objectives to be pursued, and the metrics of success. The purpose of this report is to encourage explicit, integrated consideration of sustainability and resilience, along with other financial and strategic goals, in the use of these methods.

[112] Werners, Saskia, et. al. *Adaptation pathways: A review of approaches and a learning framework.* ScienceDirect. Volume 116. Pages 266-275. February 2021. https://www.sciencedirect.com/science/article/pii/S1462901120313836.
[113] Ibid.

6. Conclusions and Recommendations

Historically, sustainability and resilience typically have been treated as different challenges and managed by separate organizational groups. This ARISE-US report, informed by a survey of select companies, has identified an emerging recognition that resilience and sustainability are intertwined, and should be managed in an integrated fashion. Concerns about resilience have increased as scientists have identified critical "tipping points" driven by global changes, including melting ice sheets, deforestation, and loss of coral reefs.[114] To prevent widespread disruptions, companies will need to collaborate with stakeholder groups, including local communities, governments, non-governmental organizations (NGOs), and supply chain partners in order to reduce risks and capture benefits in a changing environment.

Forces of change, including socio-political disruptions, technological advances, and climate volatility are driving greater economic and environmental turbulence. Cascading interactions among these forces can lead to unprecedented "polycrisis" events, such as the 2025 Los Angeles wildfires. In response to these global challenges, U.S. and other national governments, the EU, and International Organizations, including the UN, have promulgated new policies and principles aimed at ensuring continued prosperity and quality of life. The need for convergence between disaster risk reduction, sustainable development, and climate action was noted in the Sendai Framework. However, only recently have policy makers begun to squarely address this need through the evolving frameworks and initiatives not only of the Sendai Framework, but also of the SDGs, and other mechanisms such as CSRD and TCFD (see Section 4).

The above forces have led to a growing need for better awareness, assessment, and management of the external pressures that influence both business continuity and environmental stewardship. Many major companies are striving to become more agile and adaptive, while simultaneously pursuing long-term goals, such as decarbonization. The importance of the resilience-sustainability "nexus" has become evident as companies consider the full life cycle of their products and processes, including every phase of supply procurement, production, distribution, customer support, and waste disposition. In particular, the concept of "circular economy" is an important driver for waste minimization and cost reduction.

ARISE-US believes that a better understanding of the synergies and trade-offs between resilience and sustainability will enable companies to find the "sweet spot" that enables them to deliver shareholder value, while addressing both immediate demands and long-term strategic goals. This report offers a number of recommendations for the path forward, as summarized below. Many of these points also apply to other stakeholders, including governments and civil society organizations.

- Companies should consider adopting definitions – such as those provided in this report – for sustainability, resilience, and climate adaptation in order to facilitate strategy development and integration of sustainability and resilience goals.
- Rather than viewing sustainability and resilience as separate or competing priorities, companies should aim to integrate them into a unified long-term strategy. To this end, they should establish a single point of accountability, ideally within the C-suite, for the governance of the resilience-sustainability nexus in balance with financial performance goals.
- Companies should strive to embed resilience and sustainability considerations into their core business processes, including planning, design, procurement, manufacturing, marketing, and supply chain management. They should promote continuous improvement by regularly reviewing resilience and sustainability plans to adapt to changing risks and opportunities.

[114] T. M. Lenton, et al. *The Global Tipping Points Report 2023.* University of Exeter, UK. https://report-2023.global-tipping-points.org/.

- For purposes of strategic planning and investment decisions, companies should move beyond compliance with existing standards. They should actively explore the likely future trajectories of their markets and supply chains, and position themselves to continuously improve their resilience and sustainability in the face of increasing turbulence. This approach can provide opportunities to gain competitive economic advantages vis-à-vis their competitors.
- Global supply chains are particularly vulnerable to sudden disruptions, driven by the rising occurrence of both natural and human-caused disasters. Accordingly, companies should develop strategies to improve their inherent supply chain resilience. These can range from improving situational awareness and back-up capacity to increasing flexibility and agility in sourcing, manufacturing, and distribution.
- Companies can avail themselves of public financial incentives to help adopt beneficial technologies, and to encourage customers and suppliers to follow suit. Examples include the deployment of more efficient or renewable energy technologies, reduction of waste and emissions, and design of sustainable and resilient products and processes.
- To enable informed decision-making, companies should enhance their performance measurement and reporting schemes to capture the inherent interdependence among resilience, sustainability, and financial results. This may require adopting integrated metrics to account for co-benefits in resilience and sustainability.
- Companies are increasingly exposed to global forces of change outside of their control. Therefore, to mitigate physical and material financial risks and address the sustainability-resilience nexus will necessitate a systems-oriented view of product and process life cycles.
- As “business as usual” becomes less viable due to increased disaster-related risks, companies should encourage an anticipatory approach throughout their corporate cultures and workforce capacity building efforts. Specifically, they should educate cross-functional teams on how resilience and sustainability initiatives can yield measurable returns on investment.
- Companies should pursue forward-looking outreach toward their communities, customers, and business partners in order to anticipate and mitigate global threats. The “double materiality” approach mandated by the EU enables a broader recognition of shared challenges and responsibilities between companies and their stakeholders.
- To support effective management of risks and opportunities, industry associations should continue working with their members to develop new metrics, tools, and scientific protocols for quantifying business goals and trade-offs in an increasingly complex decision space.

Many of the above recommendations also apply to public sector organizations that are wrestling with the challenge of allocating resources to ensure both the sustainability and resilience of communities and nations. As described in Section 4, these entities are encouraged to promote cross-functional coordination and develop integrated approaches for policy and decision-making regarding economic, environmental, and public health and safety concerns. ARISE-US views this report as a first step toward the integrated management of resilience and sustainability. In collaboration with the UN and other partners, we are continuing to work on this key imperative, and we look forward to joining with other like-minded organizations across industry, government, civil society, and academia. The practical objective of these efforts is to help companies and the public sector achieve both sustainability and resilience goals, recognizing that they are often mutually reinforcing rather than conflicting priorities. The most successful organizations will be those that navigate this balance effectively, creating long-term value while preparing for an uncertain future.

Appendix A: Policy Frameworks for Sustainability and Resilience

This Appendix highlights several global and U.S. domestic frameworks and policies that address sustainability, resilience, or both. However, the agreements included here are not intended to be exhaustive. This summary is meant to provide a baseline of concepts and principles from which to build and implement sustainable and resilient projects and practices.

A1. Brief History of Sustainable Development

The World Commission on Environment and Development and its Chair, Gro Harlem Brundtland, are credited with developing and defining the term "sustainable development" in a 1987 Report entitled *Our Common Future*.[115] In 1992, a United Nations (UN) Conference on Environment and Sustainable Development (Rio Earth Summit)[116] was held in Rio de Janeiro, Brazil, with an associated "Agenda 21,"[117] which subsequently led to substantial policy development and implementation around sustainable development and sustainability.

In 2000, the UN, including the UN Department of Economic and Social Affairs (UN DESA), established eight Millennium Development Goals (MDGs)[118] to promote sustainable development. In 2012, the twentieth anniversary of the Rio Earth Summit (i.e., Rio+20) was held.[119] This Conference laid the groundwork for sustainability and related efforts for 2015 and beyond.

In 2015, the 2030 Agenda for Sustainable Development (2030 Agenda)[120] was adopted. The Sustainable Development Goals (SDGs)[121] comprise the core of this 2030 Agenda and supersede the MDGs. UN DESA continues to support the implementation of the SDGs and related thematic areas and partnerships.[122] The Rio Earth Summit also led to the development of the 1992 UN Framework Convention on Climate Change (UNFCCC).[123] The sustainability and climate change international agendas highlight the principle of "common but differentiated" responsibilities[124] between developed and developing nations. This means that developed and developing nations each have responsibilities to address climate change, but developed nations – given their responsibility for emitting the bulk of GHGs into the atmosphere – historically committed to more concrete emissions reduction actions. In addition, developed nations still are expected to assume greater financial responsibility to help developing countries mitigate and adapt to climate change impacts.

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[115] World Commission on Environment and Development. *Our Common Future (Brundtland Report).* 1987. https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html.
[116] UN. UN Conference on Environment and Sustainable Development (Rio Earth Summit). 1992. https://www.un.org/en/conferences/environment/rio1992.
[117] UN Department of Economic and Social Affairs (UN DESA). "Agenda 21." https://sdgs.un.org/publications/agenda21.
[118] UN. "News on Millennium Development Goals" (MDGs). https://www.un.org/millenniumgoals/.
[119] Sustainable Development Goals Knowledge Platform. "United Nations Conference on Sustainable Development, Rio+20." https://sustainabledevelopment.un.org/rio20; https://sdgs.un.org/.
[120] UN DESA – Sustainable Development. "Transforming our world: the 2030 Agenda for Sustainable Development." (2030 Agenda). https://sdgs.un.org/2030agenda.
[121] UN DESA – Sustainable Development. "The 17 Goals." https://sdgs.un.org/goals.
[122] Sustainable Development Goals Knowledge Platform. "United Nations Conference on Sustainable Development, Rio+20." https://sustainabledevelopment.un.org/rio20; https://sdgs.un.org/.
[123] UN Climate Change. "What is the UN Framework Convention on Climate Change?" (UNFCCC) https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change.
[124] UN. UNFCCC. 1992. https://unfccc.int/resource/docs/convkp/conveng.pdf.

A2. Highlights of Key Global Entities and Policy Frameworks

Individually and collectively, several UN entities and frameworks play important roles in guiding businesses, supply chains, and partners in improving their disaster risk management, while leveraging sustainability and resilience integration. The United Nations Office of Disaster Risk Reduction (UNDRR)[125] is the primary UN body for disaster risk management. It promotes resilience strengthening through "multi-hazard disaster risk management."

The UNDRR established the ARISE Network. ARISE-US also is working to enhance the understanding of disaster-related risk and reduce it, particularly by focusing on the need to more intentionally integrate sustainability and resilience. Central to UNDRR's work is the *Sendai Framework for Disaster Risk Reduction 2015-2030* (SFDRR or Sendai Framework).[126]

UNDRRR is leading a global partnership effort, Making Cities Resilient 2030 (MCR 2030),[127] that aims to help cities in their efforts to become more sustainable, resilient, and safe by 2030 – in line with the goals of the Sustainable Development Goals (SDGs), UN Habitat's New Urban Agenda (NUA),[128] Sendai Framework, Paris Agreement on Climate Change (Paris Agreement),[129] and others. MCR 2030 provides resilience roadmaps, data collection, monitoring, and other tools. Some of its partners include: UN-Habitat, the UN Development Program (UNDP), the Resilient Cities Network (RCN),[130] and the C40 Cities Initiative (C40),[131] elaborated on below. ARISE-US provides input and tools into this process.

The High-Level Political Forum on Sustainable Development[132] serves as the "central global platform" pertaining to implementation, follow-on, and review of the 2030 Agenda and the SDGs. The *Political Declaration of the High-Level Political Forum on Sustainable Development*,[133] stated that governments commit to enhancing sustainability and conservation, reducing disaster risk, and promoting resilience. Thus, this is a further step toward recognizing the importance of incorporating disaster risk reduction and resilience with sustainability, and can serve as yet another guide for entities to undertake their own such efforts.

The *Addis Ababa Action Agenda of the Third International Conference on Financing for Development*[134] provides a financing framework that sought to align financing and policy priorities in support of the implementation of the aforementioned 2030 Agenda and the SDGs.

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[125] United Nations Office of Disaster Risk Reduction (UNDRR). https://www.undrr.org/our-work/our-impact.
[126] UNDRR. *Sendai Framework for Disaster Risk Reduction 2015-2030* (SFDRR or Sendai Framework). https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030.
[127] Making Cities Resilient 2030 (MCR 2030). https://mcr2030.undrr.org/who-we-are.
[128] UN Habitat. "New Urban Agenda." https://unhabitat.org/about-us/new-urban-agenda.
[129] UN Climate Change. "The Paris Agreement." https://unfccc.int/process-and-meetings/the-paris-agreement.
[130] Resilient Cities Network (RCN). https://resilientcitiesnetwork.org.
[131] C40 Cities. "Our History." https://www.c40.org/about-c40/our-history/.
[132] UN Human Rights. Office of the High Commissioner. "High-Level Political Forum on Sustainable Development." https://www.ohchr.org/en/sdgs/high-level-political-forum-sustainable-development.
[133] UN General Assembly. "Political declaration of the high-level political forum on sustainable development convened under the auspices of the General Assembly. A/Res/78/1." September 29, 2023. https://documents.un.org/doc/undoc/gen/n23/306/65/pdf/n2330665.pdf.
[134] UN. *Addis Ababa Action Agenda of the Third International Conference on Financing for Development.* (Addis Ababa Action Agenda). 2015. https://sdgs.un.org/sites/default/files/publications/2051AAAA_Outcome.pdf.

The UN Habitat's NUA establishes policies, standards, and principles for the design, planning, development, and management of urban areas. It is synergistic with many global agreements, particularly the implementation and localization of the 2030 Agenda, and the achievement of the SDGs.

The UN Global Compact[135] is a non-binding UN pact that consists of Ten Principles.[136] It is designed to help businesses worldwide adopt more sustainable, resilient, and socially-responsible policies and principles, particularly the SDGs, and to report on their implementation.

These mechanisms are elaborated on below.

A2.1. Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework aims to achieve the "substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries."[137] It also aims to leverage global cooperation and increase financing, technology transfer, and build capacity (i.e., education, awareness, and tools) to facilitate greater understanding and better address disaster risk and the management thereof. It is supported by the UNDRR.

The Sendai Framework highlights four priorities for action to prevent and reduce disaster risks, including: (i) understanding disaster risk; (ii) strengthening governance to better manage disaster risk; (iii) investing in disaster reduction for resilience; and, (iv) enhancing disaster preparedness for effective response, and to build, or rebuild, in a more resilient manner (i.e., "build back better") with respect to recovery, rehabilitation, and reconstruction.[138] It also consists of seven targets[139] (see Figure A.1), 13 guiding principles, and 38 global indicators to measure progress.[140]

Its guiding principles that highlight sustainability and resilience can be summarized as follows:

- Develop, strengthen, and implement relevant policies, plans, practices, and mechanisms to facilitate coherence, as appropriate, across sustainable development and growth, food security, health and safety, climate change and variability, environmental management and disaster risk reduction agendas. Disaster risk reduction is essential to achieve sustainable development.
- Recognize national sovereignty.
- Acknowledge common but differentiated responsibilities, yet emphasize the importance of sustainable international cooperation.
- Share responsibilities between central Governments and relevant national authorities, sectors and stakeholders, as appropriate.
- Promote and protect human rights, including the right to development.

[135] UN Global Compact. https://www.unglobalcompact.org.
[136] UN Global Compact. "The Ten Principles of the UN Global Compact." https://unglobalcompact.org/what-is-gc/mission/principles. The principles are specified in the text herein. They are derived from: the *Universal Declaration of Human Rights*, the *International Labour Organization's Declaration on Fundamental Principles and Rights at Work*, the *Rio Declaration on Environment and Development*, and the *United Nations Convention Against Corruption*.
[137] UNDRR. "What is the Sendai Framework for Disaster Risk Reduction?" https://www.undrr.org/implementing-sendai-framework/what-sendai-framework.
[138] Ibid.
[139] Ibid.
[140] UNDRR. "Chart of the Sendai Framework for Disaster Risk Reduction 2015-2030." https://www.preventionweb.net/files/44983_sendaiframeworkchart.pdf.

- Adopt a "whole-of-society" approach to stakeholder engagement and leverage partnerships. Ensure coordination mechanisms exist within and across sectors and stakeholders, including the business sector. Fully engage institutions at all levels of government, while empowering local authorities and communities. Clearly articulate roles and responsibilities. Provide incentives, as appropriate.
- Empower and leverage human resources, ensure inclusivity, accessibility, and nondiscriminatory participation, paying special attention to people disproportionately affected by disasters, especially the poorest. Integrate gender, age, disability, and cultural perspectives into all policies and practices.
- Promote women's and youth leadership.
- Use a multi-hazard approach and inclusive risk-informed decision-making, based on the open exchange and dissemination of disaggregated data, including by sex, age and disability, as well as on easily-accessible, up-to-date, comprehensible, science-based, non-sensitive risk information, complemented by traditional knowledge.
- Understand the specific local disaster risk characteristics to better determine measures to reduce them, though drivers might be local, national, or regional; and address underlying disaster risk factors through disaster risk-informed public and private investments. Doing so proactively is more cost-effective and sustainable.

Figure A.1: The Seven Targets of the Sendai Framework

"The Ten Essentials for Making Cities Resilient" (Ten Essentials)[141] were established to operationalize and accelerate the Sendai Framework's implementation. They focus on initiating advocacy activities toward urban resilience. They map directly against the Sendai Framework's action priorities and its monitoring indicators. These are the critical steps that need to be undertaken to build and maintain resilience. They also are a key construct for the ARISE Global Network. The "Ten Essentials" are provided in Figure 3.1.

[141] UNDRR. Making Cities Resilient 2030 (MCR 2030). "The Ten Essentials for Making Cities Resilient." https://mcr2030.undrr.org/ten-essentials-making-cities-resilient.

A2.2. The Sustainable Development Goals (SDGs) and Related Frameworks

The SDGs are a set of 17 interconnected global goals comprising the core of the 2030 Agenda, adopted in 2015 (see Figure A.2 below). They address various social, economic, and environmental challenges, and promote more cross-sectoral, holistic, and sustainable development. They emphasize the importance of addressing current challenges, while ensuring the ability of future generations to meet their own needs. In so doing, the SDGs aim to foster a more resilient and sustainable future for all, demonstrating the interconnected nature of sustainability and resilience. The importance of recognizing the interlinkages with other UN agreements is featured prominently. Member States have agreed to implement the SDGs at the national level. The High-Level Political Forum tracks the extent to which countries are meeting their SDGs.

The SDGs reflect several shared principles and commitments that are foundational to sustainable development. Several of these also are reflected in the Sendai Framework's guiding principles, such as integrating holistic, cross-sectoral solutions and respecting and preserving national sovereignty, which, through this lens, emphasizes the importance of doing so along with sustainability. The sustainable development principles emphasize the need to sustainably manage and conserve natural resources and ecosystems while also sustainably developing and managing urban areas. They also emphasize the significance of promoting resilience and disaster risk reduction, and leveraging such efforts to enhance cooperation on desertification, land degradation, drought, and dust storms. Global agreements have been developed in the intervening years, for instance, on desertification,[142] emphasizing the critical need to address these topics and, given their interconnected nature with sustainability and resilience, the need to address these issues comprehensively. The SDGs are highlighted in Figure 3.2.

Several SDGs especially address resilience, particularly in the face of climate-related and other disasters. For example:[143]

- *Goal 1 (Ending Poverty):* Build the resilience of the poor and those in vulnerable situations. Reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.
- *Goal 2 (Eradicating Hunger):* Ensure food security and promote sustainable agriculture practices that enhance resilience to climate shocks.
- *Goal 9 (Infrastructure):* Build resilient infrastructure, promote sustainable industrialization, and foster innovation.
- *Goal 11 (Sustainable Cities):* Make cities and human settlements inclusive, safe, resilient and sustainable. Strengthen resilience to reduce disaster risk and increase sustainability in cities and human settlements to save lives and decrease economic losses through integrated policies and plans seeking inclusion, resource efficiency, mitigation and adaptation to climate change, and resilience to disasters; and develop and implement holistic disaster risk management at all levels, in line with the Sendai Framework.

[142] UN Convention to Combat Desertification. "Convention Overview." www.unccd.int/convention/overview.
[143] UN DESA – Sustainable Development. "The 17 Goals." https://sdgs.un.org/goals.

- *Goal 13 (Climate Action):* Take urgent action to mitigate and adapt to climate change and its impacts by strengthening resilience and adaptive capacity to climate-related hazards and natural disasters.
- *Goal 14 (Marine Ecosystems):* Sustainably manage, protect, and restore marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their *resilience*.
- *Goal 15 (Terrestrial Ecosystems):* Focus on conservation and sustainable use of terrestrial ecosystems, which contributes to ecosystem resilience.

Connections Between Different Types of Hazards and Associated SDGs

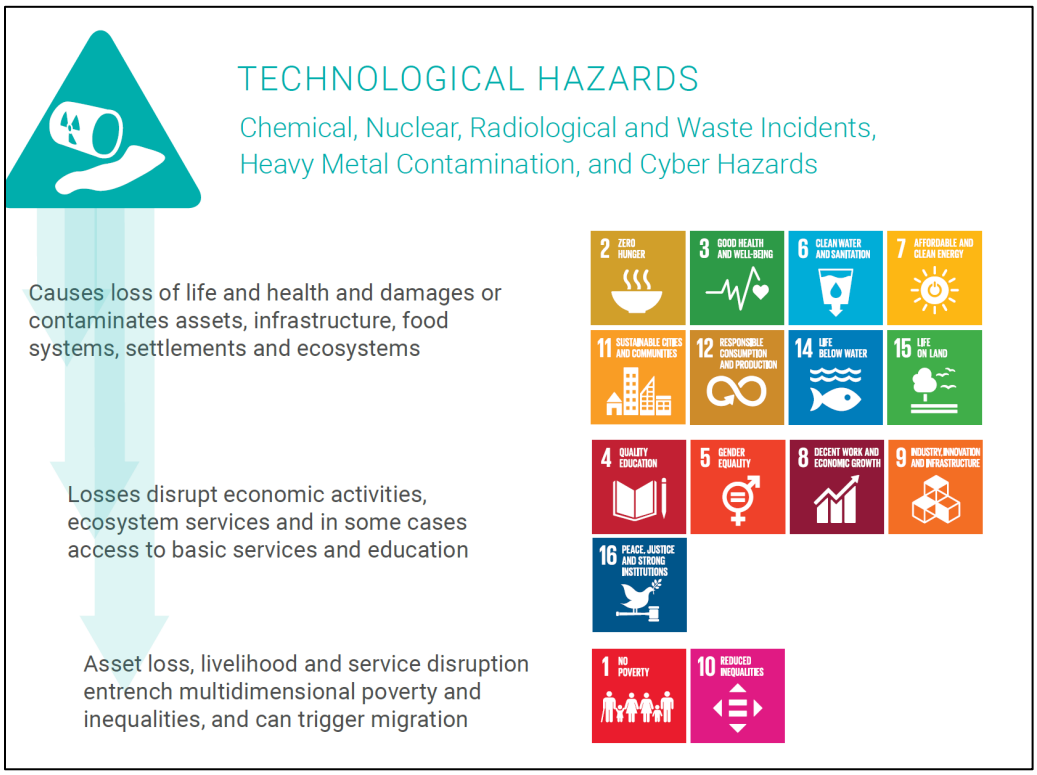
The UNDRR also has issued *Guidance* entitled *Disaster Risk Reduction and Climate Change Adaptation in the UN Sustainable Development Cooperation Framework: Guidance Note on Using Climate and Risk Management to Help Build Resilient Societies* on the linkages between natural, biological, technological, and slow-onset, climate-related hazards with sustainability, including specific SDGs, and resilience (see Figure A.2 below for an illustration of the types of connections between natural hazards and associated SDGs).[144]

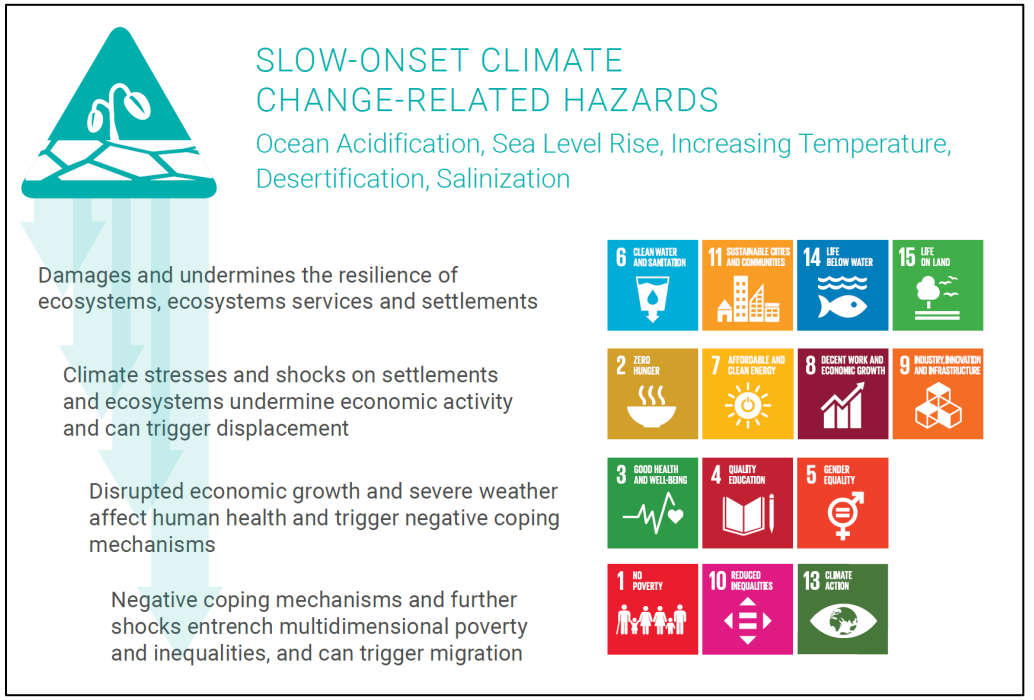
The *Guidance* contains a roadmap and list of actions to better integrate climate and disaster risk management with the SDGs. However, it does not necessarily recommend policies to enhance these linkages. Political and social-induced incidents are not included.

[144] UNDRR. "Disaster Risk Reduction and Climate Change Adaptation in the UN Sustainable Development Cooperation Framework: Guidance Note on Using Climate and Risk Management to Help Build Resilient Societies." July 2020. https://unsdg.un.org/sites/default/files/2020-08/Integrating-DRR-CCA-in-CFs-web.pdf.

Figure A.2: Connections Between Different Types of Hazards and the SDGs

Figure A.2 (Continued)





A2.3. United Nations Global Compact

The UN Global Compact is a non-binding UN pact designed to help businesses worldwide adopt more sustainable, resilient, and socially-responsible policies and principles, and to report on their implementation. It consists of the following Ten Principles.[145]

Human Rights:

- *Principle 1:* Businesses should support and respect the protection of internationally proclaimed human rights; and,
- *Principle 2:* Ensure that they are not complicit in human rights abuses.

Labor:

- *Principle 3:* Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;
- *Principle 4:* The elimination of all forms of forced and compulsory labor;
- *Principle 5:* The effective abolition of child labor; and,
- *Principle 6:* The elimination of discrimination in respect of employment and occupation.

Environment:

- *Principle 7:* Businesses should support a precautionary approach to environmental challenges;
- *Principle 8:* Undertake initiatives to promote greater environmental responsibility; and,
- *Principle 9:* Encourage the development and diffusion of environmentally-friendly technologies.

Anti-Corruption:

- *Principle 10:* Businesses should work against corruption in all its forms, including extortion and bribery.

A2.4. New Urban Agenda

The UN-Habitat-led NUA represents a shared vision for a better, and more equitable and sustainable future, in which "all people have equal rights and access to the benefits and opportunities that cities can offer, and in which the international community reconsiders the urban systems and physical form of our urban spaces"[146] as sources of solutions, rather than solely as challenges. The NUA establishes policies, standards, and principles for the design, planning, construction, development, management, and improvement of urban areas, including with respect to municipal financing, where applicable. It does so across its five main pillars of implementation:

- National urban policies;
- Urban legislation and regulations;
- Urban planning and design;
- Local economy and municipal finance; and,
- Local implementation.

The NUA serves as a "resource for every level of government, from national to local; for civil society organizations; the private sector; constituent groups; and for all who call the urban spaces of the world

[145] UN Global Compact. "The Ten Principles of the UN Global Compact." https://unglobalcompact.org/what-is-gc/mission/principles.
[146] UN Habitat. "New Urban Agenda." https://unhabitat.org/sites/default/files/2019/05/nua-english.pdf.

`home' to realize this vision."[147] It "incorporates a new recognition of the correlation between good urbanization and development," e.g., "job creation, livelihood opportunities, and improved quality of life, which should be included in every urban renewal policy and strategy."[148] The NUA also highlights the connection between it and multiple global agreements, particularly the implementation and localization of the 2030 Agenda, and the achievement of the SDGs, especially Goal 11 of making cities and human settlements inclusive, safe, resilient, and sustainable.

Below are some of the guiding Principles and Commitments that highlight the interconnected nature between sustainability and resilience in this framework. The entities involved include UN-Habitat and a range of additional UN organizations; UN Member Nations; International Organizations; and many other stakeholder groups.

NUA Principles Highlighting Sustainability and Resilience

The NUA seeks to facilitate and enhance sustainable urban development in an integrated and coordinated manner at the global, regional, national, subnational, and local levels, with participation from all relevant actors, incorporating the following principles:

- End poverty;
- Facilitate greater inclusivity, and ensure safe and equal access to physical and social infrastructure and basic services, as well as adequate and affordable housing;
- Protect human rights, socioeconomic opportunities, cultural diversity, and integration into urban spaces;
- Enhance livability, education, food security and nutrition, health and well-being, (e.g., end the HIV-AIDS, tuberculosis, and malaria epidemics);
- Eliminate discrimination and all forms of violence;
- Promote secure land tenure;
- Expand clean energy resource deployment and improve sustainable resource and land management practices; and,
- Build urban resilience by reducing disaster risks and by mitigating and adapting to climate change.

NUA Commitments Highlighting Sustainability and Resilience

Following are NUA commitments that also highlight the interconnected nature of sustainability, resilience, and climate in this Agreement, including by referencing other Agreements.

- Promote an enabling, fair, responsible, sustainable, and inclusive business environment; and support micro-, small-, and medium-sized enterprises and cooperatives throughout the value chain, especially businesses and enterprises in the social and solidarity economy operating in both the formal and informal economies.
- Strengthen the resilience of cities and human settlements, including through the development of quality infrastructure and spatial planning, to reduce the risks and impacts of disasters. This goal can be achieved by adopting and implementing integrated, age- and gender-responsive policies and plans, and ecosystem-based approaches, in line with the Sendai Framework. Such efforts also will consist of mainstreaming holistic and data-informed disaster risk reduction and management at all levels of government in coordination with relevant stakeholders to reduce vulnerabilities and risk, especially in risk-prone areas of formal and informal settlements,

[147] Ibid.
[148] Ibid.

including slums. Doing so will enable households, communities, institutions, and services to prepare for, respond, adapt to, and rapidly recover from the effects of hazards, including shocks or latent stresses.

- Move from reactive to more proactive risk-based, all-hazards, and all-of-society approaches, such as raising public awareness of risks and promoting ex-ante investments to prevent risks and build resilience, while also ensuring timely and effective local responses to address the immediate needs of inhabitants affected by natural and human-made disasters and conflicts.
- Integrate "build back better" principles into post-disaster recovery and future resilient infrastructure planning processes with disaster-related design and related best practices to mitigate future risks.
- Advance international, national, subnational and local climate actions, including climate change adaptation and mitigation, and support the efforts of cities and human settlements, their inhabitants, and all local stakeholders.
- Ensure infrastructure resilience and greenhouse gas (GHG) emission reductions from all relevant sectors occurs in a manner that is consistent with the goals of the Paris Agreement adopted under the *United Nations Framework Convention on Climate Change* (UNFCCC), including holding the increase in the global average temperature to well below 2 degrees Celsius (with the aim of limiting the increase to 1.5 degrees C) above preindustrial levels.
- Support medium- to long-term adaptation planning processes and city-level assessments of climate vulnerabilities and impacts to inform adaptation plans, policies, programs, and actions that build the resilience of urban inhabitants, including through the use of ecosystem-based adaptation.

A2.5. Addis Ababa Action Agenda of the Third International Conference on Financing for Development

The *Addis Ababa Action Agenda* provides a financing framework that seeks to align financing and policy priorities in support of the implementation of the aforementioned 2030 Agenda and the SDGs. It came to fruition in 2015 and commits to investing in efforts to strengthen local and national capacity to manage and finance disaster risk as part of national sustainable development strategies, and to ensure that countries can draw on international assistance when needed. In doing so, it encourages consideration of climate and disaster resilience in development financing to ensure sustainable results.

A2.6. UN Framework Convention on Climate Change and Its Paris Agreement

United Nations Framework Convention on Climate Change

The 1992 UNFCCC aims to stabilize GHG concentrations in the atmosphere to prevent dangerous human interference with the climate system. It recognizes the differences between developed and developing countries in terms of contributions to GHG emissions, their abilities to mitigate these emissions, and the need to adapt to climate impacts.

Paris Agreement on Climate Change

The 2015 Paris Agreement is a mechanism designed to help implement – and arose out of – the UNFCCC. The Paris Agreement seeks to bring developed and developing nations together under one framework. It primarily emphasizes the importance of mitigating greenhouse gas (GHG) emissions to prevent the worst anticipated effects of climate change. It also aims to enhance the ability of societies and ecosystems to adapt to inevitable climate impacts, and to enhance the resilience of infrastructure and communities, thereby promoting a more sustainable and inclusive future. It encourages technical and scientific support and coordination, technology transfer, and capacity building, especially to help developing countries. Countries develop and update Nationally Determined Commitments (NDCs) and National Adaptation Plans (NAPs).

Aspects of the Paris Agreement Highlighting Resilience and Adaptation

The Paris Agreement emphasizes the need for adaptation measures to reduce vulnerability and foster resilience to protect against the projected impacts of climate change, particularly for vulnerable communities and ecosystems, and to do so "in a manner that does not threaten food production." It aims to make "finance flows consistent with a pathway towards low GHG emissions and climate-resilient development" (Article 2).[149]

The Paris Agreement establishes a "global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development." Parties, as appropriate, agreed to undertake the development and implementation of national adaptation plans, and to prioritize, monitor, and evaluate such plans, and associated policies, programs, and actions. Parties agreed to build "the resilience of socioeconomic and ecological systems, including through economic diversification" and sustainable natural resource management. Technical and scientific support and coordination are encouraged (Article 7).[150] Technology transfer is important to enhance resilience and reduce GHG emissions (Article 10).[151]

Aspects of the Paris Agreement Highlighting Sustainability

The Paris Agreement encourages integrated approaches that consider the social, economic, and environmental dimensions of sustainability. In terms of climate mitigation more specifically, by setting targets to limit global temperature rise well below 2 degrees Celsius (and ideally to 1.5 degrees Celsius), the Paris Agreement aims to mitigate the most severe impacts of climate change (Article 2). This mitigation effort contributes to long-term sustainability by preserving ecosystems, biodiversity, and the well-being of present and future generations.

The Agreement notes that many actions to mitigate climate change (e.g., transitioning to renewable energy, improving energy efficiency, sustainable land use practices) also bring co-benefits for sustainable development, such as improved air quality, energy security, and economic opportunities.

Ways in Which the Paris Agreement Highlights the Sustainability-Resilience Nexus

The Paris Agreement promotes low-carbon and climate-resilient development strategies that align with the SDGs. Moreover, Article 8 acknowledges the importance of addressing *loss and damage* experienced

[149] UN. Paris Agreement. 2015. https://unfccc.int/sites/default/files/english_paris_agreement.pdf.
[150] Ibid.
[151] Ibid.

by vulnerable (i.e., least developed and small island/low-lying) countries that have contributed the least to climate change, yet are most affected by climate impacts and generally are least able to afford to address and adapt to these impacts.

It also recognizes the "role of sustainable development in reducing the risk of loss and damage," and the importance of resilient "communities, livelihoods and ecosystems." Cooperative technical assistance opportunities could include emergency preparedness, early warning systems, risk assessment and management, as well as insurance-related solutions (Article 8).[152]

Stemming from the Paris Agreement's mechanism to help manage loss and damage, a Fund for Responding to Loss and Damage (Fund) was established in 2022 and operationalized in 2023 at the international annual climate negotiations (i.e., COP 28).[153] The Fund promotes and supports climate infrastructure, community resilience, and sustainable development (including ecosystem protection and restoration) projects and initiatives for developing, low-lying, and vulnerable nations. Monitoring and evaluation are important components of these projects, as are transparency, and the use of community-based, data-driven approaches. The Fund seeks to leverage the private and not-for-profit sectors. Thus far, several countries and the European Union have made pledges to it.

Synergies with Other Global Frameworks

The UNFCCC and Paris Agreement promote sustainability and resilience, along with climate change mitigation and adaptation. They also seek to promote synergies with other international agreements, such as the Convention on Biological Diversity and the UN Convention to Combat Desertification, to achieve broader sustainability objectives.

A3. Highlights of Key United States Federal Laws

Several major U.S. laws, including program funding, that have been enacted in the past several years have increasingly focused on enhancing resilience and sustainability across various sectors. These laws collectively represent significant steps toward enhancing resilience and sustainability in the United States, addressing both immediate and long-term challenges posed by disasters and environmental degradation.

A3.1. Disaster Recovery Reform Act

The 2018 "Disaster Recovery Reform Act" (DRRA)[154] aims to incorporate a more proactive and preventive approach by enhancing infrastructure and disaster resilience. It also promotes a more sustainable and resilient approach to disaster recovery (i.e., building or rebuilding infrastructure more robustly following disasters). By integrating these principles into planning, funding, and implementation processes, the DRRA aims to foster stronger, more resilient communities that are much better equipped to withstand and recover from future disasters.

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[152] UN. Paris Agreement. 2015. https://unfccc.int/sites/default/files/english_paris_agreement.pdf.
[153] World Bank Group. "Fund for Responding to Loss and Damage." https://www.worldbank.org/en/programs/funding-for-loss-and-damage.
[154] Public Law 115-254. *Federal Aviation Administration Reauthorization Act of 2018,* Division D. October 5, 2018. https://www.congress.gov/bill/115th-congress/house-bill/302/text?q=%7B%22search%22%3A%5B%22HR+302%22%5D%7D&r=1.

Aspects of the DRRA Highlighting Resilience

The DRRA incorporates resilience as follows:

- *Pre-Disaster Preparedness*: The DRRA enhances FEMA's ability to support and promote a more comprehensive approach to disaster resilience and recovery. This includes an emphasis on risk reduction, focusing on both physical infrastructure improvements and community resilience-building activities. It encourages investments in pre-disaster mitigation activities to reduce risks and vulnerabilities in communities, i.e., to proactively enhance resilience.
    - *Incentives*: The DRRA provides incentives to states and localities to adopt more resilient and efficient building codes and standards.

Aspects of the DRRA Highlighting Sustainability

The DRRA incorporates sustainability, including:

- *Long-Term Recovery Planning*: States are to develop comprehensive, long-term recovery plans that integrate sustainability principles. These efforts include considering environmental impacts, promoting energy efficiency, and advancing clean energy and water infrastructure, where feasible.
- *Business and Community Engagement*: The Act encourages community engagement in pre-disaster and recovery planning processes to ensure that sustainability goals align with local citizen and business needs and priorities.
- *Funding:* Disaster recovery project funding prioritizes sustainability, such as renewable energy installations, efficient, smart, and resilient building practices, and natural ecosystem restoration.

Interconnections with Resilience and Sustainability

The DRRA highlights its linkages with resilience and sustainability in several ways:

- It recognizes that communities can reduce the risk of future disasters and minimize the environmental footprint of recovery efforts, by investing in resilient infrastructure and promoting sustainable recovery practices.
- It encourages collaboration across federal, state, and local governments to leverage resources and expertise to achieve resilience and sustainability objectives.
- It emphasizes the importance of adaptive management and continuous improvement in disaster recovery practices, ensuring that lessons learned from past disasters inform future resilience and sustainability efforts.

A3.2. Infrastructure Investment and Jobs Act

The 2021 "Infrastructure Investment and Jobs Act" (IIJA), or "Bipartisan Infrastructure Law,"[155] is one of two of the biggest laws in the past 50 years or more pertaining to clean energy and the environment. The IIJA: 1) creates, extends, or expands clean energy, transportation, and water infrastructure policies; and 2) provides more than $1 billion in funding over five years for such infrastructure projects. It also aims to enhance infrastructure resilience and promote sustainability (in the face of climate change),

[155] Public Law 117-58. "Infrastructure Investment and Jobs Act" (IIJA). November 15, 2021. https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.

including for underserved communities, while fostering economic growth. Relevant highlights from the second of these two major laws, the "Inflation Reduction Act,"[156] follow.
Examples of the types of programs and funding in the IIJA to improve the resilience of electric and water systems, and transportation infrastructure, and the sustainability of this infrastructure and the communities in which they are located include the following.

- *Climate Resilience:* The IIJA includes significant funding for projects that enhance resilience to climate change impacts. Such projects encompass improvements to infrastructure, such as roads, bridges, and water systems to withstand extreme weather events, including floods, hurricanes, and wildfires.
- *Natural Infrastructure:* This Law supports investments in natural infrastructure solutions, such as restoring wetlands, protecting coastal areas, and enhancing natural floodplains. These projects help mitigate the impacts of climate change by providing natural buffers against storms and floods.
- *Community Resilience:* Funding is allocated for community resilience initiatives, including measures to protect vulnerable communities from climate-related risks and to improve disaster preparedness and response capabilities.

A3.3. Inflation Reduction Act

The Inflation Reduction Act (IRA), passed in August 2022, is the second of two major clean energy, transportation, and resource management laws that have been enacted in the past several decades. It aims not only to address immediate environmental and climate challenges but also to build long-term resilience and sustainability in various sectors of the economy. The IRA primarily consists of extending and expanding tax incentives for renewable energy resources, residential and commercial energy efficiency, clean transportation, and electric vehicle charging infrastructure. The Law also aims to facilitate access for underserved communities through a range of tax and other financial incentives. It also encourages sustainable agriculture, water, and forestry management practices.

A3.4. James M. Inhofe National Defense Authorization Act for Fiscal Year 2023

As the Department of Defense (DOD) has long-recognized that climate change poses a threat to national security, i.e., is a "threat multiplier," the "James M. Inhofe National Defense Authorization Act for Fiscal Year 2023" (NDAA)[157] includes several provisions and funding aimed at improving resilience and sustainability across the DOD and its service branches, recognizing the importance of these issues for national security and operational effectiveness. Here are highlights from this Law:

- Enhancements to personnel and troop readiness and resilience (for example by adjusting training to account for extreme heat, wildfires, and drought).

[156] Public Law 117-169. "Inflation Reduction Act" (IRA). August 16, 2022. https://www.congress.gov/117/plaws/publ169/PLAW-117publ169.pdf.
[157] Public Law 117–263, as amended through Public Law 118–272. "James M. Inhofe National Defense Authorization Act for Fiscal Year 2023." The amended version was enacted on January 4, 2025. https://www.govinfo.gov/content/pkg/COMPS-17475/pdf/COMPS-17475.pdf.

- Provisions to enhance the resilience and sustainability of military installations, their infrastructure, and that of surrounding communities to climate change and extreme weather events;
- Promotion of energy efficiency and renewable energy projects for DOD and installations;
- Resource and waste conservation and management;
- Requirements that climate-related risks be incorporated into defense- and security-related planning and preparedness, operations, and so forth, including enhancing resilience, reliability, security, efficiency, and sustainability across all of these areas and efforts.
- A focus on environmental stewardship; resilient supply chains; and disaster response and preparedness.

A4. Community-Related Entities and Networks

A4.1. Resilient Cities Network (RCN)

The RCN (the successor to the Rockefeller Foundation's 100 Resilient Cities Initiative)[158] is a global network of cities dedicated to empowering these cities to build urban resilience and sustainability, and foster safer, healthier, and more prosperous urban environments for current and future generations. The RCN defines resilience as the capacity of cities to survive, adapt, and grow amid chronic stresses (e.g., poverty, unemployment, inadequate infrastructure) and acute shocks (e.g., natural disasters, pandemics). It serves as an excellent resource to help cities and other entities enhance their disaster risk preparedness and response, and resilience.

Focal areas include:

- *Climate Resilience:* Supports cities in mitigating and adapting to climate change impacts, such as sea-level rise, extreme weather events, and heatwaves.
- *Infrastructure and Services:* Enhances the resilience of critical infrastructure systems, including water supply, transportation, energy, and telecommunications.
- *Social and Economic Resilience:* Addresses socioeconomic disparities and vulnerabilities to build inclusive communities and promote economic stability.
- *Environmental Sustainability:* Promotes sustainable practices in urban planning, land use, waste management, and natural resource conservation.

Its *city resilience strategies* consist of:

- Collaboration with member cities to develop and implement comprehensive resilience strategies tailored to local challenges and opportunities.
- Pursuing sustainability principles to address climate change, promote sustainable urban development, and enhance environmental stewardship.

Its *policy advocacy* activities encompass:

- Advocacy for policies and investments that prioritize resilience and sustainability in urban development, infrastructure planning, and public policy.

[158] Resilient Cities Network (RCN). https://resilientcitiesnetwork.org.

- Engagement with national and international stakeholders to influence policies that support resilient and sustainable cities globally.

The RCN also emphasizes knowledge sharing and capacity building, including technical assistance and resources, such as sharing best practices for resilience and sustainability; public-private partnerships to leverage expertise to advance the SDGs and resilient outcomes; innovative financing mechanisms and strategies; and monitoring and evaluation.

A4.2. C40 Cities Initiative

C40 began in 2005, with leadership from former New York City Mayor Michael Bloomberg. The goal was to have the world's 40 leading cities implement ambitious climate goals and actions. C40 merged with President Bill Clinton's Climate Initiative (CCI) in 2011. In 2017, a C40 Women4Climate Program formed to enhance gender inclusivity in the climate discussion. In 2019, a C40 Global Youth Initiative was launched to add their presence. C40 has dramatically expanded over time, including to the Global South, with substantial investments and Leadership Standards, among other initiatives and engagement.

Appendix B: Tools & Methods — Deeper Dive

B1. Task Force on Climate-Related Financial Disclosures (TCFD)

As noted earlier, TCFD offers a comprehensive approach that addresses risks and opportunities related to resilience and sustainability. TCFD was established by the Financial Stability Board in 2015 to review how the financial sector should report climate-related information, and it was later extended to address all sectors. The TCFD framework identifies 17 specific areas of risk, as shown in Table B.1, and 20 specific areas of opportunity, as shown in Table B.2.[159]

Underpinning the identification of risks and opportunities in TCFD and CSRD is the concept of "double materiality," where something might be financially material *and* material in its impacts on people, society, and the environment ("impact materiality").[160] While it allows for gaps in a company's data, the CSRD effectively requires audit levels of attestation for any statements made (or omitted) on impact materiality.

Companies can use Tables B.1 and B.2 as checklists for sustainability and resilience-related issues. Some factors to consider:

Many larger companies are now (in some cases belatedly) carrying out double materiality assessments, often with the help of consultants or one of the "big four" accounting firms.

One company in the survey regularly performs its own double materiality analyses.

- Simply regarding TCFD as an administrative task would potentially miss a major opportunity. At a minimum, businesses should use this effort to catalyze thought about ways in which to improve process efficiencies, reduce waste and vehicle miles (or recycled for income), and more.
- Businesses can use TCFD to catalyze thinking through what new or changed products would be advantageous in a climate-changing world (where customer expectations may also be changing) – what new materials, new processes or entirely new items could be envisaged?
- TCFD offers an opportunity to think through a company's business continuity policies and positions. Are these fit for their purpose given the anticipated risks? What is the value of production that may be lost – and, thus, the foundation of the business case for investing in greater resilience?
- Going further still, a business might use the process to revisit its existing business strategy – what brand values and what market presence will it want to project, how will it compete and differentiate going forward, what new capabilities or market presence will it need to acquire, and what competitive advantage can be gained by being a more reliable supplier.
- Some Directives, such as the CSRD, that embodies the TCFD, require *integrated* reporting of metrics and targets, as well as coordination to create those reports coherently. Companies will need to assign overall responsibility for compliance—potentially a catalyst for organizational as well as strategic change.

[159] TCFD. *Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures.* https://www.fsb-tcfd.org/. For more on the IFRS Foundation and its standards, please see: https://www.ifrs.org/sustainability/tcfd/. Entries in both tables have been slightly paraphrased from the original. The risks and opportunities shown are not mutually exclusive – some overlap exists.

[160] European Union. "Commission Delegated Regulation (EU) 2023/2772, of 31 July 2023, supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards." Updated December 22, 2023. https://eur-lex.europa.eu/eli/reg_del/2023/2772/oj.

Table B.1: TCFD's Climate-Related Risks

Type of Risk	#	Climate-Related Risk	Potential Financial Impacts
Policy and Legal	1	Increased pricing of GHG s	Increased operating costs (compliance, insurance) Write-offs, asset impairments, early retirement of carbon-intensive assets Increased costs and/or reduced demand from fines and judgements
	2	Enhanced emissions-reporting obligations	
	3	Mandates and regulation of existing products & services	
	4	Exposure to litigation	
Technology	5	Low-carbon substitution of existing products & services	Write-offs and early retirement of existing assets Reduced demand for products and services R&D expense for new and alternative technologies Capital investment required Costs to adopt/deploy new processes
	6	Unsuccessful investment in new technologies	
	7	Upfront costs to transition to lower emissions technology	
Market	8	Changing customer behavior	Reduced demand due to shift consumer preferences Increased production costs due to changing input prices and output requirements Abrupt and unexpected shifts in energy costs Change in revenue mix and sources resulting in decreased revenues Re-pricing of assets (e.g., fossil fuel reserves)
	9	Uncertainty in market signals	
	10	Increased cost of raw materials	
Reputation	11	Shift in consumer preferences	Reduced revenue from decreased demand Reduced revenue from decreased production capacity (e.g., delayed planning approvals, supply chain interruptions) Reduced revenues from negative impacts on workforce management (e.g., employee attraction and retention) Reduction in capital availability
	12	Stigmatization of sector	
	13	Increased stakeholder concern or negative stakeholder feedback	
Physical: Acute and Chronic	14	Increased severity of extreme weather events such as cyclones and floods	Reduced revenue from decreased production capacity (e.g., transport, supply chain) Reduced revenue and higher costs from negative impacts on workforce Write-offs and early retirement of existing assets (e.g., in high risk locations) Increased operating costs (e.g., water supply) Increased capital costs (e.g., damage to facilities) Reduced revenues from lower sales/output Increased insurance premiums and potential for reduced availability of insurance
	15	Changes in precipitation patterns and extreme variability in weather patterns	
	16	Rising mean temperatures	
	17	Rising sea levels	

Table B.2: TCFD's Climate-Related Opportunities

Type of Opportunity	#	Climate-Related Opportunity	Potential Financial Impacts
Resource Efficiency	1	Use of more efficient modes of transport	Reduced operating costs (e.g., via efficiency gains and cost reduction) Increased capacity, resulting in increased revenues Increased value of fixed assets (e.g., highly-rated energy efficient buildings) Workforce benefits (e.g., improved health & safety, employee satisfaction)
	2	Use of more efficient production and distribution processes	
	3	Use of recycling	
	4	Move to more efficient buildings	
	5	Reduce water usage and consumption	
Energy Source	6	Use of lower emission sources of energy	Reduced operational costs (e.g., through use of lowest cost abatement) Reduced exposure to future fossil fuel price increases Reduced exposure to GHG emissions resulting in less sensitivity to changes in cost of carbon Returns on investments in low-emission technology Increased capital availability (e.g., as more investors favor lower-emissions producers) Reputational benefits resulting in increased demand for goods/services
	7	Use of supportive policy incentives	
	8	Use of new technologies	
	9	Participation in carbon market	
	10	Shift towards decentralized energy generation	
Products and Services	11	Development and/or expansion of low emission goods and services	Increased revenue through demand for lower emissions products and services Increased revenue through new solutions to adaptation needs (e.g., insurance risk transfer products and services) Better competitive position to reflect shifting consumer preference, resulting in increased revenue
	12	Development of climate adaptation and insurance risk solutions	
	13	Development of new products and services through R & D and innovation	
	14	Ability to diversify business activities	
	15	Shift in consumer preferences	
Markets	16	Access to new markets	Increased revenues through access to new and emerging markets... Increased diversification of financial assets (e.g., green bonds and infrastructure)
	17	Use of public sector incentives	
	18	Access to new assets and locations needing insurance coverage	

Type of Opportunity	#	Climate-Related Opportunity	Potential Financial Impacts
Resilience	19	Participation in renewable energy programs, energy efficiency measures	Increased market valuation through resilience planning (e.g., infrastructure, land, buildings) Increased reliability of supply chain and ability to operate under various conditions Increased revenue through new products and services related to ensuring resilience.
	20	Resource substitution and/or diversification	

B2. Performance Indicators and Metrics

As mentioned, it is important to understand the relationship between sustainability and resilience, rather than measuring and managing them separately. The findings of our survey suggest that most companies have some metrics for sustainability, but very few have established metrics for resilience, at least beyond statements required by regulators such as the SEC.

Table B.3 shows some examples of metrics that might help to promote an integrated approach to sustainability and resilience. There is nothing "wrong" with the separate sustainability and resilience metrics shown, but the "integrated" metrics address the important need for linking them together. Some additional factors to consider for performance indicators and metrics:

- The metrics should be the focus of regular Board and C-Suite attention - to encourage the company to take them seriously.
- As a corollary, some organizational unit needs to be formally tasked with compiling the metrics, and provided with the necessary data access and tools.
- The metrics should be visually appealing, and accessible through dashboards or map-based displays that enable drilling down into the underlying data.
- Dashboards should ideally acquire data from background systems automatically, without requiring additional manual input.
- If it is not yet possible to use integrated metrics, companies should at least report the sustainability and resilience metrics side by side, consider them together and show relative movement in both.

B3. Scenario Analysis

Both TCFD and the CSRD which embodies it make specific reference to Scenario Analysis[161] as a strategic tool for assessing the business implications of climate change, framing strategies to deal with these and explaining them to stakeholders (customers, suppliers, employees, regulators, communities).

Specifically, a scenario is a plausible set of hypothetical future outcomes based on a defined set of starting assumptions about driving forces. For example, one hypothesized of outcomes might be a world that follows the IPCC's Representative Concentration Pathway (RCP) 4.5, which would lead to a mean

[161] See for example: TCFD. "The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities." https://www.tcfdhub.org/scenario-analysis/.

warming of 1.7^{O}C by the year 2050 and 2.5^{O}C by 2100.[162] If a company took this as a scenario, it would then ask itself, for example:

- How might customer behaviors and expectations change based on the products or services that it supplies?
- What increased physical risks could be expected at each of its locations - sea level rise, storms, wildfires, heat, water shortage, etc. – and what effect would these have?[163]
- What increased geopolitical risks will there be in each location?
- What resource shortages can be expected including land, energy, water, raw materials, and skilled labor?
- What impacts could be expected in the supply chain – particularly for "single point of failure" suppliers?
- What pressures on the company's finances would there be - impacts on revenues, EBITDA, profits, insurance costs, cost of capital?
- What are the brand and PR implications of not being seen to respond adequately?
- What opportunities may arise for improved products, market traction, efficiency?
- Which of the risks and opportunities above are considered “material”? Tables B.1 and B.2 provide a more complete list of risks and opportunities to consider.

[162] Intergovernmental Panel on Climate Change (IPCC). Summary for Policymakers. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press. 2019. https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/03_SROCC_SPM_FINAL.pdf.

[163] While not linked to IPCC scenarios per se, there are increasing numbers of high-quality data sets publicly available for assessing physical risks of different kinds. Examples include FEMA's National Risk Index, which assesses risk and capacity to respond by zip code or census tract; and, World Resources Institute’s water stress, flood risk, and food security analysis tools. More are provided by TCFD. Op. cit.

Table B.3: Possible Examples of Integrated Sustainability and Resilience Metrics

Subject Area	Sustainability Metrics	Resilience Metrics	Integrated Metrics
Compliance	Completion of TCFD (or similar framework) in all sustainability categories	Completion of framework for all risk categories	Integration of sustainability and resilience in projected scenarios
Supply chain	Supplier sustainability rating (e.g., reduced waste, energy use)	Supplier risk rating (e.g., political risk, history of disruptions)	Supply chain ratings for all factors, including climate, and physical risks[164]
	Supplier efficiency and environmental footprint	Diversified supply base, availability of alternative sources	Supplier diversification with efficiency improvements
Risk	Brand (or stock) value at risk due to sustainability	Probability x lost value for a specific disruption	Combined risk from sustainability & resilience
Investment	Sustainability Return on Investment (SROI)[165]	Resilience Return on Investment (RROI)[166]	Portfolio ROI including all sustainability and/or resilience projects
Climate	(See right)	(See right)	Carbon Resilience Index: sustainability and risk scores[167]

Alternatively, a company may choose to base its scenarios on different imagined social outcomes – around population growth, for example, where climate is one of the underlying factors. It is important to identify the opportunities that may arise as well as the risks. As the company creates its scenarios, it can then start to assess the resiliency of its existing strategy to these impacts, and consider possible interventions to adapt to, or mitigate adverse impacts and capitalize on potential opportunities.

These interventions may include climate mitigation, or at least harm reduction actions such as more sustainable sources of supply and perhaps reformulating products to use these; or they may include actions focused directly on adaptation and resilience, such as building hardening, duplicating suppliers and increasing buffer stocks. As already noted, trade-offs between sustainability and resilience-focused actions will likely abound. Some methodologies for dealing with these trade-offs are set forth below.

Following are additional points to consider in the use of scenarios:[168]

- Scenarios should challenge conventional wisdom about the future. With climate change, "business as usual" is inadequate – scenarios can help companies assess how they must change.
- Scenarios should provide just enough detail to portray the key factors hypothesized.

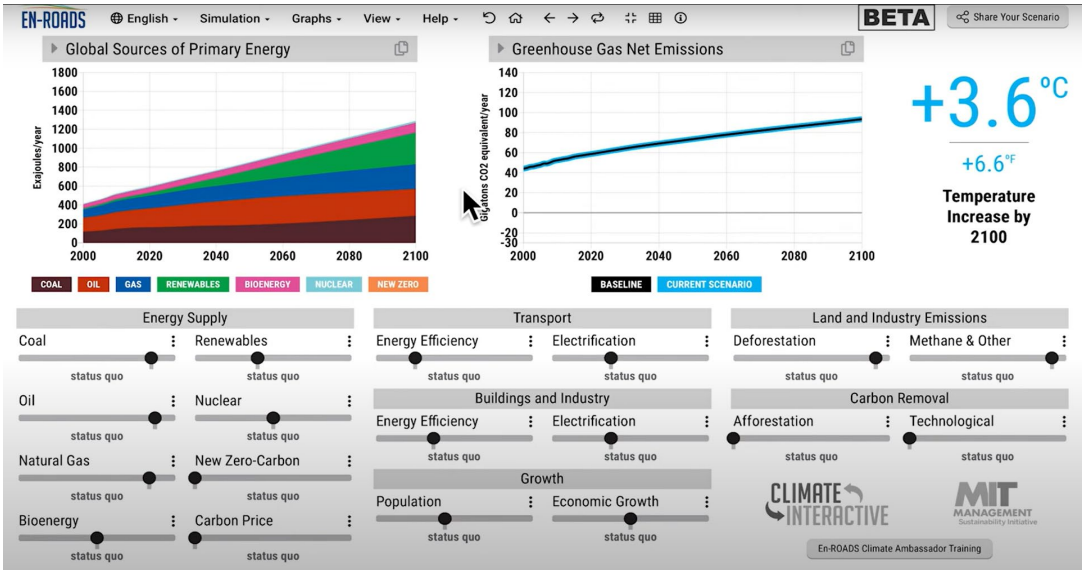
[164] There are numerous pre-defined rating schema. See for example: Bureau Veritas, Ecovadis, or Resilinc.
[165] See for example: The Wall Street Journal. "Trouble Seeing Sustainability's Business Value? Calculate Its ROI." https://deloitte.wsj.com/cfo/trouble-seeing-sustainabilitys-business-value-calculate-its-roi-44972e08.
[166] See for example: Disaster Recovery Journal. "The ROI of Resilience: Building Your Case." April 4, 2024. https://drj.com/webinars_main/april-4-2024-the-roi-of-resilience-building-your-business-case/.
[167] There are several carbon resilience indices. For example: Transition Pathways Initiative (TPI), FTSE Russell TPI Climate Transition Index, and CDP Climate Change A List.
[168] This Section is based substantially on the TCFD. Op. cit.

- Scenarios are not forecasts or predictions.
- Scenarios should be distinct from each other, by focusing not just on different levels of outcome (for example different IPCC RCPs), but also on different combinations of factors that are affected.
- Scenarios should have strong internal consistency in exploring how factors interact.
- Scenarios and logic should be documented to support explanation and disclosure requirements.
- Scenarios may be qualitative, especially for companies using them for the first time. With growing expertise, quantitative analysis can be added, for example in assessing the financial implications of different response pathways.
- To support strategic decision-making, companies can develop dynamic simulation models and/or use adaptation pathways to project financial and external impacts of each scenario. (See below).

B4. System Dynamics Simulation

As mentioned earlier, simulation methods can be used to explore the implications of future scenarios under a variety of different assumptions. In particular, the system dynamics approach, developed at MIT, enables modeling of systems with dynamic feedback loops. One widely used tool from MIT is En-ROADS (Energy-Rapid Overview and Decision-Support), a powerful climate simulation model developed by Climate Interactive, the MIT Sloan Sustainability Initiative, and Ventana Systems.[169] As shown in Figure B.1, the model allows users to explore the impact of various policies and actions (e.g., carbon pricing, renewable energy adoption, and deforestation reduction) on climate-related outcomes (e.g., energy prices, temperatures, air quality, and sea level rise).

Figure B.1: Example of En-ROADS Interactive Display

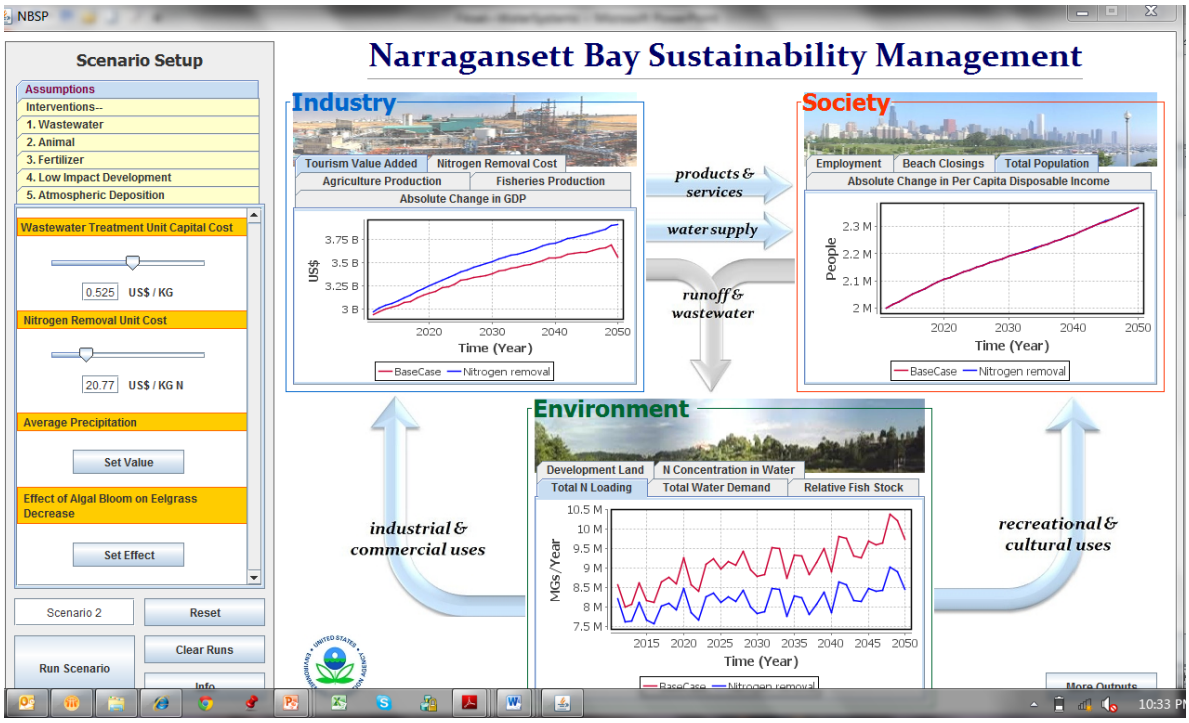


The U.S. EPA applied a similar approach at a regional scale in the Narragansett Bay watershed, where challenges such as nitrogen runoff from farms and wastewater plants threaten the viability of the fishing and tourism industries.[170] EPA convened stakeholders, including local governments, companies, and

[169] Climate Interactive. "The En-ROADS Climate Solutions Simulator." https://www.climateinteractive.org/en-roads/.
[170] Fiksel, J., et. al. "The Triple Value Model: A Systems Approach to Sustainable Solutions." Clean Technologies and Environmental Policy. Volume 16, Issue 4. Pages 691-702. 2014.

researchers to help develop a system dynamics model based on the generic Triple Value Framework (see Figure 2.1). Figure B.2 shows the interface that allows users to define various policies and assess the environmental, industrial, and societal outcomes, including both sustainability and resilience.

Figure B.2: User Interface for EPA's "Triple Value" Model



B5. Real Options Analysis

Real options analysis (ROA) is a quantitative technique for assessing the economic benefit of the flexibility, given the uncertainty around future scenarios influenced by climate change, sea level rise, and other disruptive forces. For example, it can be utilized to support the adaptation pathways[171,172] approach discussed in B.6 below.

ROA improves upon traditional cost-benefit analysis (CBA) which might otherwise be used to justify mitigation or adaptation actions.[173,174,175] In CBA, future cashflows discounted to their present value are estimated at the start of the program, reflecting an implicit "all or nothing" assumption. By contrast, ROA builds on traditional CBA by calculating the value of opportunities ("real options") to change the investment trajectory in response to future events. In the context of this report, such opportunities might include options to switch between adaptation pathways, which may involve abandoning or

[171] Liu, Jamie, and P. Krans. "An economic approach to investing in climate adaptation." ICF. September 22, 2021. https://www.icf.com/insights/environment/real-options-analysis-climate-resilience-investment.
[172] Martello, M.V., et. al. "Real Options analysis for valuation of climate adaptation pathways with application to transit infrastructure." Wiley On-Line Library, Volume 44, Issue 5. Pages 1046-1066. May 2024. https://onlinelibrary.wiley.com/doi/full/10.1111/risa.14218.
[173] Liu and Krans. Op. cit.
[174] Martello, et. al. Op. Cit.
[175] Buurman and Babovic. Op. cit.

delaying, expanding or advancing, or substituting spending (see Table B.2 above). The value of this flexibility would then be expressed as reduced risk of misapplying funds, and in levels of risk reduction achieved for the amount projected to be spent.

Points to consider when contemplating the use of ROA include the following:

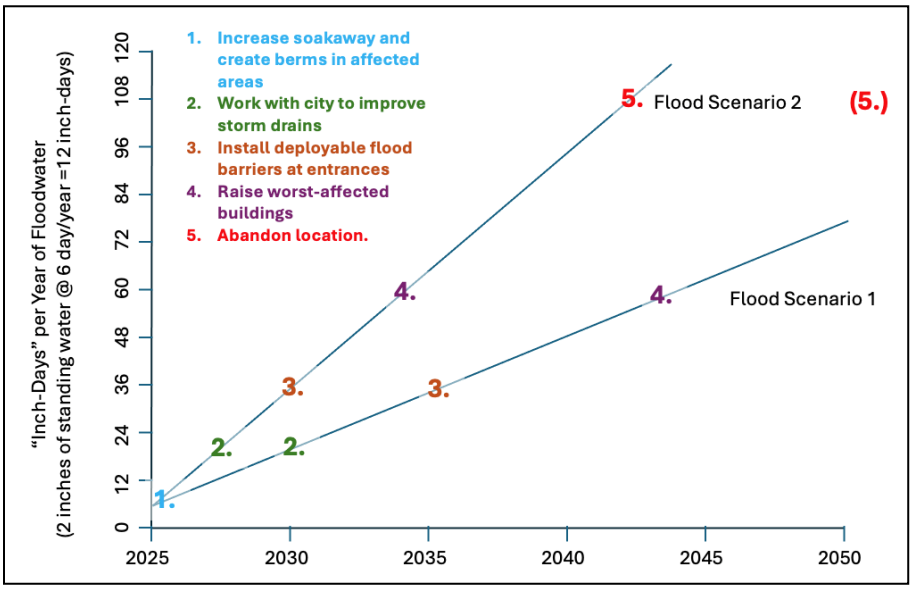
- ROA is more complex and can be computationally very intensive if, for example, Monte Carlo simulation of possible outcomes is used.
- ROA assumes that probabilities can be assigned to all possible future events, but it cannot account for unpredictable or inconceivable "black swan" risks.

B6. Adaptation Pathways

Adaptation pathways are sequenced programs of alternative actions that can be implemented as the impacts of climate change unfold and as new challenges emerge.[176] Pathways may include actions that can be implemented now with "no or low regrets;"[177] and they may identify specific thresholds where the "next" action would be triggered. The approach is usually applied at the societal or governmental level (or for specific pieces of infrastructure), and when linked to scenarios it can structure and inform corporate decision-making as well.

Figure B.3 below gives an example of an industrial site in a flood-prone location, perhaps with pluvial and tidal flooding due to climate change. The company defines two scenarios for how the flooding intensity might unfold up to 2050, and then creates an escalating "menu" of possible adaptive actions with thresholds over time at which these actions might be taken. Thresholds are expressed as "inch days per year" of flooding where 2 inches of standing water over 6 days per year equates to 12 inch-days. (Inch-days could be indexed to lost production, clean-up expenses, stormwater fees and so on, to derive a financial cost). It might then lay out its adaptive actions as shown in Figure B.3.

Figure B.3: Hypothetical Example of Adaptation Pathway: Flood-Prone Production Site



[176] Werners, Saskia, et. al. Op Cit.
[177] Ibid.

Option 1 is a "no-regret" action that should happen anyhow; and option 5 never actually arrives in Flood Scenario 1. Note that options 1 and 2 can also be considered as improvements in sustainability (in the case of 2, when coupled with better storm water retention), whereas options 3, 4, and 5 are focused on resilience alone. This allows the company to begin with sustainable options and only then, if circumstances require it, switching to a resilience focus *per se*, by which time any adverse environmental impact of the resilience actions may have been reduced through new materials or techniques. With this approach, the company can manage uncertainty by monitoring how flood risk is unfolding over time and switching between pathways as needed.

Factors to consider when using adaptation pathways include the following:

- As stated above, the adaptation pathways methodology works well when combined with scenario development.
- Pathways can be as high level or as detailed as required. The above example relates to a specific production location, but one could as easily envisage applying it, for example, to a company's product roadmap, based on possible evolutions in customer sentiment towards sustainability or possible future supply chain difficulties.
- Companies may want to work with cities where they are based to understand (or partner with the city to create) potential adaptation pathways for key infrastructure, land zoning and so on to understand the implications for them.

KEY ACRONYMS

AIA - American Institute of Architects
ARISE-US – ARISE is the Private Sector Alliance for Disaster Resilient Societies; this is the United States' Network of ARISE, led by the UN Office for Disaster Risk Reduction (UNDRR)
ASTM International - American Society for Testing and Materials

BSR - Business for Social Responsibility

CBA - Cost Benefit Analysis
CBRA - Cost/Benefit/Risk Analysis
CSO - Chief Sustainability Officer
CSRD - Corporate Sustainability Reporting Directive (European Union)

DRR - Disaster Risk Reduction
DRRA - Disaster Recovery Reform Act

ESG - Environmental, Social, and Governance
EU - European Union

FEMA - Federal Emergency Management Agency

GAR - Global Assessment of Risk (UNDRR)
GEMI - Global Environmental Management Initiative
GHG - Greenhouse Gas

HLPF - High Level Political Forum (UN)

IDMC - International Displacement Monitoring Center
IFI - International Financial Institution
IFRS - International Financial Reporting Standards Foundation
IIGCC - Institutional Investors' Group on Climate Change
IIJA - Infrastructure Investment and Jobs Act
IOM - International Organization on Migration
IPCC - Intergovernmental Panel on Climate Change
IRA - Inflation Reduction Act
ISO - International Standards Organization

LCA - Life Cycle Analysis
LCCA - Life Cycle Cost Analysis
LCEA - Life Cycle Environmental Assessment
LCRA – Life Cycle Resilience Assessment
MCR 2030 - Making Cities Resilient 2030

MDG - Millenium Development Goal

NAP - National Adaptation Plan (Paris Agreement)
NDAA - National Defense Authorization Act
NFIP - National Flood Insurance Program (FEMA)
NGO – Non-Governmental Organization
NIBS - National Institute of Building Science
NUA - New Urban Agenda (UN Habitat)

PCRAM - Physical Climate Resilience Assessment Methodology
PDD - Platform on Disaster Displacement
RCN - Resilient Cities Network
RCP - Representative Concentration Pathway (IPCC)
ROA - Real Options Analysis
RROI - Resilience Return on Investment

SCRAM - Supply Chain Resilience Assessment and Management
SDG - Sustainable Development Goal
SEM - Stakeholder Engagement Mechanism (UNDRR)
SROI - Sustainability Return on Investment

TCFD - Task Force on Climate-Related Financial Disclosures
TNFD - Task Force on Nature-Related Financial Disclosures

UN - United Nations
UNDRR - UN Office for Disaster Risk Reduction
UNDESA - UN Department of Economic and Social Affairs
UNDP - UN Development Programme
UNEP - UN Environment Programme
UNFCCC - UN Framework Convention on Climate Change
UNOPS - UN Office for Project Services
US DOD - US Department of Defense
US EPA - US Environmental Protection Agency

WBCSD - World Business Council on Sustainable Development
WRI - World Resources Institute